Oxfordshire Rail Corridor Study

How can the rail system in Oxfordshire best support economic growth?



Department for Transport

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ENGLAND'S ECONOMIC HEARTLAND

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Oxfordshire Rail Corridor Study

Strategic Report

How can the rail system in Oxfordshire best support economic growth?

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The Oxfordshire Rail Corridor Study in the context of the COVID-19 pandemic

The Oxfordshire Rail Corridor Study (ORCS) was undertaken between March 2019 and January 2020 before the onset of COVID-19, and the impacts of the subsequent pandemic are not factored into the study's analysis or recommendations.

The pandemic has had, and will continue to have, a major economic impact, and major impacts on rail demand, in the short term at least. That said, the study concerns supporting planned growth over a much longer period and local planning policy has not changed. The site allocations and targets for housing and employment growth in Oxfordshire that underpin the study remain valid. The economic, social, and environmental drivers which dictate that improved rail services are required to support growth also remain valid, and reinforce the ability of rail to reinvigorate regional economic growth.

The COVID pandemic led to a significant drop in rail passenger numbers as the public followed Government advice to avoid use of public transport during 2020, including rail, although demand is expected to return as the pandemic passes. Whilst there may be a longer-term impact and a change in travel patterns, mobility will remain central to social and economic activity, and rail will retain a crucial role in provision of mass mobility, and in facilitating the establishment of new housing and employment hubs and the connectivity between these. It will also be central to meeting the Governments zero-carbon targets by 2050 through modal shift and providing a cleaner, greener mode of travel.

Demand for rail freight did not decline to anything like the extent of passenger demand and has already recovered. The role and value of rail freight for mass distribution and logistics has become more prominent during the pandemic. Catering for construction traffic, which is a major role of this corridor, will be increasingly important to the agenda of building back better. This further strengthens the need for this strategic freight corridor to accommodate rail freight growth.

Current governmental guidance on considering the impacts of COVID-19 concerns the development and appraisal of business cases, rather than long-term strategic planning, of which ORCS is an example. The business case development arising from ORCS is following and will continue to follow the latest government guidance and consider a range of sensitivities to reflect the most current analysis on rail demand for both passenger and freight markets. Therefore, the conclusions and strategic recommendations of the Oxfordshire Rail Corridor Study remain valid as a basis for long term planning and development of business cases for further investment.

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Oxfordshire Rail Corridor Study

How can the rail system in Oxfordshire best support economic growth?

1. Executive summary

Oxfordshire is one of the most productive economic regions in the United Kingdom with uniquely high growth forecast over the next fifteen years as a result of the growth identified in existing and emerging Local Plans, supported by the Housing and Growth Deal agreed with government. Housing and employment growth must be supported by a transformation in transport infrastructure. Oxfordshire's rail system – which functions as a strategic hub for local and national services – has accommodated significant growth in the last ten years but has little further capacity and does not link important hubs within Oxfordshire.

The Oxfordshire Rail Corridor Study assesses the impacts of planned growth on Oxfordshire's rail system and identifies the role the system can play to support growth. It delivers four key outputs that build sequentially to describe the future role of rail in supporting Oxfordshire's growth:

- The Oxfordshire Planned Growth Scenario (OPGS) – short, medium, and long-term forecasts of Oxfordshire's rail markets forming an evidence-based mandate for improvements
- Conditional Outputs for Oxfordshire's Rail System – a set of objective, quantitative statements of the rail outputs required to support the OPGS
- Oxfordshire Train Service Specifications – a recommended suite of industry-aligned and endorsed proposals for train services that deliver the Conditional Outputs
- Oxfordshire Rail System Interventions – a prioritised list of the system enhancements required to deliver the Oxfordshire Train Service Specifications

The housing growth already committed in Oxfordshire is delivering population and employment increases well above the national average. The Oxfordshire Planned Growth Scenario converts this growth into locally sensitive rail demand forecasts that reflect the precise pattern and scale of growth. These show that demand for rail in Oxfordshire will increase significantly more than would otherwise have been forecast.

There are seven growth hubs in the Oxfordshire rail system: Banbury, Bicester Village, Culham, Didcot Parkway, Hanborough, Oxford, and Oxford Parkway. This study assesses how Oxfordshire's rail system can support growth at these hubs. The market for rail freight in Oxfordshire is also forecast to grow and Oxfordshire's rail system will continue to have a vital strategic role.

Conditional Outputs for Oxfordshire's Rail System define what the rail system must deliver to support growth. This indicates that capacity improvements are required on inter-regional services and two other service groups, whilst substantial connectivity improvements are required between Oxfordshire's seven growth hubs. Improved connectivity is also required between Oxford and priority inter-regional locations, including Heathrow Airport. Analysis of potential new stations suggests that two stations on the Cowley Branch Line have a role to play in supporting growth.

Conditional outputs for freight services involve providing capacity for more services, enhancing waccess to the network, and accommodating changes in the rail freight industry.

Major improvements to rail services in Oxfordshire are required to deliver the conditional outputs determined by the study. The proposal is that 70 % more services are required as well as amendments to calling patterns and service coverage. Recommendations for new services are also proposed considering the programme for East West Rail and the aspirations of Midlands Engine Rail and North Cotswolds Line Task Force. How these could be reconfigured to meet the conditional outputs is also set out. Owing to the pace of growth most additional and amended services are required by 2028.

The proposed 2033 train service specification improves direct connections between Oxfordshire's growth hubs by 160 % and between Oxford and priority inter-regional connections by 106 %. This level of improvement is required to deliver the conditional outputs. All improvements, and particularly those to inter-regional connections, will have economic benefits beyond Oxfordshire.

A key proposal is that the majority of passenger services are extended through, rather than terminating at, Oxford station. Another key feature is provision of new direct services to Bristol and Swindon and strengthening of connections with Birmingham, Worcester, and the South Coast to support Oxfordshire's economic growth.

Additional and amended services do not meet capacity shortfalls for inter-regional and London Marylebone services so lengthening of these services is recommended.

A number of significant interventions are required to deliver the Oxfordshire Train Service Specifications. Delivery of Oxford Phase 2 is critical to support the 2024 specification and all subsequent specifications. A portfolio of interventions is required to deliver the 2028 specification. Some can be associated with individual service enhancements, but the majority represent a comprehensive system upgrade between Oxford North Junction and Didcot that is required to unlock the portfolio of new services necessary to support growth in Oxfordshire.

Key interventions identified at this stage include Oxford station, which should be developed following the existing masterplan principles, four tracking between Oxford station and Radley, and grade separation of Didcot East Junction. Alongside the key interventions proposed to deliver the specifications, other interventions are identified that may need to be delivered to provide a robust train service. The identified suite of interventions comprise a system that supports growth in the long term.

The outputs of ORCS have been endorsed at a cross-industry Steering Group and should be considered as the bases of strategic rail planning for Oxfordshire. The outputs provide an opportunity to inform and influence the development of major programmes including East West Rail, and of new aspirations, such as the new station proposals at Grove and Begbroke.

The next steps are to establish a portfolio of interventions that can enter the Rail Network Enhancements Pipeline and secure a decision to progress to the next stage and the development of Strategic Outline Business Cases.

Continued engagement with the many beneficiaries of this extremely ambitious programme of investment is essential. Consideration should be given to how such beneficiaries can support the case for investment, including by identifying opportunities for third party funding.

2. The need for the Oxfordshire Rail Corridor Study

2.1. The Oxfordshire Rail Corridor Study

The Oxfordshire Rail Corridor Study (ORCS) is led by Network Rail in collaboration with industry partners including the DfT, local authorities, and train operators.

ORCS establishes a recommended strategy for developing services provided by the rail system in Oxfordshire in order to support growth in and beyond Oxfordshire, in answer to the question *how can the rail system in Oxfordshire best support economic growth?*

There are four principal outputs, which build upon one another:

1. An **Oxfordshire Planned Growth Scenario** outlining forecast rail demand growth based on the extent and pattern of employment and housing growth in the county set out in Local Plans.
2. **Conditional Outputs for Oxfordshire's Rail System** specifying the rail services that are required in order to accommodate the Oxfordshire Planned Growth Scenario.
3. **Oxfordshire Train Service Specifications** detailing all the rail services that are required to operate in Oxfordshire in order to deliver the Conditional Outputs.
4. Identification of **Oxfordshire Rail System Interventions** that are required in order to deliver the train service specifications.

The outcome is a strategy for investment in the rail system in order to deliver the outputs that support economic growth in Oxfordshire. This report describes that strategy.

2.2. Growth in Oxfordshire

Oxfordshire has one of the strongest economies in the UK, contributing £23bn Gross Value Added (GVA) to the UK exchequer in 2017. It is also rapidly growing at an average of 3.9% annually since 2006. The county has significant assets in research and development and an international brand that draws talent and investment to both the City of Oxford and across Oxfordshire to the numerous science, innovation, technology and business parks located in the county. Oxfordshire's knowledge-led economy generates the highest number of university spin-out companies in the UK, underlining its importance to the national economy.

Despite these strengths, Oxfordshire has low productivity relative to many peers. Moreover, as Oxfordshire's economy grows there is an increased strain on the county's infrastructure: housing is becoming increasingly unaffordable and rail, road and energy infrastructure is not sufficient to meet growing demand. This also places it at an increasing disadvantage to its international competitor locations.

The opportunity to change this has arisen from Oxfordshire's shared commitment to managing growth across its partners, which come together on the Oxfordshire Growth Board that includes all Local Authorities, the Oxfordshire Local Enterprise Partnership (OxLEP) and other stakeholders.

The Oxfordshire Housing & Growth Deal, a ground-breaking agreement with central government, underpins the commitment to build 100,000 new homes in Oxfordshire by 2031. This is a step change in delivery of new housing, equating to 5,100 units per year against an average of 2,333

between 2011 and 2015. Oxfordshire's population is forecast to grow by 39 % between 2016 and 2040.

Employment growth is equally significant, and the primary locations are along the Oxfordshire Knowledge Spine, including the research centres at Harwell and Culham, Milton Park, and the Oxford and Begbroke science parks, as well as the City of Oxford, Bicester, Didcot, and Witney.

Both housing and employment growth rely upon suitable transport infrastructure. Rail has a significant role. Integral to the Growth Deal is a £200m+ package of transport and other infrastructure investment, with further significant funding committed for Housing Infrastructure Fund projects on major transport corridors.

However, the funding identified largely covers highway-based schemes. A number of rail proposals are set out in the Oxfordshire Infrastructure Strategy (OxIS), adopted by the Growth Board in 2017, which identified priority projects needed to support growth to 2040.

The Oxfordshire Local Industrial Strategy (LIS), published by OxLEP in 2019, recognises the challenges and opportunities for rail. Infrastructure in Oxfordshire is under strain and the projection for the Oxfordshire economy to double in size and create 108,000 additional jobs by 2040 means infrastructure must be improved to relieve the existing pressure and accommodate future growth, while responding to increasing concerns around climate change.

Much of this growth is already allocated in local plans. Ensuring that the rail system can support this growth and identifying the interventions required to do so is a critical function of the Oxfordshire Rail Corridor Study.

2.3. Oxfordshire's rail system

Oxford is at the heart of a rail corridor that links the Great Western Mainline (GWML) at Didcot with the London Marylebone to Birmingham line south of Banbury. This corridor is vital for passenger and freight services between the north and south of the country. The same corridor provides branches to important rail corridors through the North Cotswolds to Worcester, and to Bicester (and in future to Bedford and Cambridge).

Oxford station is a key origin and destination for passenger services to cities including London, Birmingham, Worcester, Hereford, Winchester, and Southampton. It is also the hub of the important local rail market in Oxfordshire with lines emanating from Oxford to the towns of Banbury, Bicester, Didcot, and Hanborough and the settlements west along the North Cotswolds Line. Didcot, positioned on the GWML, is a vital node in the UK rail network and is a junction for all north-south passenger and freight traffic west of London.

2.3.1. Demand for Oxfordshire's passenger rail services

Over 20 million journeys were made to and from Oxfordshire stations in 2017-18. Demand for rail travel in Oxfordshire has grown rapidly and above the UK average. Journeys to and from stations in Oxfordshire have increased by 75 % in the 10 years to 2018 against a UK average increase of 44 %.

Oxford station is by far the busiest of Oxfordshire stations with 7.9 million journeys in 2017-18. This is an increase of 69 % over ten years. Three other stations saw over one million journeys – Didcot Parkway, Banbury, and Bicester North.

Stations towards London Marylebone have seen substantial growth since the introduction of services between Oxford and London Marylebone. Oxford Parkway station is Oxfordshire's fifth busiest station despite only opening in 2016.

The success of Oxford Parkway station and the service to London Marylebone demonstrates the benefits of investment and is why this study explores the potential for new stations on the Cowley Branch Line, at Grove, and at Begbroke.

ORCS focuses on the system requirements arising from future growth, but the impacts of recent high growth are captured in the analysis and inform the recommended service specification.

2.3.2. Investment in Oxfordshire's rail system

Following major infrastructure programmes Oxfordshire enjoys new trains, improved service frequencies and journey times, and a new direct route to London. Further planned works deliver additional improvements, including to Oxford station itself, where an additional platform and station entrance will allow more services and reduce congestion.

The East West Rail programme will provide entirely new opportunities including direct links with Milton Keynes, Bedford and Cambridge. Making the most of East West Rail is an important part of the strategy for rail in Oxfordshire.

However, there are crowding issues on some services in Oxfordshire, and it is not possible to make direct journeys from most of the county to nearby regions including the southwest and Wales. It is also not possible to make direct journeys between some of Oxfordshire's main growth settlements. These issues will become more acute as Oxfordshire grows, and have the potential to hinder that growth.

2.4. The scope of the study

ORCS focuses primarily on housing and employment growth within Oxfordshire. Growth sites are as identified in the Local Plans of the five planning authorities within the county (data accurate in March 2019). Growth outside Oxfordshire but supported by the rail system within Oxfordshire is also considered in the form or requirements for freight and inter-regional passenger services.

ORCS primarily concerns the train services required to support growth. Sustainability and accessibility are prerequisites to that growth and as key drivers for national rail strategy are the focus of rail industry policy development. These policies must be implemented alongside ORCS recommendations on service development so that growth is supported sustainably and equitably.

The rail system on which the study focuses is the core corridor through Oxfordshire, which is between Didcot and Banbury, and the lines to Bicester Village and the North Cotswolds. The Cowley branch is also in scope (Figure 1). The Chiltern Mainline and the Great Western Mainline east of Didcot Parkway are not considered as the markets and service offerings respond to different strategic drivers.

The study considers all passenger and freight train services through or within the scope area. It also includes stations and freight terminals. Four new stations are considered for the role they may play in supporting growth – two on the Cowley Branch Line, one at Grove and one at Begbroke.



Figure 1 – ORCS rail system geographical scope

2.5. Supporting sustainable growth

The role of the rail system in Oxfordshire in supporting economic growth cannot ignore the need to support that growth sustainably. The ambitious connectivity targets identified offer the opportunity for rebalancing away from road travel for many daily journeys. Improved rail services can have a major role in decreasing the environmental impact of travel through the lower impact of rail versus road travel.

Decarbonisation is a key driver in national rail system strategy. ORCS does not make specific recommendations on decarbonisation but rather proposes a train service specification that supports planned growth in Oxfordshire. Capacity and connectivity outputs detail what is required in order to support growth and are not influenced by traction mode. However, decarbonisation of the rail system is a national priority and is expected to be implemented alongside the strategy for services described in this report. The strategic case for decarbonisation may be explored in additional ORCS work but is made elsewhere (Rail Industry Decarbonisation Taskforce final report, RSSB, 2019; Traction Decarbonisation Network Strategy, Network Rail, 2020).

Similarly, a requirement of the rail system in Oxfordshire is that accessibility is continually improved so that barriers to use are reduced and removed. Improving accessibility is another key driver in national rail system strategy so ORCS does not make specific recommendations. Improved accessibility is a prerequisite of supporting Oxfordshire's growth and network strategy

will be implemented alongside the strategy for services described in this report (Railway for Everyone Strategy, Network Rail, 2020).

The solutions to these issues are technological. Harnessing developments in technology is vital for the rail system in order to support growth in Oxfordshire. Technological developments can contribute to delivering outputs, through introduction of intelligent infrastructure, advanced train control systems, and enhanced rolling stock, as well as to improving passenger experience, through provision of information and smart ticketing, and an increase in in-journey productivity with better digital connectivity.

Technological solutions are also required to integrate rail with other forms of transport in improving door-to-door journeys. The role of new technologies in improving the operation and attractiveness of the rail system in Oxfordshire is developed further in Appendix A.

3. The Oxfordshire Rail Corridor Study approach

3.1. Stakeholders

ORCS is a collaboration between a range of organisations. The key stakeholders include the DfT, the Oxfordshire Growth Board, Oxfordshire County Council, Oxford City Council, Great Western Railway, Chiltern Railways, Cross Country Trains, East West Railway Company, freight operating companies, the East West Rail Consortium, England's Economic Heartland, and Network Rail.

The county council is also responsible for bringing in the views of other important stakeholders including OxLEP and Oxfordshire's district councils.

3.2. Study structure

ORCS consists of two sequential elements: a Strategic Study, and Development Work. The strategic study establishes what is required from the rail system in Oxfordshire to support growth and is summarised in this report. The development work consists of developing rail system interventions that are required to enact the strategy. Both elements are overseen by a steering group consisting of the key stakeholders.

The strategic study delivers four important outputs that build upon one another and together answer the headline question *how can the rail system in Oxfordshire best support economic growth?*

These outputs are:

1. The Oxfordshire Planned Growth Scenario (OPGS) – short, medium, and long-term forecasts of Oxfordshire's rail markets forming an evidence-based mandate for improvements
2. Conditional Outputs for Oxfordshire's Rail System – a set of objective, quantitative statements of the rail outputs required to support the OPGS
3. Oxfordshire Train Service Specifications – a recommended suite of industry-aligned and endorsed proposals for train services that deliver the Conditional Outputs
4. Oxfordshire Rail System Interventions – a prioritised list of the system enhancements required to deliver the Oxfordshire Train Service Specifications

The study answers the headline question by addressing strategic questions identified by the steering group. The answers to these strategic questions consist of analysis of Oxfordshire's rail markets to quantify future demand, and then identifying the rail system outputs that support that demand. This informs the first two outputs – the Oxfordshire Planned Growth Scenario and the Conditional Outputs for Oxfordshire's Rail System.

The Conditional Outputs for Oxfordshire's Rail System form the basis for developing a recommended suite of train services and system capabilities that best meet the conditional outputs, resulting in the recommended Oxfordshire Train Service Specification.

The Oxfordshire Train Service Specification is then assessed against current network capability to identify the interventions required. These Oxfordshire Rail System Interventions form the priorities for development work. In this way a direct link is established between the benefits sought and the rail investment required.

Development work on rail system interventions is informed by the conclusions of the strategic study. One intervention – Introduction of Passenger Services to the Cowley Branch Line – was undertaken concurrently with the strategic study and is published alongside this report. Figure 2 describes this structure.

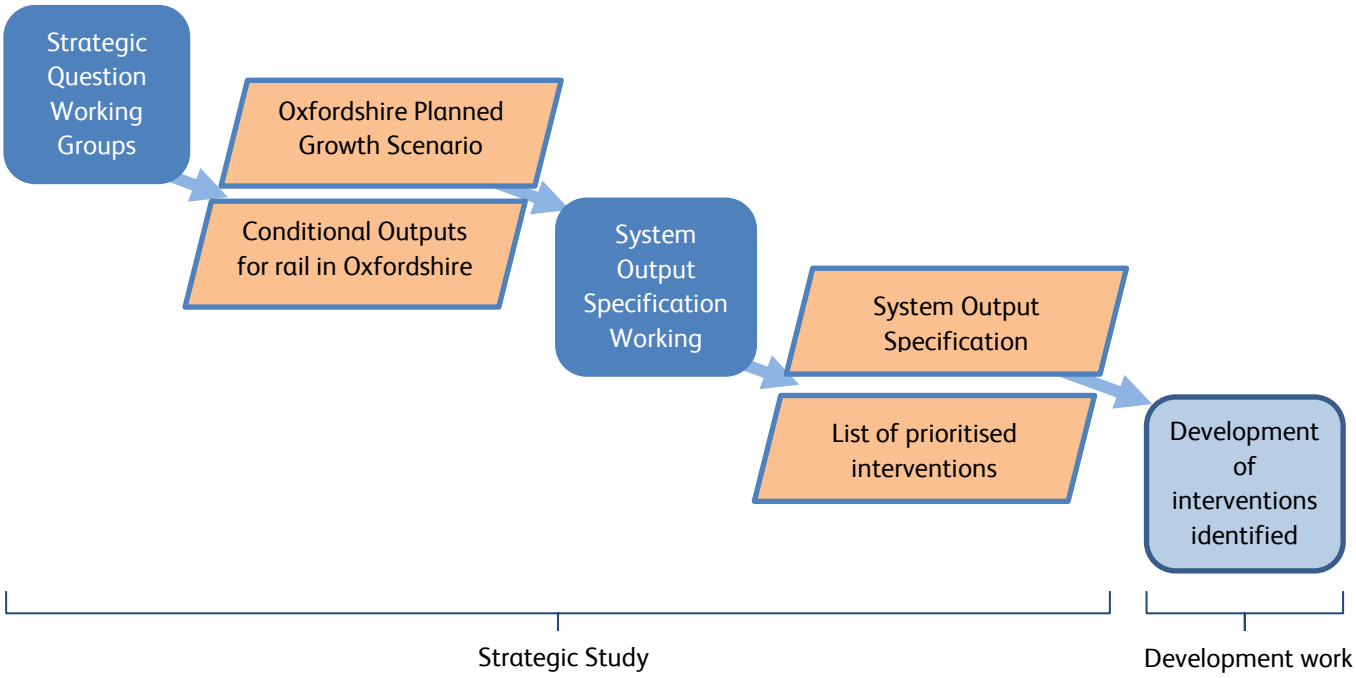


Figure 2 – ORCS structure simplified

4. The market for rail services in Oxfordshire

To understand what Oxfordshire's rail system needs to provide it is important to understand how the market that rail serves is expected to grow.

4.1. The passenger rail market in Oxfordshire

4.1.1. The Oxfordshire Planned Growth Scenario

The five Local Authority Districts within Oxfordshire all feature ambitious plans for housing and job creation in their Local Plans. Planned increases represent a step change in population and employment and are well above the projected national average. This will markedly impact travel patterns and characteristics, especially for commuting flows.

The location, size, and delivery timeframe of all planned housing and employment sites are detailed in the five local plans. This data, collated by Oxfordshire County Council, is the primary source for the Oxfordshire Planned Growth Scenario. This incorporates a level of detail that is not captured in the DfT Transport Appraisal Guidance (TAG) method of demand forecasting.

The Oxfordshire Planned Growth Scenario offers a demand forecast that incorporates the specifics of Local Authority plans for housing and employment into the recognised forecasting framework. The result is a demand forecast that follows the established method but is sensitive to the scale and pattern of growth in Oxfordshire.

These forecasts are the basis for identifying gaps between the capacity and connectivity levels delivered by the currently committed train service and what is required to support Oxfordshire's growth at various forecast horizons.

4.1.2. Growth pattern in Oxfordshire's Local Plans

Within Oxfordshire there is distinct geographic variation in the distribution of housing and employment sites in the local plan period, and both housing and employment growth is more concentrated in some areas than others. The distribution follows the Knowledge Spine from around Bicester in the north to the Didcot area in the south (Figure 3).

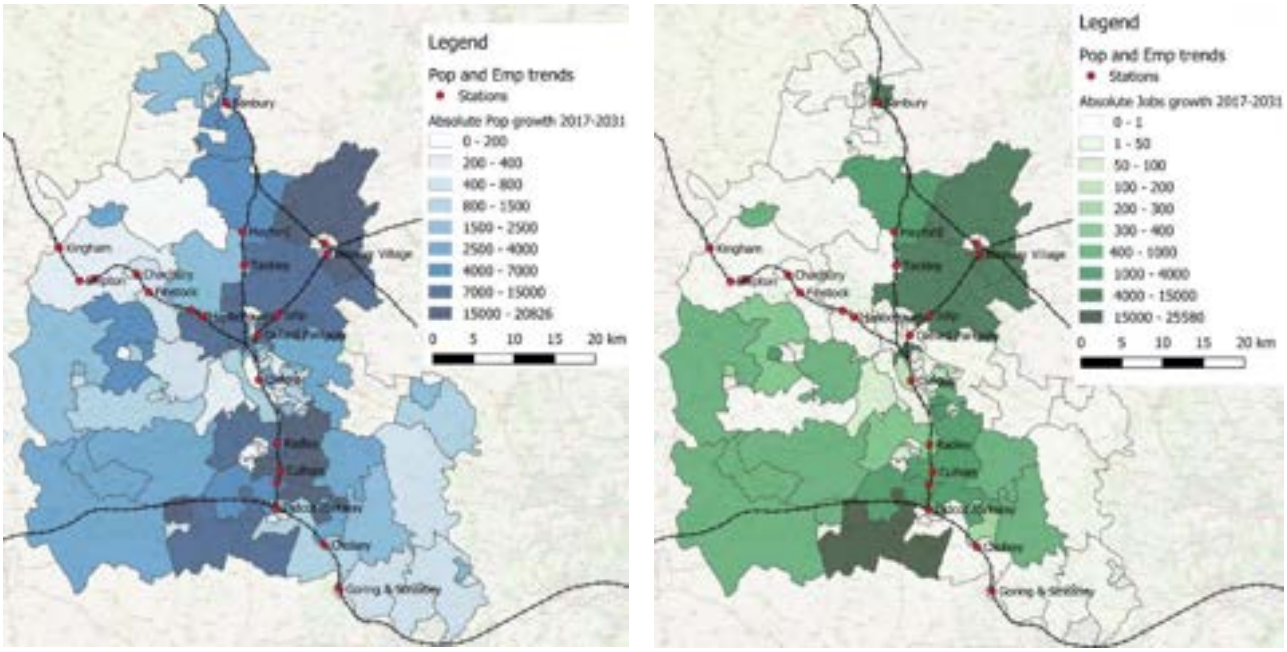


Figure 3 – Population (blue) and jobs (green) increase as a result of planned sites in Oxfordshire's five Local Plans

At a district level housing is spread relatively evenly across the four districts but constrained in Oxford City, whilst employment growth is concentrated in Cherwell, Oxford City, and Vale of White Horse (Figure 4).

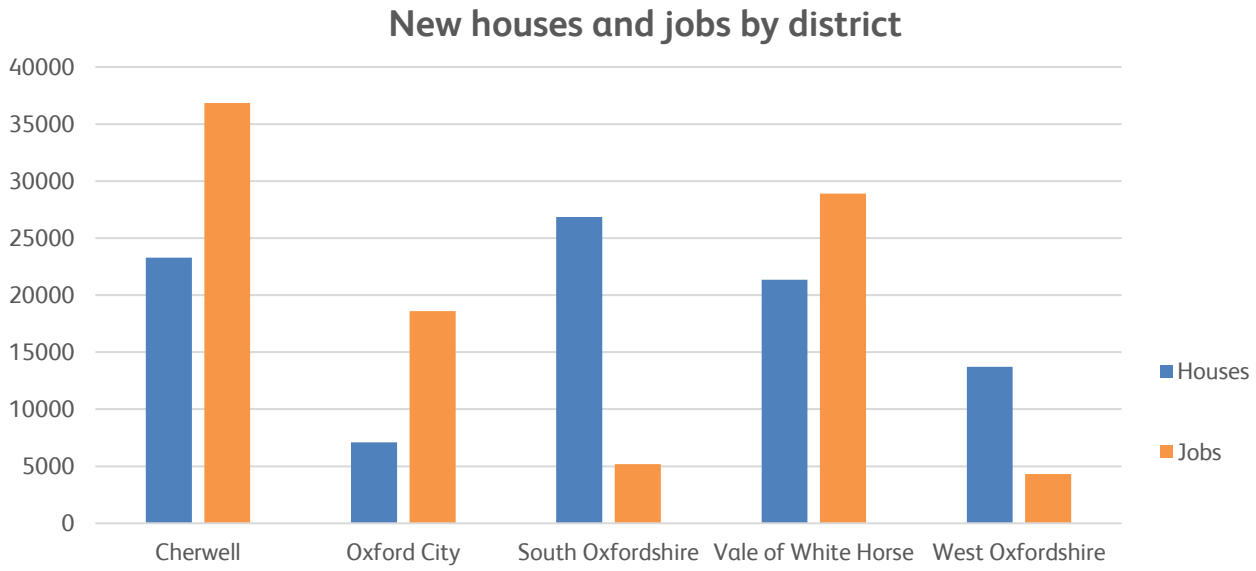


Figure 4 – local plan housing and employment allocations by district

Looking at the larger allocations at the level of the settlements to which they are allocated reveals a similar picture. The larger housing allocations are more spread, whilst employment locations are fewer and larger.

The distribution of housing and employment allocations correlates with the geography of rail corridor. Correlation applies for both housing and employment, with the three settlements with

the largest housing allocations – Bicester, Banbury, and Didcot – and two largest employment allocations – Bicester and Oxford – mapping closely to the rail corridor (Figure 5).

Growth is clustered around existing hubs. This clustering is reflected in the OPGS demand forecasts and is a major factor in the recommended strategy.

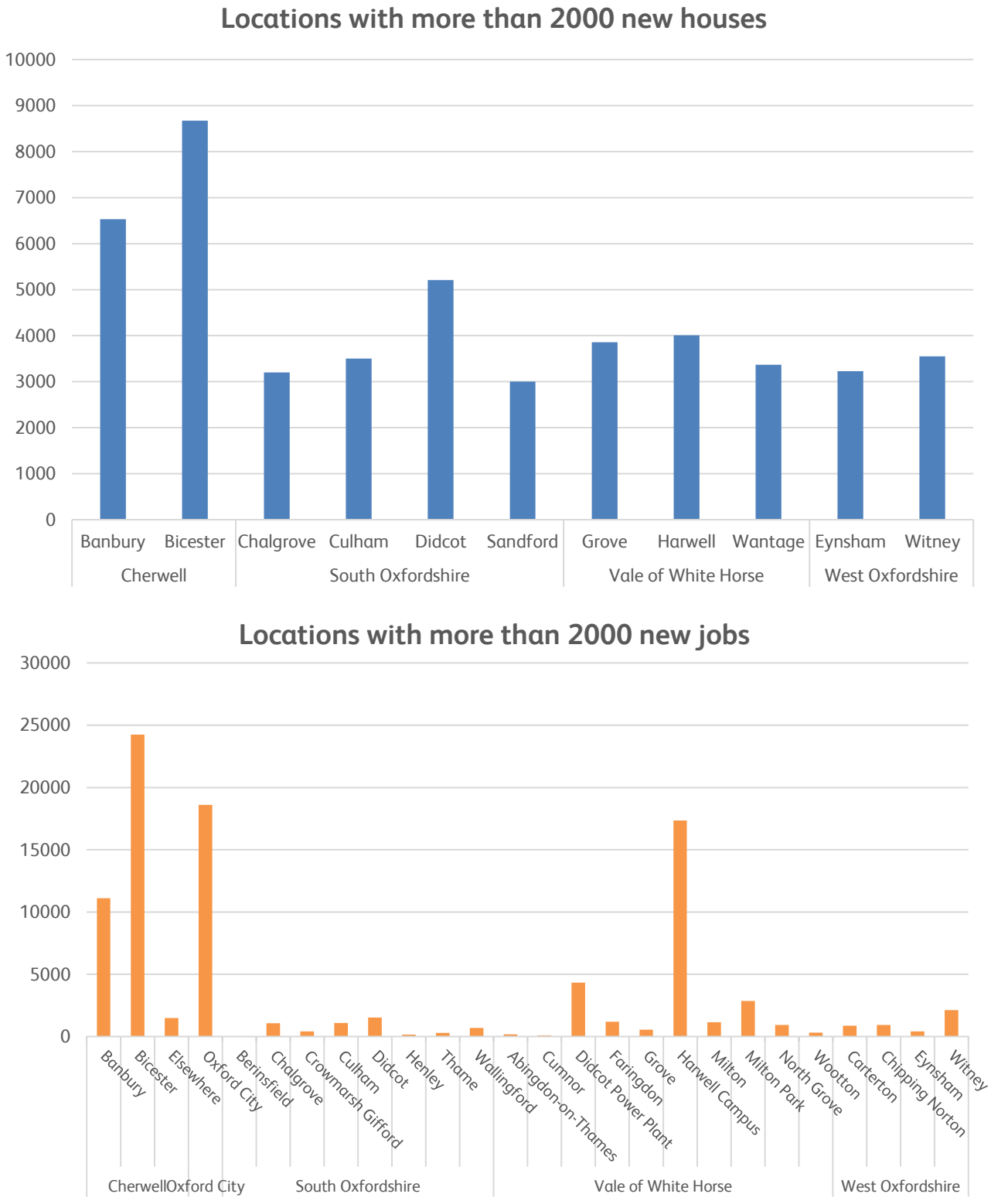


Figure 5 – Settlements with allocations of more than 2000 homes (blue) and jobs (red)

4.1.3. Constructing the Oxfordshire Planned Growth Scenario forecast

The key inputs for the OPGS forecasts are Local Plan housing and employment data and Census data on population, employment, and travel to work patterns. Census data is used at the level of Middle Layer Super Output Areas (MSOAs) – the 87 statistical subunits of similar population that comprise the county of Oxfordshire.

Using these data sources a bespoke framework allows mapping of Local Plan housing and employment sites to stations and the quantification of rail demand growth flowing from those sites. The method is:

1. Population and employment figures from Local Plan sites allocated to each MSOA within Oxfordshire
2. MSOAs mapped to stations according to stakeholder-informed weightings based on population distribution and infrastructure within the MSOA
3. Rail demand flowing from Local Plan growth calculated using existing commuting journey trends and rail mode share. Population growth drives origin station demand; employment growth drives destination station demand
4. Distance factor applied to factor down rail demand in MSOAs which are not near stations and where there is negligible commuting rail mode share
5. Rail demand forecasts compiled for each station in Oxfordshire for the five forecast timeframes: 2024, 2028, 2033, 2038 and 2050

The OPGS rail demand forecasts employ official statistics and a recognised framework but supplant macro level assumptions on growth with specific local planning data to reveal the extent of the growth in rail demand attributable solely to planned housing and employment.

Timeframes identified

Growth forecasts are presented for five forecast timeframes – 2024, 2028, 2033, 2038, and 2050. These timeframes provide the underlying structure for the recommended strategy, with Conditional Outputs, Train Service Specifications, and recommended interventions for each timeframe responding to the forecasts.

The first four timeframes represent five-yearly intervals points from the study data baseline in 2018, although the first scenario was identified as 2024 owing to alignment with existing major rail programmes – namely Oxford Phase 2 and East West Rail Western Section. Five yearly intervals provide the sensitivity to reflect the phasing of growth within Local Plans. The final scenario reflects a long-term system view to verify the trajectory of the strategy.

4.1.4. Rail demand forecasts under the Oxfordshire Planned Growth Scenario

To ensure a robust analytical approach the Oxfordshire Planned Growth Scenario demand forecast is compared against a TAG compliant 'Do Nothing' scenario that uses national population and employment assumptions instead of local plan data. The Do Nothing scenario uses the DfT Exogenous Demand Growth Estimation model, which refers to a range of demand drivers including levels of population and employment and economic forecasts and presents the impact of predicted changes on rail demand.

The Oxfordshire Planned Growth Scenario generates strikingly more demand than the Do Nothing scenario at almost all Oxfordshire stations (Figure 6). Under the OPGS there is seven times as much growth in rail demand at Didcot Parkway as would otherwise be forecast to 2031. The proportional difference is equally marked at Bicester Village and Culham, whilst Oxford, Banbury, Hanborough, and Oxford Parkway all see at least double the growth in the OPGS.

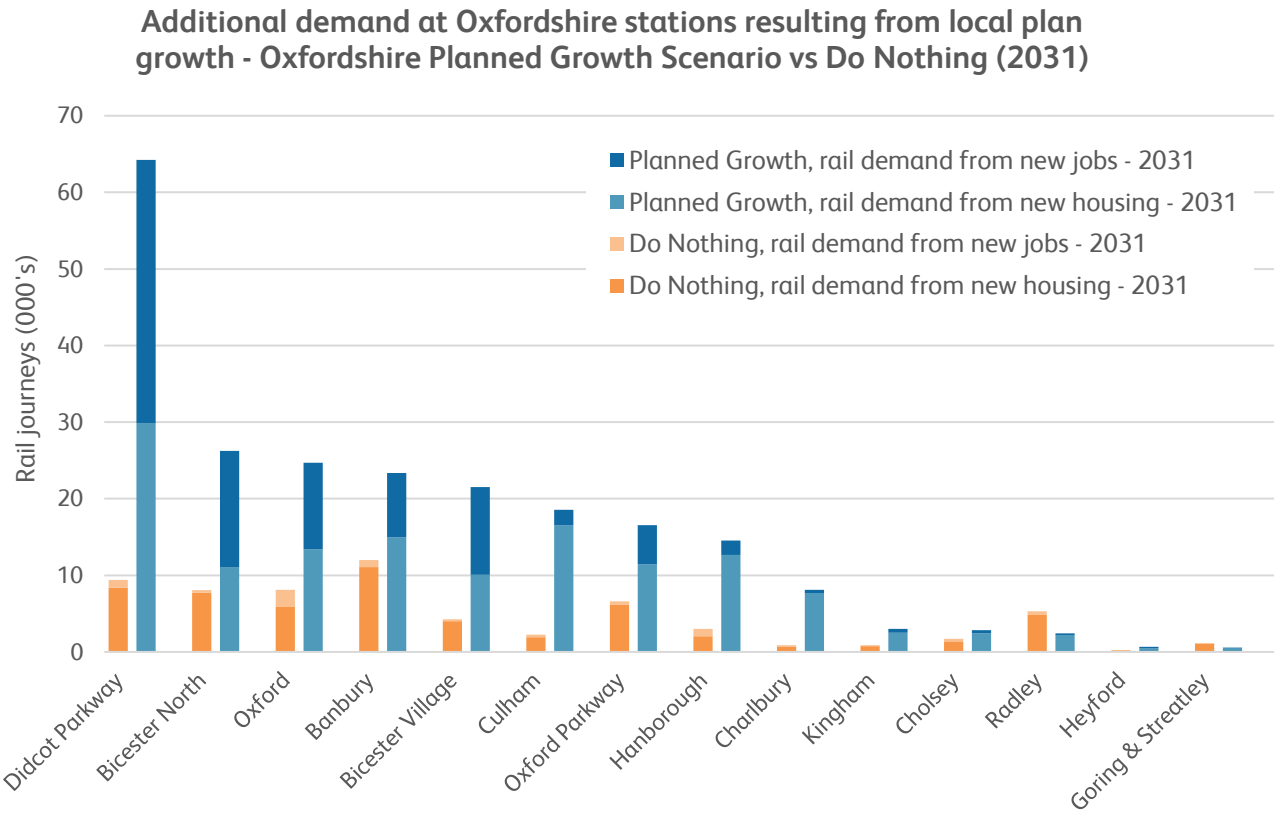


Figure 6 - Additional demand in 2031 resulting from local plan housing and jobs growth under OPGS and Do Nothing scenario

Didcot Parkway immediately stands out as a major housing and employment hub owing to the several sizable housing and employment sites in adjacent MSOAs. Employment related growth is also significant at Bicester, Oxford, and Banbury, whilst growth at Culham and Hanborough is predominantly driven by housing, consistent with the distribution of local plan sites.

Whilst housing is still the dominant demand driver in the OPGS employment sites have a far greater impact that in the Do Nothing scenario. The growth in employment based demand to Didcot Parkway and Bicester demonstrates their increasing role as hubs for inward commuting and therefore the necessity for the rail system to provide for this to support economic growth.

The OPGS also exhibits greater variation across stations than the Do Nothing, which reflects the specific distribution of local plan sites. By refining the allocation of MSOAs to stations the accuracy of demand forecasting at the local level is improved. For example, under the Do Nothing forecast Culham station sees little growth. This reflects the historically superior service from Radley station which is therefore privileged in the conventional Do Nothing approach. Left unchecked this effect perpetuates existing service patterns. In fact, Culham is a major site of housing growth and therefore features strong rail demand growth in the OPGS.

The OPGS shows that there are seven key growth hubs in the Oxfordshire rail system: Banbury, Bicester (with strong growth across both Bicester stations), Culham, Didcot Parkway, Hanborough, Oxford, and Oxford Parkway (Figure 7). This is consistent with the pattern of growth allocated in local plans. These seven key hubs see growth that is higher than other Oxfordshire stations and significantly higher than in the Do Nothing scenario. Accommodating growth in demand at the seven key hubs is central to the role of the rail system in support economic growth.

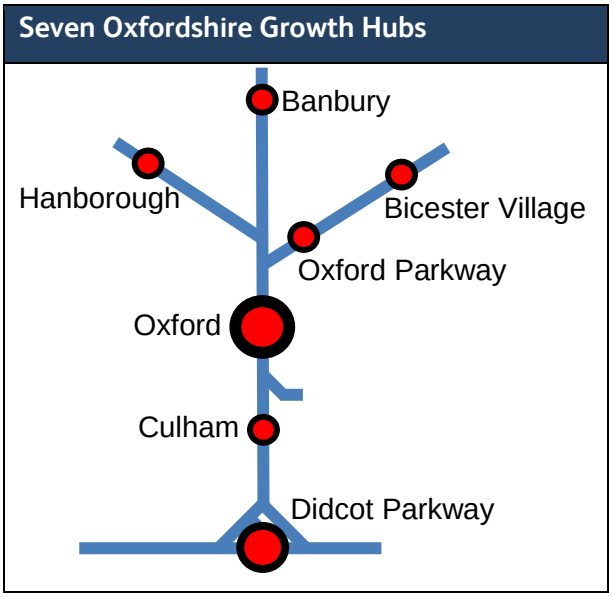


Figure 7 – The seven key growth hubs in Oxfordshire's rail system

An important metric in understanding rail demand is the compound annual growth rate (CAGR), which quantifies year on year growth. In the Do Nothing scenario there is limited variation in the CAGR across different stations. In fact, CAGR can vary significantly based on local growth and service provision. For example in the ten years to 2017-18 Hanborough station saw a CAGR of 9.7% whilst Appleford saw minus 1.9%.

Figure 8 shows the CAGR for the seven key hubs in Oxfordshire. In each case the growth rate is not only high but significantly higher than in the Do Nothing scenario.

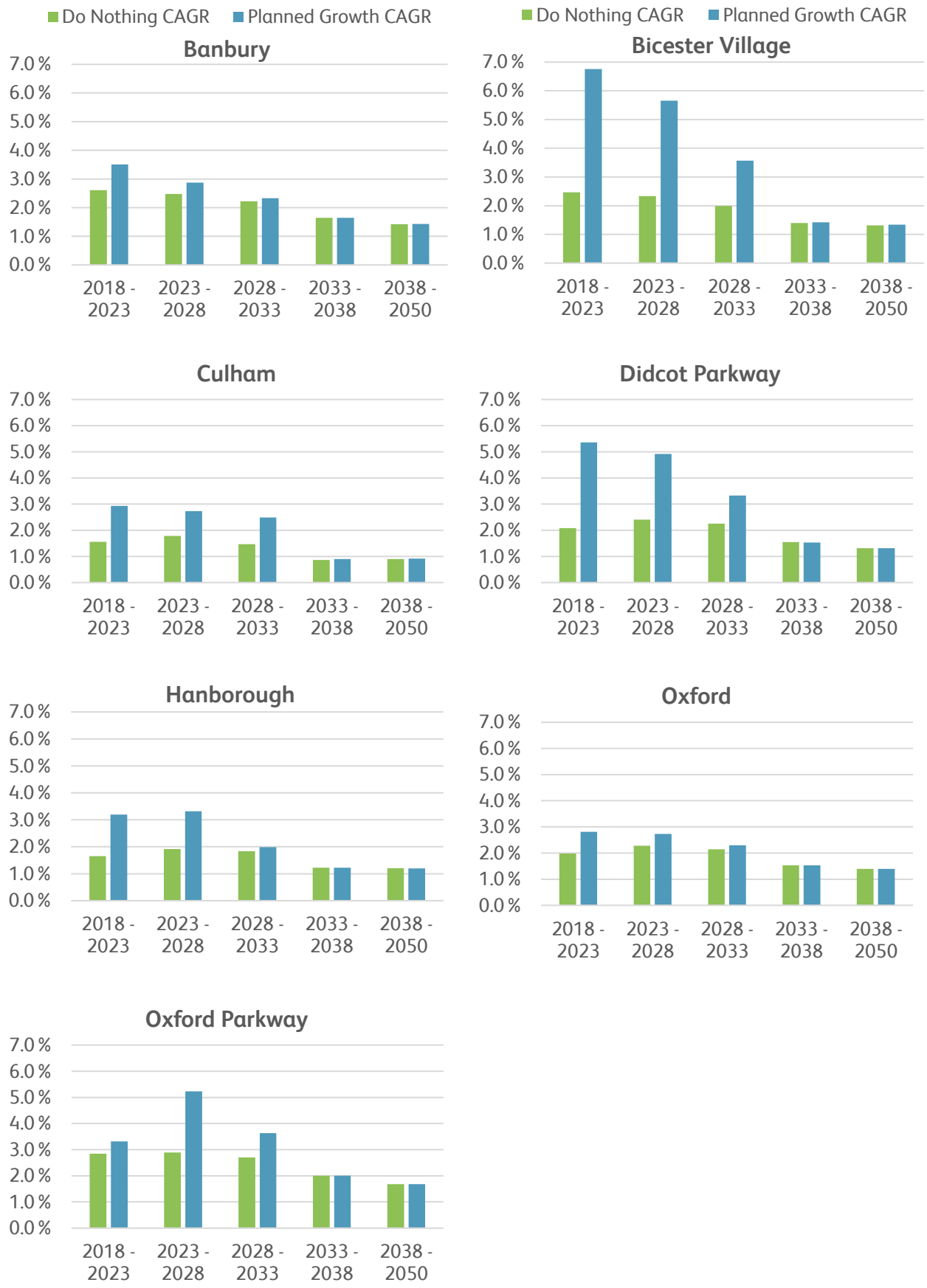


Figure 8 – Compound Annual Growth Rates at Oxfordshire growth hubs – OPGS vs Do Nothing

Didcot Parkway is noteworthy again, particularly given the already high base, but the highest CAGR is seen at the Bicester stations. This highlights the importance of Bicester in the changing pattern of Oxfordshire's commuter travel market. Whilst growth at Oxford is relatively lower this reflects a very high base and demonstrates that whilst it remains the dominant hub the pattern of growth in the county is spreading to the other hubs.

The rail demand forecasts derived from the OPGS are fundamental to identifying Conditional Outputs for Oxfordshire's rail system, which in turn is the basis for the recommended strategy.

The OPGS is not merely a means to an end. It is in itself a valuable output. It uses a framework endorsed by all partners including the DfT to provide a locally-focused and fully evidenced basis for strategic planning that is sensitive to the specific pattern and level of growth in Oxfordshire. The OPGS reveals the true extent of the impact of growth on Oxfordshire's rail system and creates a mandate for the improvements required to support that growth.

4.2. The freight rail market in Oxfordshire

4.2.1. Market context

Oxfordshire hosts one of the most significant freight routes in the country. The route between the Port of Southampton and terminals and markets in the West Midlands and north runs directly through Oxfordshire and is a strategically vital freight route, critical to the UK economy. Therefore, the needs of rail freight are a crucial consideration in any strategy for the rail system in Oxfordshire.

The principal commodities through Oxfordshire are intermodal and automotive flows. The rail freight market has changed significantly in recent years. Coal traffic has declined massively whilst intermodal freight has substantially increased to become the largest single commodity sector conveyed by rail. This further increases the strategic importance of the route through Oxford.

Rail freight in Oxfordshire is not limited to intermodal flows passing through the county. There are significant and strategic sources and terminals in Oxfordshire that drive automotive, aggregates, military, and rail industry freight traffic (Figure 9).

Oxfordshire role	Location	Type of flow
Source of freight flow	BMW Cowley MOD Bicester	Automotive Military
Terminal for freight flow	Appleford sidings Banbury Reservoir Banbury Road Hinksey Yard	Aggregates Aggregates Aggregates Rail industry logistics
Through freight flows	*South coast – Midlands* *South Wales – London ports* *Mendips – London* *S Wales / Bristol to London / S Coast*	Intermodal, automotive Steel Aggregates Intermodal
Sidings	Didcot Yard	Various

Figure 9 – Freight sites and flows in Oxfordshire

Each of the freight sites within Oxfordshire has and is expected to retain strategic value. Therefore, the sites and the capability of the rail system affording access to them must be retained as part of the strategy for rail in Oxfordshire.

Cumulatively the roles described in Figure 9 equate to substantial demand for capacity for freight services in Oxfordshire that must be accommodated alongside passenger services.

4.2.2. Freight demand forecasts

Network Rail has recently revised freight market forecasts for 2023, 2033, and 2043. The new forecasts present different scenarios considering the relative value of rail versus road haulage and macro-economic growth. These yield high, medium, and low growth scenarios. In all scenarios demand for rail freight increases, but by varying degrees (Figure 10).

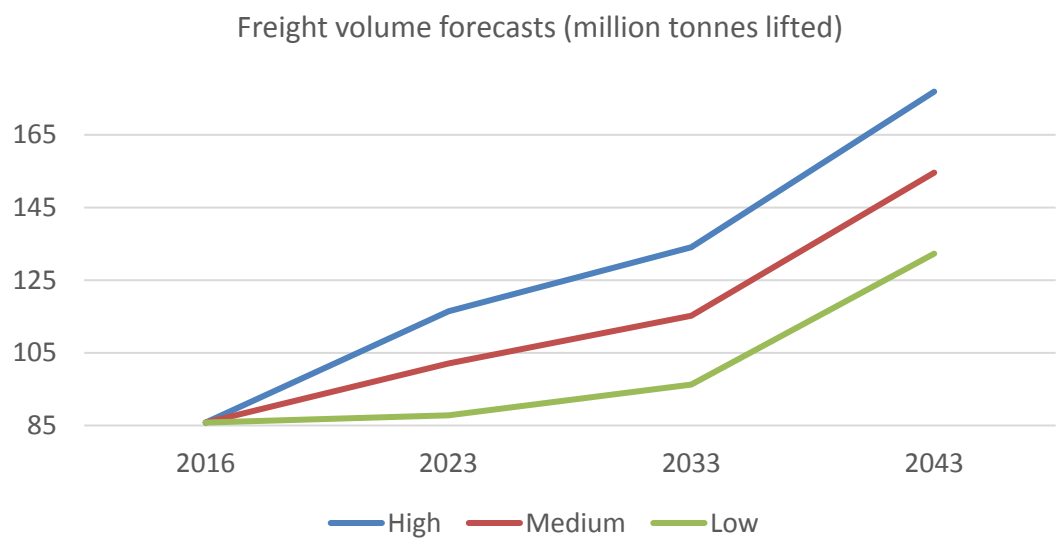


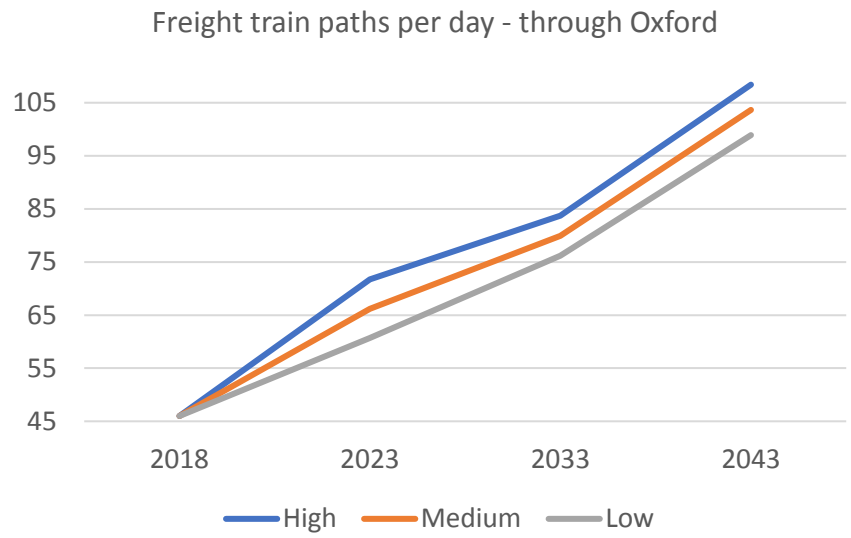
Figure 10 – Forecast freight tonnes lifted (m), Network Rail Freight Market Studies 2019

These new forecasts provide the ideal basis for identifying what the freight market requires from the rail system in Oxfordshire. However, they do not include additional freight demand flowing from the route options introduced by East West Rail, which should be included in the freight capacity requirement for Oxfordshire.

The introduction of East West Rail is likely to increase demand for rail freight through Oxfordshire. Oxfordshire will gain direct connections to the West Coast Mainline at Bletchley (EWR Western section) Midland Mainline at Bedford (EWR Central Section). Each offers routing benefits for freight. The western section offers shorter journeys between the south coast and some midlands intermodal terminals, whilst the central section offers comparable journeys between east coast ports and Oxfordshire, the southwest and South Wales whilst avoiding London.

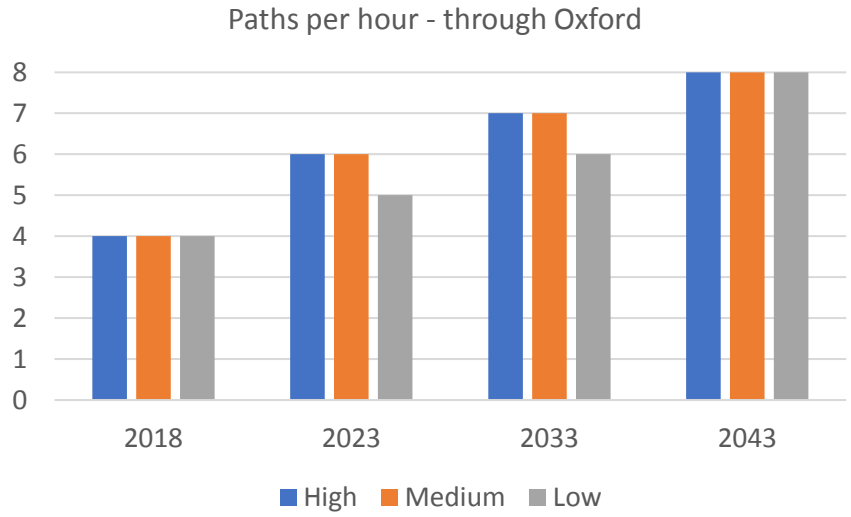
ORCS forecasts for freight capacity required in Oxfordshire combine the updated market studies and Network Rail forecasts on the usage of East West Rail for rail freight to identify a capacity requirement for freight services on the network in Oxfordshire. This is identified both in terms of freight trains paths per day (Figure 11) and freight train paths per hour (Figure 12). When converted to hourly paths, which are the basis of timetable development, the requirement is the

same in the medium and high growth scenario, whilst the 2043 forecast is the same in the low growth scenario, with the increase simply deferred.



	High	Med	Low
2018	46	46	46
2023	72	66	61
2033	84	80	76
2043	108	104	99

Figure 11 – Forecast freight trains paths per day through Oxford



	High	Med	Low
2018	4	4	4
2023	6	6	5
2033	7	7	6
2043	8	8	8

Figure 12 – Forecast freight train paths per hour through Oxford

4.2.3. Freight industry developments

Beyond providing sufficient capacity for growth the key issues for freight concern the capability of infrastructure in the rail system, and access to it.

Many capability requirements are driven by the inevitable conflicts with passenger services, which will increase as demand for each grows. The ability to loop freight trains so that other services can pass is a crucial feature of the rail corridor through Oxford and must remain so. Similarly, the capability of the junctions used by freight is crucial, since slower and more restrictive junctions consume scarce capacity.

Capability requirements are also driven by changes in the industry. The move towards longer, heavier trains, which offer efficiency benefits for haulage and capacity usage, drives enhanced infrastructure capability requirements that Oxfordshire's rail system must accommodate.

Rail freight also has an important environmental role, both as a source of emissions and as a means of inducing modal shift from road haulage, which is relatively a far greater source of emissions. Supporting rail freight growth is therefore instrumental to improving environmental outcomes, but the capability of the system can lessen the environmental impact of rail freight, for example by conversion from diesel to electric traction. At the same time industry trends towards more environmentally efficient freight rolling stock must continue.

The freight industry requires frequent, predictable, and reliable access to the rail network. Both the intermodal and automotive markets demand high levels of service continuity as goods cannot be stockpiled easily. Conflict with passenger services in the day and with maintenance requirements overnight constrains the ability of the system to support freight growth, and this constraint will be exacerbated as freight demand increases.

There is increasing demand for longer operational hours and better mitigation of impacts where access is degraded. Closures – whether routine or special – of part or all of the railway for maintenance or construction projects disproportionately impact freight. Diversionary routes are also required so that when routes must be closed alternatives with the right capability exist.

4.2.4. Freight market analysis – findings

The freight market requirements for the rail system in Oxfordshire can be grouped into categories of capacity, capability, access, and environment (Figure 13). Conditional Outputs specifying what the rail freight industry requires from the rail system in Oxfordshire respond to these categories.

Theme	Finding
Capacity	The volume of rail freight in and through Oxfordshire is forecast to increase significantly in the period to 2043
Capability	Means of mitigating conflicts between services – such as looping and junction capability – will need to be improved in order to accommodate growth Freight trains will become longer and heavier Oxfordshire freight sites will continue to be strategically significant
Access	An increasing level of access for freight users to a fully functioning rail system is required
Environment	Rail freight in Oxfordshire will contribute to national and local environmental goals and system changes may support this

Figure 13 – Freight market analysis findings

5. Conditional Outputs for Oxfordshire's Rail System

Conditional outputs are statements of what the rail system in Oxfordshire needs to deliver in order to support the Oxfordshire Planned Growth Scenario and freight system requirements. Taken together they allow specification of train services and other system outputs that achieve the strategic goals in the given growth scenarios.

Conditional outputs for passenger services are proposed for capacity and connectivity, whilst for freight they are proposed for capacity and capability. Capacity conditional outputs specify seating requirements on different journey flows for passenger services and numbers of trains per hour for freight services and are based on demand forecasts. Connectivity conditional outputs specify a level of passenger service between two points that must be met to support planned growth. Capability conditional outputs specify functions that the rail system should deliver and are based on stakeholder consultation and expertise in addition to the underlying growth trend.

Passenger and freight conditional outputs are identified through separate analytical processes, but are equally important in deriving the recommended strategy, including Train Service Specifications.

Taken together the Conditional Outputs for Oxfordshire's Rail System form the basis for developing the proposed strategy in the form of Oxfordshire Train Service Specifications. Improvements to existing services and introductions of new services are identified by requirements defined in the conditional outputs.

There may be other ways that services could be configured to meet the conditional outputs for Oxfordshire's rail system. ORCS proposes the recommended configuration based on the principles of meeting as many outputs with as few new services as possible in order to make best use of network capacity and aligning with services in existing programmes. The conditional outputs represent a valuable output of ORCS since any development in the configuration of services in Oxfordshire based on wider circumstances can be verified against these objective statements to ensure that they still deliver the outcome of supporting economic growth.

5.1. Conditional Outputs for passenger services

5.1.1. Capacity

Identifying capacity conditional outputs follows a straightforward process. The ORCS aspiration is for all passengers to have seats so capacity conditional outputs specify that where a gap exists between the forecast number of passengers and provision of seats this gap is closed. Capacity gaps for specific service groups are identified by comparing peak loading forecasts with current seating provision.

Peak loadings, including the number of passengers boarding and alighting services at each station, are forecast for all Oxfordshire services using the OPGS and Do Nothing reference case.

In the Do Nothing scenario peak loadings increase at an average of 2 % per year across the county. This rate of growth would exacerbate existing crowding and cause crowding on more services. However, it both underestimates growth compared to the OPGS and masks the impact

by not reflecting the distribution of growth as sensitively, meaning the impact on specific service groups is less clear.

Under the more refined OPGS forecasts a range of loading growth rates is identified. Compared to the Do Nothing scenario in the 2031 timeframe the OPGS forecasts:

- 5.7 % greater loading on arrivals into Oxford and 6.7 % into Oxford Parkway – i.e. substantially more inward commuting owing to employment growth across Oxford combined with housing growth across the county
- 8.5 % greater loading on departures from Didcot Parkway, 9.5 % from Bicester Village, and 8 % from Oxford Parkway – i.e. substantially more outward commuting owing to housing growth proximate to these hubs generating additional demand

The OPGS also considers the impact of East West Rail Western Section services by building in forecasts from East West Railway Company albeit noting that these assume services terminate at Oxford (Figure 14). These introduce entirely new journey opportunities and have a significant impact on demand.

Station	EWR loading impact
Banbury	0.3 %
Bicester Village	15.5 %
Culham	7.6 %
Didcot Parkway	1.3 %
Hanborough	1.5 %
Oxford	4.7 %
Oxford Parkway	14.7 %

Figure 14 – Percentage increase in train loadings at key stations in response to East West Rail Western Section services

Forecast peak loadings are grouped into service groups – sets of services characterised by calling patterns – and compared to the capacity provided for that service group in the Do Minimum scenario (which includes East West Rail Western Section services).

This reveals that additional capacity is required to accommodate peak loading for three service groups:

1. **Inter-regional services**
   The biggest capacity issue is for inter-regional services, where PM peak loadings at Oxford and Banbury drive the need for significant additional capacity in southbound and particularly northbound from the earliest timeframe – 2024. These are the services operated by CrossCountry trains.
2. **Oxford corridor stopping services**
   Additional capacity is required to relieve congestion on Oxford corridor stopping services. This requirement – arising in 2028 – is driven by AM peak loadings between Radley or Culham and Oxford and therefore additional capacity cannot be provided by longer distance services.
3. **Oxford to London Marylebone services**

Additional capacity is also required to relieve congestion on Oxford to London Marylebone services. Although East West Rail services provide much capacity between Oxford and Bicester the demand for the journey to and from London means that crowding is forecast on trains to and especially from London Marylebone.

Conditional Outputs specify the required additional capacity in the form of additional carriages (Figure 15), which are assumed to be of the same capacity as the current stock for the service group.

Service group	Additional carriages required				
	2024	2028	2033	2038	2050
Northbound inter-regional	7	9	11	12	16
Southbound inter-regional	5	7	8	9	12
Oxford corridor southbound stopping	0	1	1	2	3
Oxford corridor northbound stopping	0	2	3	4	5
Oxford to London Marylebone	0	0	2	3	5
London Marylebone to Oxford	1	2	3	4	6

Figure 15 – Cumulative additional carriages required in peak hour to accommodate Oxfordshire demand

5.1.2. Conditional Output statements – passenger capacity

Ref.	Conditional Output
PGCO1	Provide an additional 5-7 carriages on Oxford inter-regional services by 2024
PGCO2	Provide an additional 7-9 carriages on Oxford inter-regional services by 2028
PGCO3	Provide an additional 8-11 carriages on Oxford inter-regional services by 2033
PGCO4	Provide an additional 9-12 carriages on Oxford inter-regional services by 2038
PGCO5	Provide an additional 12-16 carriages on Oxford inter-regional services by 2050
PGCO6	Provide an additional 1 carriage on Oxford-London Marylebone services by 2024
PGCO7	Provide an additional 2 carriages on Oxford-London Marylebone services by 2028
PGCO8	Provide an additional 2-3 carriages on Oxford-London Marylebone services by 2033
PGCO9	Provide an additional 3-4 carriages on Oxford-London Marylebone services by 2038
PGCO10	Provide an additional 5-6 carriages on Oxford-London Marylebone services by 2050
PGCO11	Provide an additional 1-2 carriages on Oxford corridor stopping services by 2028
PGCO12	Provide an additional 1-3 carriages on Oxford corridor stopping services by 2033
PGCO13	Provide an additional 2-4 carriages on Oxford corridor stopping services by 2038
PGCO14	Provide an additional 3-5 carriages on Oxford corridor stopping services by 2050

Figure 16 – Passenger capacity conditional outputs – peak hour

5.1.3. Connectivity

Connectivity concerns how well connected two places are by rail, and the ease and attractiveness of travelling between them. ORCS adopts the standard premise of strategic rail planning that connectivity should increase with economic activity – larger hubs require better connectivity. Since connectivity improvements not only respond to but also generate economic activity providing the level of connectivity required to support planned growth in Oxfordshire is likely also to induce additional growth.

Connectivity in Oxfordshire is considered according to two structural principles:

1. Local connectivity – between two stations within Oxfordshire
2. Inter-regional connectivity – between an Oxfordshire station and a major town or city outside Oxfordshire

Local connectivity includes consideration of new stations in Oxfordshire, whilst inter-regional connectivity includes consideration of London commuting connectivity, and connectivity to Heathrow Airport.

Identifying connectivity conditional outputs require a relatively more complex method to determine the quality of rail connectivity today and what improvements are required to support forecast growth.

Primarily, ORCS connectivity conditional outputs use the metric of **Generalised Journey Time (GJT)**. This is an established metric that accounts for journey time, the frequency of service, and interchange requirements to provide an objective measure of connectivity. Because it includes values for frequency and interchange GJT can be significantly greater than actual best-case journey time. GJT can be improved by reducing journey time, increasing frequency of service, removing interchanges, or a combination of the three.

Connectivity conditional outputs are proposed to bridge the gap between current connectivity and connectivity required in future years to support planned growth in the form of generalised journey time (GJT) improvements between locations.

Whilst connectivity targets are calculated for each timeframe the conditional outputs are specified for the timeframe 2033. This timeframe represents the culmination of the OPGS and the point at which there is most divergence from the Do Nothing scenario. However, targets for the other timeframes inform the proposed train service specifications.

5.1.4. Local connectivity

Local connectivity involves services between stations within Oxfordshire. In order to understand the required connectivity improvements between Oxfordshire stations arising from planned growth the existing level of connectivity from all stations to Oxford is taken as a benchmark. The level of connectivity provided in 2019 between each Oxfordshire station and Oxford itself is assumed to be adequate for a demand flow of that size. Crucially the demand flow is by all modes, not only by rail. The necessary level of rail connectivity can then be established as the size of flow grows according to OPGS forecasts.

Conditional outputs specify the required connectivity level in the form of GJT where improvements are required. The required GJT is calculated using the following method:

1. A *connectivity value* is calculated from each Oxfordshire station to Oxford by comparing the *generalised speed* (GJT divided by miles by rail) of the rail service against the theoretical 'crow fly' time (i.e. a direct route at a constant speed) for the same journey.
    a. This metric allows comparison between all flows and considers the frequency, speed, circuitousness and interchange requirement of the rail journey.
2. The *connectivity value* for each station is plotted against the overall demand to Oxford by all modes, resulting in a benchmark connectivity profile (Figure 17 –). This allows the required *connectivity value* between any two sizes of location to be inferred.

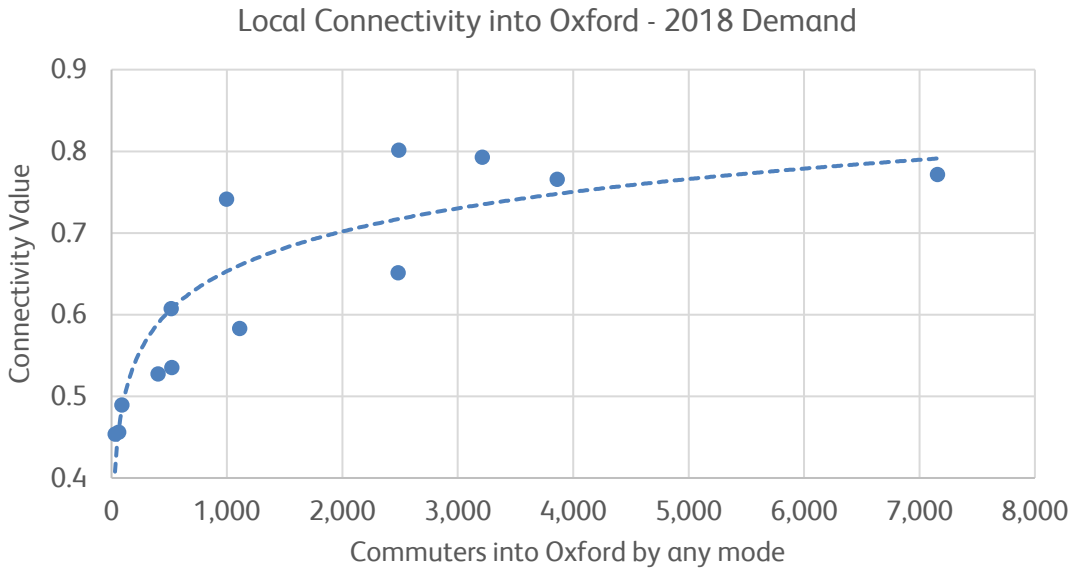


Figure 17 – Aspirational connectivity profile for local flows based on benchmark of current flows into Oxford

3. Overall demand by all modes between all MSOAs within Oxfordshire is determined using 2011 Census travel to work data.
4. Overall demand by all modes is uplifted in line with OPGS housing (origin demand) and employment (destination demand) forecasts.
5. MSOAs are associated with stations using the mapping undertaken in the OPGS construction, with the same distance factors applied. This yields a demand forecast matrix for all stations for any given year.
6. The required *connectivity value* is then determined by comparing the forecast commuting demand by all modes against the benchmark profile. The connectivity conditional output in the form of GJT is calculated by converting the *connectivity value* to *generalised speed* and then GJT.

One of the strengths of this method is that by considering demand by all modes it identifies rail connectivity improvements for markets that are not currently well served by rail. Looking only at rail demand between Didcot and Bicester, for example, would suggest this is not an important flow and therefore does not require significant improvement, whereas considering demand by all modes reveals that it is a significant flow, but is not well served by rail.

Connectivity between 19 pairs of Oxfordshire stations needs improving (Figure 18) in 2033. These 19 improvements are the conditional outputs for local connectivity. They are prioritised based on a function of overall size of demand, growth in demand, and GJT improvement required. Each conditional output specifies the GJT that should be achieved.

The 19 conditional outputs can be summarised by three themes:

1. Improve GJT between Bicester Village and Didcot Parkway by c.20 minutes
2. Improve GJT between intermediate stations on the Bicester to Didcot arc of Oxford parkway, Oxford and Culham by c.10 minutes
3. Improve GJT between Hanborough and Didcot Parkway by c.15 minutes

Because the method is responsive to demand as it grows in line with local plan sites both the number of priority flows and the aspirational GJT values change over the timeframes. As hubs grow new flows are prioritised, and the connectivity requirement increases. There are 18 connectivity targets for 2024 and 21 for 2050. Conditional outputs are based around 2033, which represents the full build out of local plan growth.

5.1.5. Conditional output statements – local connectivity

Ref.		Origin	Destination		GJT (mins)	Priority
PGCO15	For the flow…	Culham	Oxford	…Provide a GJT of…	45	*1*
PGCO16		Hanborough	Didcot Parkway		59	*2*
PGCO17		Didcot Parkway	Culham		46	*3*
PGCO18		Oxford Parkway	Didcot Parkway		59	*4*
PGCO19		Culham	Didcot Parkway		47	*5*
PGCO20		Bicester Village	Didcot Parkway		65	*6*
PGCO21		Hanborough	Oxford Parkway		56	*7*
PGCO22		Didcot Parkway	Bicester Village		66	*8*
PGCO23		Hanborough	Bicester Village		65	*9*
PGCO24		Didcot Parkway	Oxford Parkway		62	*10*
PGCO25		Oxford Parkway	Hanborough		61	*11*
PGCO26		Didcot Parkway	Hanborough		67	*12*
PGCO27		Oxford	Culham		48	*13*
PGCO28		Oxford Parkway	Banbury		66	*14*
PGCO29		Cholsey	Oxford		53	*15*
PGCO30		Hanborough	Banbury		68	*16*
PGCO31		Hanborough	Radley		62	*17*
PGCO32		Culham	Cholsey		71	*18*
PGCO33		Radley	Oxford Parkway		62	*19*

Figure 18 – Local connectivity conditional outputs (prioritised GJT aspirations)

5.1.6. New Stations connectivity

Another strength of the method used to derive GJT requirements between Oxfordshire stations is that is provides a framework to understand the role that a new station might be expected to play in the OPGS. The exercise of mapping MSOAs to stations is revised to factor in the proposed new stations and their catchment areas, based on stakeholder expertise.

The same method is used to calculate the total demand flow by all modes from the MSOAs served by the new stations to all other MSOAs. The rail GJT required to deliver a *connectivity value* in line with size of demand flow is then identified. Demand flows only appear as priorities where the size of demand flow is big enough to trigger a rail connectivity value in line with the benchmarking exercise.

Four potential new stations identified by stakeholders are considered – two on the Cowley Branch Line, known as Oxford Science Park and Oxford Business Park, one known as Grove on the GWML west of Didcot Parkway, and one known as Begbroke north of Oxford. Connectivity to long distance commuting destinations is also considered in addition to local connectivity for these new stations. Analysis of the connectivity requirements of new stations is against the timeframe 2033.

In the OPGS there is:

- Considerable demand between the Cowley branch stations and other Oxfordshire stations, particularly as employment destinations – 17 out of 20 local flows and 2 out of 4 priority long distance commuting flows involve Oxford Science Park or Business Park.
- Moderate demand between Grove station and Didcot Parkway, Oxford, London, and Swindon owing to housing growth around Grove generating commuting journeys – 2 out of the 20 local flows and 2 out of 4 priority long distance commuting flows involve Grove.
- Limited demand between Begbroke and Oxford owing to housing growth around Begbroke, with some abstraction from Hanborough – 1 out of 20 priority flows and 0 out of 4 priority long distance commuting flows involves Begbroke.

New station priority demand flows are presented in Figure 19. An analogous existing flow (by all modes) is included for comparison. It cannot be inferred that there should be an equivalent level of service between the new station flow and analogous flow. The distance between locations and competition with other modes is not equivalent. Caution is required for very short flows and those where the destination is far from the station, as alternative travel modes may be preferable. However, the indication of market size for which new stations would provide rail options is useful.

Priority	Origin	Destination	Commuters (all modes)	Existing analogous flow
1	Oxford Science Park	Oxford	5512	Hanborough - Oxford
2	Oxford Business Park	Oxford	3508	Oxford – Didcot
3	Oxford	Oxford Business Park	3429	Oxford – Didcot
4	Oxford	Oxford Science Park	2957	Bicester Village- Oxford
5	Grove	Didcot Parkway	3268	Bicester Village- Oxford
6	Oxford Science Park	Oxford Business Park	2602	Radley – Oxford
7	Begbroke	Oxford	1610	Culham - Oxford
8	Oxford Parkway	Oxford Business Park	1166	Oxford Parkway – Bicester Village
9	Hanborough	Oxford Business Park	1130	Oxford Parkway – Bicester Village
10	Didcot Parkway	Oxford Science Park	1029	Hanborough – Didcot
11	Grove	Oxford	1069	Hanborough – Didcot
12	Bicester Village	Oxford Business Park	988	Hanborough – Didcot
13	Hanborough	Oxford Science Park	882	Oxford – Culham
14	Didcot Parkway	Oxford Business Park	902	Oxford – Culham
15	Oxford Parkway	Oxford Science Park	919	Oxford – Culham
16	Radley	Oxford Business Park	767	Oxford Parkway – Didcot
17	Oxford Business Park	Oxford Science Park	1283	Banbury – Oxford
18	Radley	Oxford Science Park	792	Oxford Parkway – Didcot
19	Culham	Oxford Science Park	761	Oxford Parkway – Didcot
20	Culham	Oxford Business Park	663	Oxford Parkway – Hanborough
Long distance commuting				
1	Grove	London	581	Oxford – Reading
2	Oxford Science Park	London	401	Charlbury – London
3	Oxford Business Park	London	322	Oxford – Swindon
4	Grove	Swindon	494	Culham - London

Figure 19 – New stations priority flows with OPGS 2033 demand

Notably, the four highest priority flows are between Oxford and the Cowley Branch Line stations. Flows between these stations and Oxford Parkway, Hanborough, and Didcot Parkway also feature, and there is demand for long distance commuting to London.

Conditional outputs for new stations state the priorities of connectivity improvements which represent the case for further investigation. A thorough demand forecasting exercise is required if any aspiration is to develop.

5.1.7. Conditional output statements – new stations connectivity

Ref	Conditional Output
PGC043	The priority of new stations in Oxfordshire is: 1. Oxford Science Park and Oxford Business Park (Cowley Branch Line stations) 2. Grove 3. Begbroke
PGC044	Connectivity priorities for the Cowley Branch Line stations are: 1. Oxford 2. Oxford Parkway 3. Hanborough 4. Didcot Parkway 5. London
PGC045	Connectivity priorities for Grove are: 1. Didcot Parkway 2. Oxford 3. London 4. Swindon
PGC046	Connectivity priority for Begbroke is Oxford

Figure 20 – New stations connectivity conditional outputs

5.1.8. London commuting connectivity

London is a special case as by far the largest economic hub in Oxfordshire's orbit, and the source of the highest long-distance commuting demand from Oxfordshire by a distance.

Oxfordshire enjoys a high volume of services to London, with routes via Reading to London Paddington and via Bicester Village to London Marylebone. However, as hubs across Oxfordshire grow, ever better connectivity with London is required.

To understand the requirements for London services in the OPGS the local connectivity method of identifying a connectivity value to establish GJT requirements is reprised. This reveals that London requires enhanced connectivity from each of Oxfordshire's seven growth hubs (Figure 21) in the 2033 timeframe.

Oxfordshire hub	Additional London commuters	GJT improvement required (mins)
Oxford	13 %	19
Banbury	20 %	28
Oxford Parkway	21 %	26
Hanborough	20 %	27
Didcot Parkway	31 %	10
Bicester Village	29 %	11
Culham	44 %	13

Figure 21– Growth in London commuting market and GJT improvement required – 2033

As for local connectivity the conditional outputs for London commuting are in the form of GJTs to be achieved for each priority flow.

5.1.9. Conditional output statements – London commuting connectivity

Ref.		Origin	Destination		GJT (mins)	Priority
PGCO35	For the flow…	Oxford	London	…Provide a GJT of…	74	*1*
PGCO36		Banbury	London		84	*2*
PGCO37		Oxford Parkway	London		84	*3*
PGCO38		Hanborough	London		87	*4*
PGCO39		Didcot Parkway	London		66	*5*
PGCO40		Bicester Village	London		91	*6*
PGCO41		Charlbury	London		100	*7*
PGCO42		Culham	London		103	*8*

Figure 22 – London commuting connectivity conditional outputs

5.1.10. Inter-regional connectivity

Inter-regional connectivity involves services between an Oxfordshire station and a major town or city outside Oxfordshire. 16 regional towns and cities are identified by stakeholders as high priority inter-regional connections, based on their size, proximity, and strategic significance.

These 16 are analysed to determine the relationship between connectivity improvements and economic growth in order to define priorities for improved connectivity based on the 2033 timeframe.

Improving connectivity delivers economic growth through agglomeration benefits – improved productivity resulting from labour market interaction, knowledge transfer, and linkages between goods and suppliers. Improved GJT delivers agglomeration benefits by increasing the effective proximity of economic hubs in the form of businesses, jobs, and workers.

The relative value of improving inter-regional connections is determined using the DfT's WITA model, which calculates the GJT improvement that would be required to generate a fixed economic benefit, in the form of an uplift in Oxfordshire's GDP.

The analysis reveals that the relationship between GJT improvement and agglomeration benefit is a function of the proximity of the destination to Oxfordshire and the size of the economic hub at the destination.

The 16 inter-regional connections are presented by the proportional GJT improvement required to deliver a fixed increase in Oxfordshire's GDP output (Figure 23). Larger hubs and hubs nearer Oxford require less proportional GJT improvement to deliver the same economic benefit.

Inter-regional connection	GJT 2019	% improvement to deliver equivalent benefit	Interchange required 2019?
Birmingham	96	3%	N
Reading	43	4%	N
Bristol	145	7%	Y
Swindon	87	7%	Y
Coventry	87	9%	N
High Wycombe	76	12%	N
Manchester	222	14%	N
Milton Keynes	178	14%	N
Cardiff	187	15%	Y
Northampton	172	16%	Y
Leicester	211	22%	Y
Worcester	155	25%	N
Derby	114	25%	N
Bedford	263	33%	N
Cheltenham	181	35%	Y
Cambridge	276	47%	Y

Figure 23 – Prioritised inter-regional connections based on % GJT improvement required to deliver equivalent GDP uplift

The GJT improvements required are calibrated to achieve the same economic benefit. Therefore, conditional outputs cannot be derived from the GJT values themselves, as they can for local connectivity. Instead the GJT values are a measure of efficiency to guide where connectivity improvements should be concentrated. Therefore, one conditional output for inter-regional services is to prioritise those flows requiring the least improvement in order to realise an equivalent benefit.

GJT can be substantially improved by removing an interchange. Therefore, the other conditional output for inter-regional services is to prioritise those connections where removal of an interchange would form a high proportion of the GJT improvement required. This is intuitive, reflecting that the attractiveness of a journey between Oxford and Swindon, for example, is greatly enhanced if that journey can be made without interchange.

5.1.11. Conditional output statements – inter-regional connectivity

Ref	Conditional Output
PGCO47	Prioritise improving inter-regional connections to connections where smaller GJT improvements are required to deliver the same economic benefit (Birmingham, Reading, Bristol, and Swindon).
PGCO48	Prioritise improving inter-regional connections where an interchange delivers a high proportion of GJT improvement required (Bristol, Swindon, Cardiff, and Northampton)

Figure 24 – Inter-regional connectivity conditional outputs

5.1.12. Heathrow Airport connectivity

Oxford is a key source of demand for Heathrow Airport. Demand from Oxford to Heathrow by any mode of transport is higher than from any other major town or city in the south east outside London in the year 2021 in forecasts undertaken for the Western Rail Link to Heathrow project.

A high share of demand flow from Oxford to Heathrow is by road, including a share of 60 % by coach, which reflects poor GJT by rail when compared to journey time by road.

The appropriate level of rail connectivity between Oxford and Heathrow is identified by comparing the relative road and rail offering with the other settlements in the Western Rail Link to Heathrow analysis. This provides a measure of how well the rail service competes against the road alternative for each flow.

As the size of the flow increases the rail system should aim to deliver a more competitive service relative to road. Plotting the ratio of rail GJT to road journey time for each settlement against forecast demand reveals that although demand from Oxford is the highest by some distance the ratio is no better than average among settlements (Figure 25).

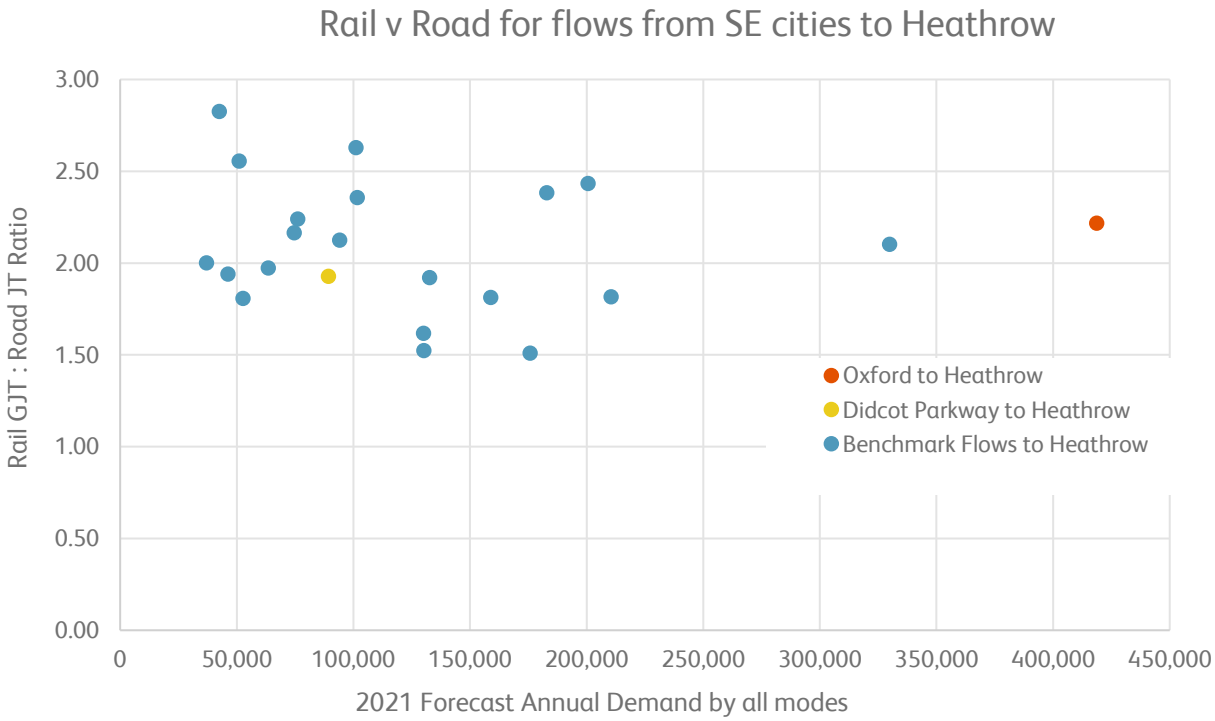


Figure 25 – Road rail relationship for flows to Heathrow from regional centres across the south east, plotted against forecast demand

Of the sampled flows whose rail access to Heathrow is via the GWML Oxford has the second highest Rail GJT : Road JT ratio.

In order for the rail service to support the scale of demand from Oxford to Heathrow the Rail GJT : Road JT ratio should be the lowest of the sampled flows. Therefore, connectivity between Oxford and Heathrow requires improvement. This is calculated as a GJT improvement of 30-40 minutes for an overall GJT of under 100 minutes.

5.1.13. Conditional output statements – Heathrow Airport connectivity

Ref.	Conditional Output
PGCO49	Improve GJT from Oxford to Heathrow by 30-40 minutes
PGCO50	Provide a GJT from Oxford to Heathrow of under 100 minutes

Figure 26 – Heathrow Airport connectivity conditional outputs

5.2. Conditional Outputs for freight

Freight conditional outputs follow the broad themes of capacity and capability. Freight conditional outputs for Oxfordshire's rail system are derived from the analysis of the rail freight market in Oxfordshire as described in section 4.2. Capability outputs are grouped into the themes Opportunity, Access, Capability, Junctions, and Environment.

5.2.1. Conditional output statements – freight capacity

Theme	Conditional Output
Capacity	Between Didcot North and Oxford North Junction (total including both directions): • Provide 6 freight paths per hour in 2024 • Provide 7 freight paths per hour in 2033 • Provide 8 freight paths per hour in 2043
	Of which: • 1 freight path per hour to/from Didcot West Junction and the remainder to/from Didcot East Junction scenarios • *And* – from the introduction of East West Rail – 2 freight paths per hour to/from Bletchley via EWR and the remainder to/from Banbury • *And* 2 freight paths per hour capable of 1,600 tonne weight 775m length train.

Figure 27 – Freight capacity conditional outputs

5.2.2. Conditional output statements – freight capability

Theme	Conditional Output
Opportunity	• Retain the capability for rail freight to and through Oxfordshire throughout the study period – recognising the size and benefits of the rail freight industry and the criticality of the rail system in Oxfordshire to it. • Provide the opportunity for rail freight to benefit from East West Rail Western and Central sections – recognising the significant opportunities of reduced journey times and avoidance of congested sections of the network. • Recognise opportunity to support major infrastructure projects in and outside Oxfordshire with rail freight.
Access	• Coordinate disruptive works such as undertaking renewals during enhancement blockades to minimise the impacts on freight services of routine (i.e. overnight) access restrictions. • Optimise signal spacing to increase capacity during bi-directional running / one-track operation that is a routine occurrence under the maintenance regime. • Develop a W10 gauge diversionary route avoiding Oxfordshire that provides viable journey times.

	• Increase hours of access to a fully functioning rail system towards an ideal of 24 hours.
Capability	• Accommodate 775 metre long and 1,600 tonne weight freight trains throughout Oxfordshire's rail system. • Retain capability of the Bicester MOD site. • Retain capability of the Hinksey Network Rail site, which is critical for Network Rail possession services. • Retain the ability to serve the BMW Cowley site at no less than current frequency of freight services. • Reduce the operational impact of moves between the Cowley branch and southbound locations (e.g. Didcot and beyond).
Junctions	• Raise the speed of Kennington Junction to the Cowley branch to minimise the impact on mainline services. • Raise the speed of the crossover between the mainline (DCL) and Bicester line (OXD) at Oxford North Junction to allow freight trains to maintain speed of at least 60mph. • Retain the current looping capability in Oxford station area delivered by Oxford Phase 1 project.
Environment	• Reduce the relative environmental impact of rail freight including noise, vibrations, and emissions by embracing new locomotive and wagon technologies. • Reconsider the aims and objectives of the electric spine programme, recognising the potential environmental benefits of increasing electric rail freight.

Figure 28 – Freight capability conditional outputs

6. Oxfordshire Train Service Specifications

The principal output of ORCS is a suite of Oxfordshire Train Service Specifications that propose the volume and configuration of passenger and freight train services that need to operate in Oxfordshire in order to meet the Conditional Outputs for Oxfordshire's rail system.

A Train Service Specification is proposed for each timeframe, each building on the previous specification incrementally to meet as many conditional outputs as possible with as few services, in order to make best use of network capacity.

Proposed specifications are developed through a process of identifying suites of services and testing these against the conditional outputs and refining where necessary in order to best meet the outputs.

Each specification builds on the preceding one, with the 2024 specification building on the timetable structure introduced in December 2019. The 2024 specification is limited to services that the system can support after delivery of Oxford Phase 2 and East West Rail Western Section because significant interventions to enable other new services are not feasible in the timeframe. Subsequent specifications are unconstrained by infrastructure.

The endorsed Oxfordshire Train Service Specifications are subject to analysis to identify system interventions that are required to deliver them. A programme of required interventions to deliver the specifications constitutes an investment portfolio for the rail system in Oxfordshire and is the final ORCS output. However, the Oxfordshire Train Service Specifications are an important output and will act as the strategic baseline for rail system planning in Oxfordshire, and as a weight to inform and influence wider programmes as they develop.

6.1. Constructing the Oxfordshire Train Service Specifications

The Oxfordshire Train Service Specifications are constructed by identifying new and extended services that are required to meet the Conditional Outputs for Oxfordshire's rail system.

A number of existing programmes at various stages of development propose new passenger services for Oxfordshire. These proposed new services comprise the initial proposals for the Oxfordshire specifications. By using previously identified service enhancements as a base ORCS recommendations are strategically aligned and based in the body of existing strategic and development work.

Identified services are batched into timeframe years based on envisaged delivery to form initial specifications for each timeframe. These are added to the base specification and GJTs are calculated and tested against conditional outputs. The specification is also tested against the capacity outputs.

Where conditional outputs are not achieved opportunities to amend services and introduce new services are identified, prioritised according to outstanding conditional outputs. GJTs are then recalculated and re-tested against conditional outputs and this process of refinement is continued until the optimal specification is reached.

The optimal specification of services forms the Oxfordshire Train Service Specification for each timeframe.

This method – simplified in Figure 29 – yields an objective measure of whether conditional outputs are achieved for capacity outputs and those connectivity outputs phrased as GJT targets. For inter-regional connectivity conditional outputs it gives an objective measure of the extent of improvements delivered against the priorities.

	Train Service Specification development process
1.	Services identified that could meet conditional outputs
2.	Services batched to form specification for each timeframe based on envisaged delivery
3.	Specifications analysed to calculate GJTs (using MOIRA2) and capacities by adding new services to December 2019 base
4.	Specifications tested against conditional outputs
5.	Specifications refined according to conditional output shortfalls
6.	Specifications re-tested and confirmed

Figure 29 – Simplified Train Service Specification development process

6.2. Identifying proposed new services

Proposed new services are identified initially from programmes currently in development that have reached or are approaching the Strategic Outline Business Case stage. These consist of: East West Rail Western and Central Sections, Oxford Phase 2, Midlands Engine Rail, and the North Cotswolds Line Task Force (NCLTF). The exceptions are new services arising directly from ORCS conditional outputs, which includes the new stations.

The timeframes and specifications of the new services proposed by these programmes inform the initial specifications tested against the conditional outputs (Figure 30).

	Enhancement	Source	Tph	Origin	Destination	Oxfordshire calls (& inter-regional hubs)
2024	EWR Western Section	EWR	2	Milton Keynes	Oxford	(Milton Keynes), Bicester Village, Oxford Parkway, Oxford
	EWR Western Section	EWR	1	Bedford	Oxford	(Bedford), Bicester Village, Oxford Parkway, Oxford
	Oxford Phase 2	Chiltern	0.5	Birmingham	Oxford	(Birmingham Moor St), Banbury, Oxford
2028	Cowley Branch	ORCS	2	Cowley	Oxford	Oxford Business Park, Oxford Science Park, Oxford
	Hanborough	NCLTF	2	Hanborough	Oxford	Hanborough, Oxford
	North Cotswolds	NCLTF	1	Paddington	Gt Malvern	Oxford, Hanborough, (Worcester)
	EWR Central Section	EWR	2	Cambridge	Oxford	(Cambridge), (Bedford), Bicester Village, Oxford Parkway, Oxford
	Coventry corridor	Midlands Engine Rail	1	Birmingham	Oxford	(Birmingham Moor St), Banbury, Oxford
	Solihull Corridor	Midlands Engine Rail	1	Birmingham	Oxford	(Birmingham Moor St), Banbury, Oxford
	Banbury shuttle	ORCS	0.5	Banbury	Oxford	Banbury, Heyford, Tackley, Oxford
	Grove new station	ORCS	~	~	~	*Hourly call in EWR Central Section service*
2033	EWR+	EWR	2	Cambridge	Oxford	(Cambridge), (Bedford), Bicester Village, Oxford Parkway, Oxford
	Begbroke new station	ORCS	~	~	~	*Hourly call in Banbury shuttle*

Figure 30 – Initial specifications of identified new services by timeframe

Freight conditional outputs are built into the specifications according to the year in which additional capacity is required (Figure 31). Increases in freight capacity in future scenarios are assumed to be outside the high peak hour in keeping with network strategy, whilst the baseline level of freight in the high peak is retained.

Year	Source	Tph	From	To	Notes
2024	ORCS	1	Didcot North Jn	Oxford North Jn	*- Tph column refers to in each direction* *- 0.5tph means one train every 2 hours* *- Routing in each scenario to provide:* *- 0.5tph from Didcot West* *- 1tph from Gavray Jn*
2033	ORCS	0.5	Didcot North Jn	Oxford North Jn	
2038	ORCS	0.5	Didcot North Jn	Oxford North Jn	

Figure 31 – Freight conditional outputs included in Oxfordshire Train Service Specifications

6.3. Testing initial specifications against conditional outputs

Testing the initial specifications reveals deficiencies against the majority of passenger capacity and connectivity conditional outputs. Fewer than half of the local connectivity outputs, only a third of new station outputs, and only a sixth of inter-regional outputs are met in 2033. Principally this is because the initial specification of services as per existing plans does not deliver

cross-Oxford services and so a connectivity gap across Oxford remains. Oxfordshire's seven growth hubs are not sufficiently well connected to one another or priority connections beyond Oxfordshire.

There is significant improvement against inter-regional locations, but only against 2 of the 6 conditional output priorities. Similarly, passenger capacity outputs are not met. The freight capacity outputs are met and do not require further refinement.

6.4. Refining service specifications

Refinements to the specifications are targeted at the outstanding conditional outputs, ensuring that the resulting specifications are benefit led. Strategic fit and viability are also factored using stakeholders' expert judgement. Refinements agreed to the initial specifications address the shortfalls revealed in the initial testing, namely improving connectivity across Oxford, and removing interchanges to priority inter-regional connections (Figure 32). Refinements are not confined to the identified new services but also to services in the baseline specification.

	Enhancement	Source	Tph	Origin	Destination	Refinement
2024	EWR Western Section	EWR	2	Milton Keynes	*Didcot Parkway*	Extend to Didcot in path of GW shuttle; Culham call in each service
	EWR Western Section	EWR	1	Bedford	Oxford	
	Oxford Phase 2	Chiltern	0.5	Birmingham	Oxford	
2028	Cowley Branch	ORCS	2	Cowley	*London Marylebone*	Formed by extension of 2 Marylebone trains
	Hanborough	NCLTF	2	Hanborough	*Didcot Parkway / London Pad*	Extend 1 to Didcot & 1 to London; Culham call in each service
	North Cotswolds	NCLTF	1	Paddington	Gt Malvern	
	EWR Central Section	EWR	2	Cambridge	*Bristol / Southampton*	Extend 1 to Bristol and 1 to Southampton
	Coventry corridor	Midlands Engine Rail	1	Birmingham	*Bristol*	Extend to Bristol
	Solihull Corridor	Midlands Engine Rail	1	Birmingham	Oxford	
	Banbury shuttle	ORCS	0.5	Banbury	Oxford	
	Grove new station	ORCS	~	*Hourly call in EWR CS service*		
2033	EWR+	EWR	2	Cambridge	Oxford	
	Begbroke new station	ORCS	~	*Hourly call in Banbury shuttle*		

Figure 32 – Refinements (red) to the initial specifications

Iterations of refinements to the service specifications are re-tested against the conditional outputs, with notable improvement. Final refinements result in optimised specifications that

meet a large majority of conditional outputs and represent the most beneficial viable service (Figure 33). These form the proposed Oxfordshire Train Service Specifications.

CO category		Initial TSS	Additional	Final TSS
Local Connectivity	2024	6 %	44 %	**44%**
	2028	37 %	74 %	**74%**
	2033	42 %	74 %	**84%**
	2038	45 %	-	**85%**
	2050	43 %	-	**81%**
New stations	2024	**-**	**-**	**-**
	2028	35 %	53 %	**53%**
	2033	35 %	53 %	**53%**
Inter-regional	2024	17 %	17 %	**17%**
	2028	33 %	66 %	**100%**
	2033	33 %	100 %	**100%**
Heathrow	2024	0 %	-	**0%**
	2028	100 %	-	**100%**
	2033	100 %	-	**100%**

Figure 33 – Conditional outputs met by initial and refined service specifications

6.4.1. Refinements to East West Rail services

Refinements are proposed to the East West Rail Western and Central Section services in order to meet conditional outputs. Both differ from the configuration proposed by East West Railway Company, which currently sees all East West Rail services terminate at Oxford. In particular, extension of Central Section services to Bristol and Southampton is a significant departure and may not be acceptable as part of East West Rail. These services are specified in this study because they are required to meet conditional outputs, assessed as strategically feasible by the study working group, and align with previous strategic studies including Network Rail's Western Route Study (2015). Should they prove not to be deliverable alternative means of delivering conditional outputs will need to be considered, or acceptance that not all can be met.

6.5. The Oxfordshire Train Service Specifications

Both peak hour and off-peak Oxfordshire Train Service Specifications are presented for each timeframe (Figure 34 and Figure 35). The base 2019 train service specification is also presented, with each specification building from its predecessor. Services are grouped and colour coded for comparison and legibility.

The conditional outputs primarily describe a peak level of service in the 2033 timeframe, and therefore the peak specification is assessed against the conditional outputs. The off-peak hour specification includes the additional freight capacity required and a slightly reduced level of passenger services in line with both the base specification and wider system strategy.

The Oxfordshire Train Service Specifications represent a significant uplift in the number of services compared to the base specification – 54 % in the 2028 timeframe and 69 % in the 2033 timeframe. This reflects the scale of improvement required to support the level of growth in Oxfordshire.

There is a step change in the volume of services proposed in 2028. This reflects the phasing of growth in the local plan period under consideration in the OPGS. Whilst 2033 is the first timeframe that includes the entirety of OPGS growth in fact the majority is delivered by 2028 and therefore drives the 2028 specification.

6.5.1. The Oxfordshire Train Service Specification – peak hour

2019 **13tph**

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Oxford (Banbury)	Paddington
GW fast	Worcester SH	Paddington
GW fast	Hereford	Paddington
GW slow	Banbury	Didcot
GW slow	Oxford	Reading
XC	Birmingham NS	Southampton
XC	Manchester	Bournemouth
Chiltern	Oxford	Marylebone
Chiltern	Oxford	Marylebone
Chiltern	Oxford	Marylebone
Freight	*Aynho jn*	*Didcot North jn*
Freight	*Aynho jn*	*Didcot North jn*

2024 **15tph**

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Oxford (Banbury)	Paddington
GW fast	Worcester SH	Paddington
GW fast	Hereford	Paddington
XC	Birmingham NS	Southampton
XC	Manchester	Bournemouth
Chiltern	Oxford	Marylebone
Chiltern	Oxford	Marylebone
Chiltern	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR WS	Bedford	Oxford
Shuttle	Banbury	Oxford

2028 **20tph**

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Oxford (Banbury)	Paddington
GW fast	Worcester SH	Paddington
GW fast	Hereford	Paddington
XC	Birmingham NS	Southampton
XC	Manchester	Bournemouth
Chiltern	Cowley	Marylebone
Chiltern	Cowley	Marylebone
Chiltern	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR CS	Cambridge	Bristol
EWR CS	Cambridge	Southampton
Shuttle	Banbury	Oxford
NCLTF	Hanborough	Didcot
NCLTF	Hanborough	Paddington
Midlands	Birmingham MS	Bristol
Midlands	Birmingham MS	Oxford

2033 **22tph**

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Oxford (Banbury)	Paddington
GW fast	Worcester SH	Paddington
GW fast	Hereford	Paddington
XC	Birmingham NS	Southampton
XC	Manchester	Bournemouth
Chiltern	Cowley	Marylebone
Chiltern	Cowley	Marylebone
Chiltern	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR CS	Cambridge	Bristol
EWR CS	Cambridge	Southampton
Shuttle	Banbury	Oxford
NCLTF	Hanborough	Didcot
NCLTF	Hanborough	Paddington
Midlands	Birmingham MS	Bristol
Midlands	Birmingham MS	Oxford
EWR+	Cambridge	Oxford
EWR+	Cambridge	Oxford

Shaded services in London direction only

Figure 34 – Oxfordshire Train Service Specification – peak hour

6.5.2. The Oxfordshire Train Service Specification – off peak hour

2019 10tph

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Great Malvern	Paddington
GW slow	Oxford	Didcot
GW slow*	Oxford	Didcot
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Oxford	Marylebone
CR	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Aynho jn*	*Didcot North jn*

**extends to Banbury every 3 hours*

2024 14tph

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Great Malvern	Paddington
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Oxford	Marylebone
CR	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR WS	Bedford	Oxford
CR*	Birmingham MS	Oxford
Shuttle	Banbury	Oxford
Freight	*Oxford North jn*	*Didcot North jn*

**alternate hours to Ban-Oxf shuttle for 1tph*

2028 16tph

Type	Origin	Destination
GW fast	Worcester SH	Paddington
GW fast	Great Malvern	Paddington
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Cowley	Marylebone
CR	Cowley	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR CS	Cambridge	Bristol
EWR CS	Cambridge	Southampton
Shuttle	Banbury	Oxford
Freight	*Oxford North jn*	*Didcot North jn*
NCLTF	Hanborough	Didcot
Midlands	Birmingham	Bristol

2033 17.5tph

Type	Origin	Destination
GW fast	Worcester SH	Paddington
GW fast	Great Malvern	Paddington
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Oxford	Marylebone
CR	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR CS	Cambridge	Bristol
EWR CS	Cambridge	Southampton
Shuttle	Banbury	Oxford
Freight	*Oxford North jn*	*Didcot North jn*
NCLTF	Hanborough	Didcot
Midlands	Birmingham	Bristol
EWR+	Cambridge	Oxford
*Freight**	*Oxford North jn*	*Didcot North jn*

**0.5 ftph*

Figure 35 – Oxfordshire Train Service Specification – off peak hour

6.6. The service specifications explained

Each specification builds on the December 2019 specification and includes at minimum the same level of service. New services in the 2024 specification are limited to those that the system can support after delivery of Oxford Phase 2 and East West Rail Western Section. Subsequent specifications are not constrained by fixed infrastructure assumptions but informed by stakeholders' expert judgement on viability and wider system strategic fit.

6.6.1. The 2019 specification

The 2019 base specification includes five service groups: GW London services; GW local services; Inter-regional services; Chiltern London services; and Freight services.

The basic pattern is two trains per hour in each direction for each service group, totalling 10 trains per hour in each direction. This is augmented in the peaks by additional London trains, with a slight skew in the Up (London) direction in both one-hour peaks (Figure 36).

	AM peak		Off peak		PM peak	
	Up	Dn	Up	Dn	Up	Dn
GW fast	4	2	2	2	3	2
GW slow	2	2	2	2	2	2
CrossCountry	2	2	2	2	2	2
Chiltern	3	3	2	2	4	3
Freight	2	2	2	2	2	2
Total	**13**	**11**	**10**	**10**	**13**	**11**
Grand total	24		20		24	

Figure 36 – Service levels at Oxford in the base, 2019 specification

GW slow trains all serve the Oxford to Didcot corridor with most calling at Radley, some at Culham and few at Appleford. Some run through to Reading to maintain peak local connectivity, and extend to Banbury and occasionally Moreton-in-Marsh. GW fast trains to London Paddington consist of one service from Worcester and one from Oxford in the off peak, with additional trains in the morning peak starting back along the North Cotswold route from Worcester or Great Malvern, with one from Banbury. Inter-regional and Chiltern London services each follow a regular pattern.

All improvements required – the conditional outputs – are against this specification.

6.6.2. The 2024 specification

2024 Peak hour 15tph

	Type	Origin	Destination
1	GW fast	Oxford	Paddington
2	GW fast	Oxford (Banbury)	Paddington
3	GW fast	Worcester SH	Paddington
4	GW fast	Hereford	Paddington
5	XC	Birmingham NS	Southampton
6	XC	Manchester	Bournemouth
7	Chiltern	Oxford	Marylebone
8	Chiltern	Oxford	Marylebone
9	Chiltern	Oxford	Marylebone
10	*Freight*	*Oxford North jn*	*Didcot North jn*
11	*Freight*	*Oxford North jn*	*Didcot North jn*
12	EWR WS	Milton Keynes	Didcot
13	EWR WS	Milton Keynes	Didcot
14	EWR WS	Bedford	Oxford
15	Shuttle	Banbury	Oxford

2024 Off peak hour 14tph

Type	Origin	Destination
GW fast	Oxford	Paddington
GW fast	Great Malvern	Paddington
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Oxford	Marylebone
CR	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR WS	Bedford	Oxford
CR*	Birmingham MS	Oxford
Shuttle	Banbury	Oxford
Freight	*Oxford North jn*	*Didcot North jn*

**alternate hours to Ban-Oxf shuttle for 1tph*

Figure 37 – Oxfordshire Train Service Specification 2024

The assumed infrastructure limits the extent to which services can be configured to meet identified targets in 2024, but significant improvements are achieved.

This is particularly the case in local connectivity, where extension of two East West Rail services through Oxford to Didcot delivers large improvements to priority flows between Didcot and Culham and Oxford Parkway and Bicester Village – without extension one priority flow is met whereas with extension eight priority flows are met.

Since capacity constraints dictate that these EWR extensions cannot form additional services it is assumed that they replace existing GW slow services between Didcot and Oxford. Notably, additional services are not required to deliver these benefits, merely linking two service groups. This indicates the significant beneficial impact of extending these services.

Because some of the existing GW slow services between Didcot and Oxford extend north of Oxford this leaves a connectivity gap between Banbury and Oxford, which is backfilled with a shuttle service. In alternate hours this service extends to Birmingham Moor Street, providing a small inter-regional connectivity benefit.

The introduction of East West Rail Western Section services has a large benefit in itself, significantly improving connectivity between Oxford, Oxford Parkway, and Bicester Village, as well as inter-regional connectivity through direct connections with Milton Keynes and Bedford.

The off-peak specification includes the additional freight capacity required and does not include one of the peak London Marylebone services, but is otherwise identical.

6.6.3. The 2028 specification

2028 Peak hour 20tph

	Type	Origin	Destination
1	GW fast	Oxford	Paddington
2	GW fast	Oxford (Banbury)	Paddington
3	GW fast	Worcester SH	Paddington
4	GW fast	Hereford	Paddington
5	XC	Birmingham NS	Southampton
6	XC	Manchester	Bournemouth
7	Chiltern	Cowley	Marylebone
8	Chiltern	Cowley	Marylebone
9	Chiltern	Oxford	Marylebone
10	*Freight*	*Oxford North jn*	*Didcot North jn*
11	*Freight*	*Oxford North jn*	*Didcot North jn*
12	EWR WS	Milton Keynes	Didcot
13	EWR WS	Milton Keynes	Didcot
14	EWR CS	Cambridge	Bristol
15	EWR CS	Cambridge	Southampton
16	Shuttle	Banbury	Oxford
17	NCLTF	Hanborough	Didcot
18	NCLTF	Hanborough	Paddington
19	Midlands	Birmingham MS	Bristol
20	Midlands	Birmingham MS	Oxford

2028 Off peak hour 16tph

Type	Origin	Destination
GW fast	Worcester SH	Paddington
GW fast	Great Malvern	Paddington
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Cowley	Marylebone
CR	Cowley	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR CS	Cambridge	Bristol
EWR CS	Cambridge	Southampton
Shuttle	Banbury	Oxford
Freight	*Oxford North jn*	*Didcot North jn*
NCLTF	Hanborough	Didcot
Midlands	Birmingham	Bristol

Figure 38 – Oxfordshire Train Service Specification 2028

The 2028 specification represents a very significant uplift in services and delivers an equally significant growth benefit. This is made possible by the coincidence with the envisaged service entry dates of three major programmes that will deliver new services in Oxfordshire – East West Rail Central Section, Midlands Engine Rail, and the North Cotswolds Line Task Force. All of these new services are required to support Oxfordshire's growth, and all are configured to deliver maximum benefit in the 2028 specification.

The core North Cotswolds Line Task Force service of two trains from the Worcester area and two Hanborough starters each hour is adopted. The Hanborough starters would link four of the seven Oxfordshire growth hubs and deliver crucial benefits. One of the Hanborough services is extended to London Paddington in the peak hour, providing additional London commuting connectivity from the same four growth hubs. This additional London service is deemed viable in light of proposed GWML capacity improvements. In the off-peak hour one of the Hanborough services is removed.

Both East West Rail Central Section and Midlands Engine Rail services deliver significant benefits for Oxfordshire. They improve connectivity between growth hubs (respectively Oxford, Oxford Parkway, and Bicester Village; and Oxford and Banbury) and provide a very strong service along the inter-regional arcs to Birmingham and Cambridge with clear connectivity benefits. East West Rail Central Section provides direct connectivity with Cambridge, whilst the Midlands Engine Rail services help meet the capacity conditional output for inter-regional flows north of Oxford.

However, both East West Rail Central Section and Midlands Engine Rail services require extension through Oxford in order to best support Oxfordshire's growth. Without extension only 33 % of the inter-regional priority connections are improved; with extension 100 % are. Extension to Didcot Parkway provides cross-Oxford priority flows and links Oxfordshire's growth hubs with one another and with priority inter-regional locations to the north. Further extension to the south and west of Oxfordshire provides new connections to Swindon and Bristol and strengthens connectivity with Reading and the south coast, maximising the inter-regional benefits of these new services.

The extensions to East West Rail Central Section services to Bristol and Southampton are recommended by this study but do not align with the current East West Railway Company service specification. Further development should seek to develop the case for these extensions, but alternative means of providing these services should be considered, alongside the implications of not extending these services on the Oxford corridor.

Provision of a direct service between Oxford and Swindon and Bristol has major benefit, and the specification of two trains per hour represents an adequate level of service both to encourage modal shift and facilitate economic growth. The service is formed of one Midlands Engine Rail train one East West Rail Central Section in order to offer the maximum number of new direct journeys. Grove is added as a station call taking advantage of one of these services and reflecting its potential role.

Extension of the other East West Rail Central Section to Southampton via Reading again creates entirely new journey options and strengthens connectivity on a priority arc. It also helps meet the capacity conditional output for inter-regional flows south of Oxford.

The benefits of extending the proposed new inter-regional services are likely to extend beyond Oxfordshire. Both access the core GWML market at Didcot Parkway and provide a new range of direct journey options far beyond Oxfordshire.

The Cowley Branch Line stations are introduced for 2028 in recognition of the significant growth areas they will serve. They are served by extended London Marylebone to Oxford services. This is preferable to a dedicated Oxford-Cowley shuttle service or extension of any other service because it delivers on the connectivity priorities with direct connections to Oxford Parkway, Bicester Village, and London.

In the off peak the continuing requirement for extra freight capacity and the primarily commuting driver for new services means that only one NCLTF and one Midlands Engine Rail service is provided.

Underpinning these services is the principle that the optimal specification meets the maximum number of outputs with the minimum number of services. Regardless of this principle, required connectivity benefits cannot be delivered without linking services across Oxford for two reasons. Firstly, the interchange requirement at Oxford would mean that flows between Oxfordshire hubs would not be met. Secondly, the platform capacity required for multiple terminating services would be more than double that for through services and could not be delivered at Oxford station. This would necessitate a choice between options, which would compromise delivery against the outputs and therefore not support Oxfordshire's growth.

6.6.4. The 2033 specification

2033 Peak hour 22tph

	Type	Origin	Destination
1	GW fast	Oxford	Paddington
2	GW fast	Oxford (Banbury)	Paddington
3	GW fast	Worcester SH	Paddington
4	GW fast	Hereford	Paddington
5	XC	Birmingham NS	Southampton
6	XC	Manchester	Bournemouth
7	Chiltern	Cowley	Marylebone
8	Chiltern	Cowley	Marylebone
9	Chiltern	Oxford	Marylebone
10	*Freight*	*Oxford North jn*	*Didcot North jn*
11	*Freight*	*Oxford North jn*	*Didcot North jn*
12	EWR WS	Milton Keynes	Didcot
13	EWR WS	Milton Keynes	Didcot
14	EWR CS	Cambridge	Bristol
15	EWR CS	Cambridge	Southampton
16	Shuttle	Banbury	Oxford
17	NCLTF	Hanborough	Didcot
18	NCLTF	Hanborough	Paddington
19	Midlands	Birmingham MS	Bristol
20	Midlands	Birmingham MS	Oxford
21	EWR+	Cambridge	Oxford
22	EWR+	Cambridge	Oxford

2033 Off peak hour 17.5tph

Type	Origin	Destination
GW fast	Worcester SH	Paddington
GW fast	Great Malvern	Paddington
XC	Newcastle	Southampton
XC	Manchester	Bournemouth
CR	Oxford	Marylebone
CR	Oxford	Marylebone
Freight	*Oxford North jn*	*Didcot North jn*
Freight	*Oxford North jn*	*Didcot North jn*
EWR WS	Milton Keynes	Didcot
EWR WS	Milton Keynes	Didcot
EWR CS	Cambridge	Bristol
EWR CS	Cambridge	Southampton
Shuttle	Banbury	Oxford
Freight	*Oxford North jn*	*Didcot North jn*
NCLTF	Hanborough	Didcot
Midlands	Birmingham	Bristol
EWR+	Cambridge	Oxford
*Freight**	*Oxford North jn*	*Didcot North jn*

**0.5 ftph*

Figure 39 – Oxfordshire Train Service Specification 2033

The majority of conditional outputs are required for and delivered by the 2028 specification, so the 2033 specification represents only a small uplift.

The 2033 specification includes two additional East West Rail services from Cambridge to Oxford. These provide an extremely good level of service between Oxford and Cambridge, further improving connectivity both between the Oxfordshire growth hubs of Oxford, Oxford Parkway, and Bicester Village, and between Oxfordshire and inter-regional locations along this arc.

Begbroke is also added as station call in proposed services, recognising that it could play a role in supporting growth in this timeframe in accordance with the conditional outputs.

Further freight capacity is provided off peak in line with forecasts. Otherwise no further additional or extended services are proposed for 2033.

6.6.5. Beyond the 2033 specification

ORCS considers timeframes of 2038 and 2050, and specifications for these years are assessed against conditional outputs. The 2033 specification meets the same very high number of conditional outputs in these years so additional passenger services are not proposed. There is a final freight capacity increase of 0.5ftph required by 2043, so this is provided in 2038. Consideration of growth beyond the local plan period to 2033 as assessed in the OPGS would

likely lead to revised specifications for these timeframes.

6.7. Performance against Conditional Outputs for Oxfordshire's Rail System

6.7.1. Local connectivity

The specifications are tested against the local connectivity conditional outputs, which are specified against the 2033 timeframe. They are also assessed against targets for each of the other timeframes. The results for the tests against 2033 are presented (Figure 40).

In 2024 eight out of 18 connectivity targets are met. Without extension of East West Rail services south of Oxford only one out of 18 targets is met. Generally, if the flow is on the Bicester-Didcot arc the connectivity target is met, otherwise it is not. Given infrastructure constraints in this scenario the specification is considered to be optimised.

In 2028 the raft of service enhancements results in the significant majority – 14 out of 19 – of connectivity targets being met, with major improvements against all targets.

In 2033 16 out of 19 local connectivity conditional outputs are met, including the top 14 priorities (Figure 40). The three conditional outputs that are not met see significant improvement and the one of these that is between growth hubs (Hanborough to Banbury) is not a priority for further improvement given rail network geography.

Ref	Origin	Destination	GJT			CO Met
			2033	Change	Target	
PGCO15	Culham	Oxford	32	30	45	Yes
PGCO16	Hanborough	Didcot Parkway	50	35	59	Yes
PGCO17	Didcot Parkway	Culham	26	32	46	Yes
PGCO18	Oxford Parkway	Didcot Parkway	44	36	59	Yes
PGCO19	Culham	Didcot Parkway	26	31	47	Yes
PGCO20	Bicester Village	Didcot Parkway	54	38	65	Yes
PGCO21	Hanborough	Oxford Parkway	52	24	56	Yes
PGCO22	Didcot Parkway	Bicester Village	54	38	66	Yes
PGCO23	Hanborough	Bicester Village	64	24	65	Yes
PGCO24	Didcot Parkway	Oxford Parkway	44	37	62	Yes
PGCO25	Oxford Parkway	Hanborough	52	32	61	Yes
PGCO26	Didcot Parkway	Hanborough	49	43	67	Yes
PGCO27	Oxford	Culham	32	30	48	Yes
PGCO28	Oxford Parkway	Banbury	65	20	66	Yes
PGCO29	Cholsey	Oxford	62	8	53	No
PGCO30	Hanborough	Banbury	72	18	68	No
PGCO31	Hanborough	Radley	65	20	62	No
PGCO32	Culham	Cholsey	63	20	71	Yes
PGCO33	Radley	Oxford Parkway	51	26	62	Yes

Figure 40 – Local connectivity conditional outputs met by 2033 specification

There is no change to services in 2038 or 2050, but an extra flow becomes a priority in each year as demand continues to grow, and in each case is met by the 2033 service proposed. This provides confidence that the 2033 specification has enduring benefit and represents a long-term strategic solution for supporting Oxfordshire's growth.

6.7.2. Local connectivity outcomes quantified

One of the key requirements arising from the OPGS in order to support economic growth is improving linkages between Oxfordshire's growth hubs. In 2019 there are 54 direct links between these hubs in the peak hour. The 2024 specification delivers a 57 % improvement in direct links between the hubs, and the 2028 specification delivers an additional 50 % improvement. The 2033 specification delivers a further improvement so that the total number of direct connections between Oxfordshire's seven growth hubs in 2033 is 140 (Figure 41). By this measure the Oxfordshire Train Service Specification for 2033 improves local connectivity by 160 % over 2019.

2019

	Banbury	Bicester	Culham	Didcot	Hanborough	Oxford	Oxford Parkway	
Banbury		2	0.5	1	0	4	0	***7.5***
Bicester	2		0	0	0	3	3	***8***
Culham	0.5	0		2	0	2	0	***4.5***
Didcot	1	0	2		1	4	0	***8***
Hanborough	0	0	0	1		1.5	0	***2.5***
Oxford	4	3	2	4	1.5		3	***17.5***
Oxford Parkway	0	3	0	0	0	3		***6***
TOTAL								***54***

2024

	Banbury	Bicester	Culham	Didcot	Hanborough	Oxford	Oxford Parkway	
Banbury		2	0	0	0	4	0	***6***
Bicester	2		2	2	0	6	6	***18***
Culham	0	2		2	0	2	2	***8***
Didcot	0	2	2		1	4	2	***11***
Hanborough	0	0	0	1		1.5	0	***2.5***
Oxford	4	6	2	4	1.5		6	***23.5***
Oxford Parkway	0	6	2	2	0	6		***16***
TOTAL								***85***

2028

	Banbury	Bicester	Culham	Didcot	Hanborough	Oxford	Oxford Parkway	
Banbury		2	0	1	0	5	0	***8***
Bicester	2		2	3	0	7	7	***21***
Culham	0	2		4	2	4	2	***14***
Didcot	1	3	4		3	8	3	***22***
Hanborough	0	0	2	3		4	0	***9***
Oxford	5	7	4	8	4		7	***35***
Oxford Parkway	0	7	2	3	0	7		***19***
TOTAL								***128***

2033

	Banbury	Bicester	Culham	Didcot	Hanborough	Oxford	Oxford Parkway	
Banbury		2	0	1	0	5	0	***8***
Bicester	2		2	3	0	9	9	***25***
Culham	0	2		4	2	4	2	***14***
Didcot	1	3	4		3	8	3	***22***
Hanborough	0	0	2	3		4	0	***9***
Oxford	5	9	4	8	4		9	***39***
Oxford Parkway	0	9	2	3	0	9		***23***
TOTAL								***140***

Figure 41 – Direct links between Oxfordshire growth hubs in Oxfordshire Train Service Specifications

6.7.3. New stations connectivity

The specifications are tested against the new stations connectivity conditional outputs and assessed against the priority flows.

All the new stations connectivity conditional outputs are met (Figure 42). This reflects the fact that conditional outputs for new stations state priorities for further investigation rather than an assertion that new stations are required. A thorough demand forecasting exercise against a given level of demonstrably operable train service is required if any aspiration is to develop.

Ref	Conditional Output	Met
PGC043	The priority of new stations in Oxfordshire is: 1. Oxford Science Park and Oxford Business Park 2. Grove 3. Begbroke	Yes – reflected in service and timeframe specified
PGC044	Connectivity priorities for the Cowley Branch Line stations are: 1. Oxford 2. Oxford Parkway 3. Hanborough 4. Didcot Parkway 5. London	Yes, direct journeys offered to (1), (2), and (5), with optimised interchange for (3) and (4).
PGC045	Connectivity priorities for Grove are: 1. Didcot Parkway 2. Oxford 3. London 4. Swindon	Yes, direct journeys offered to (1), (2), and (4)
PGC046	Connectivity priority for Begbroke is Oxford	Yes, direct journey offered

Figure 42 – New stations connectivity conditional outputs met by 2033 specification

Nine out of 17 connectivity targets are met (Figure 43). For the Cowley Branch Line stations targets are met where a direct journey is provided. The single connectivity target for Begbroke is met by the proposed hourly call in the local shuttle. For Grove neither target is met owing to the hourly service level. Calling an additional service at Grove would meet both targets and may be an option within the specification.

Origin	Destination	2033	Target	Met
Oxford Science Park	Oxford	33	50	Yes
Oxford Business Park	Oxford	35	54	Yes
Oxford	Oxford Business Park	37	54	Yes
Oxford	Oxford Science Park	35	53	Yes
Grove	Didcot Parkway	49	40	No
Oxford Science Park	Oxford Business Park	32	36	Yes
Begbroke	Oxford	46	50	Yes
Oxford Parkway	Oxford Business Park	44	55	Yes
Hanborough	Oxford Business Park	64	54	No
Didcot Parkway	Oxford Science Park	67	58	No
Grove	Oxford	67	53	No
Bicester Village	Oxford Business Park	57	54	No
Hanborough	Oxford Science Park	61	56	No
Didcot Parkway	Oxford Business Park	69	51	No
Oxford Parkway	Oxford Science Park	42	49	Yes
Radley	Oxford Business Park	83	57	No
Oxford Business Park	Oxford Science Park	29	39	Yes

Figure 43 – New stations connectivity targets met by 2033 specification

6.7.4. London commuting connectivity

London commuting conditional outputs are not achieved. Because Oxfordshire is already well connected to London by frequent, fast, and direct services the additional service proposed in the Oxfordshire Train Service Specification does not yield the targeted improvement.

However, the additional peak service specified from 2028 provides an extra direct connection from four growth hubs – Hanborough, Oxford, Culham, and Didcot Parkway – and therefore provides substantial benefit. The total number of direct peak hour services to London is:

- 8 from Oxford
- 6 from Didcot Parkway
- 4 from Banbury
- 3 from Oxford Parkway, Bicester Village, and Hanborough
- 2 from Culham

The specification is not further refined to deliver the London commuting conditional outputs because the level of service that would be required is not feasible alongside competing strategies for London services, against an already high level of Oxfordshire service.

In addition to the improvements to the London service connectivity is improved dramatically to other important long-distance commuting markets including Swindon, with a new 2tph direct connection, and Birmingham, with doubling to a 4tph direct connection.

6.7.5. Inter-regional connectivity

Both inter-regional conditional outputs are met (Figure 44).

Ref	Conditional Output	Met
PGC047	Prioritise improving inter-regional connections to connections where smaller GJT improvements are required to deliver the same economic benefit (Birmingham, Reading, Bristol, and Swindon).	Yes – improvements to five connections that require minimum improvement for equivalent benefit, including the four priorities
PGC048	Prioritise improving inter-regional connections where an interchange delivers a high proportion of GJT improvement required (Bristol, Swindon, Cardiff, and Northampton)	Yes – interchanges removed for five connections, including three priorities

Figure 44 – Inter-regional connectivity conditional outputs met by 2033 specification

Connectivity improvements are delivered for 15 of the 16 priority connections (Figure 45). Major improvements are delivered by East West Rail to the priority connections of Milton Keynes, Northampton, Bedford, and Cambridge. Connectivity with Birmingham – the highest priority connection – is significantly improved. The 8 % improvement delivered is equivalent to an improvement of greater than 100 % to Cambridge.

The extensions to Bristol and Southampton are crucial and transform the inter-regional connectivity benefits, which are otherwise limited to the connections listed above, by removing interchanges in priority flows.

Comparison of the improvement percentage to the *improvement required to deliver equivalent benefit* reflects the scale of the improvements provided in connectivity to Birmingham, Swindon, Bristol, and Milton Keynes. This improvement is directly applicable to supporting economic growth, and the improvements to inter-regional connections are some of the key benefits of the specification for Oxfordshire's and the wider economy.

Origin	Destination	2019 GJT	2033 GJT	Improvement required to deliver equiv. benefit	% improvement delivered
Oxford	Birmingham	96	88	3 %	8 %
Oxford	Reading	43	42	4 %	2 %
Oxford	Bristol	145	107	7 %	26 %
Oxford	Swindon	87	61	7 %	30 %
Oxford	Coventry	87	77	9 %	11 %
Oxford	High Wycombe	76	78	12 %	-3 %
Oxford	Manchester	222	221	14 %	1 %
Oxford	Milton Keynes	178	67	14 %	62 %
Oxford	Cardiff	187	174	15 %	7 %
Oxford	Northampton	172	116	16 %	33 %
Oxford	Leicester	211	209	22 %	1 %
Oxford	Derby	155	154	25 %	1 %
Oxford	Worcester	114	102	25 %	11 %
Oxford	Bedford	263	100	33 %	62 %
Oxford	Cheltenham	181	170	35 %	6 %
Oxford	Cambridge	276	133	47 %	52 %

Figure 45 – Inter-regional connectivity benefits delivered by 2033 specification.

6.7.6. Inter-regional outcomes quantified

Improving links with economic hubs outside Oxfordshire is essential for supporting economic growth both in Oxfordshire and beyond. The Oxfordshire Train Service Specification delivers direct services to 10 of the 16 priority inter-regional connections, including five which currently have no direct service (Figure 46). Overall there is a 106 % increase in direct hourly services to inter-regional priority connections.

The majority of direct connections are provided at a frequency of at least two trains per hour, with a frequency of at least four trains per hour for five connections. Significant connectivity benefits are delivered even where there are not direct services through reduced interchange and increased frequency of services.

	Direct trains per hour					Non-direct connectivity benefits
	2019	2024	2028	2033	Imp.	
Birmingham	*2*	3	4	4	**+ 2**	
Reading	*7*	7	8	8	**+ 1**	
Bristol	*0*	0	2	2	**+ 2**	
Swindon	*0*	0	2	2	**+ 2**	
Coventry	*1*	1	2	2	**+ 1**	
High Wycombe	*3*	3	3	3		Additional connections via Banbury & Bicester
Manchester	*1*	1	1	1		Additional connections via Birmingham
Milton Keynes	*0*	2	2	2	**+ 2**	
Cardiff	*0*	0	0	0		Single interchange via Swindon / Bristol
Northampton	*0*	0	0	0		Single interchange via Milton Keynes / Bletchley
Leicester	*0*	0	0	0		Single interchange via Bedford
Derby	*1*	1	1	1		Additional connections via Birmingham
Worcester	*2*	2	2	2	***+1***	Additional direct off-peak service
Bedford	*0*	1	2	4	**+ 4**	
Cheltenham Spa	*0*	0	0	0		Single interchange via Swindon / Bristol
Cambridge	*0*	0	2	4	**+ 4**	
TOTAL	***17***	**21**	**31**	**35**	**+18**	

Figure 46 – Direct trains between Oxford and priority inter-regional connections in Oxfordshire Train Service Specifications

The final specification places Oxford as the hub of a wide system of strong links between local and national economic hubs (Figure 47). This provides a system that ensures not only that economic growth in Oxfordshire is supported, but also that Oxfordshire can support economic growth outside the county.

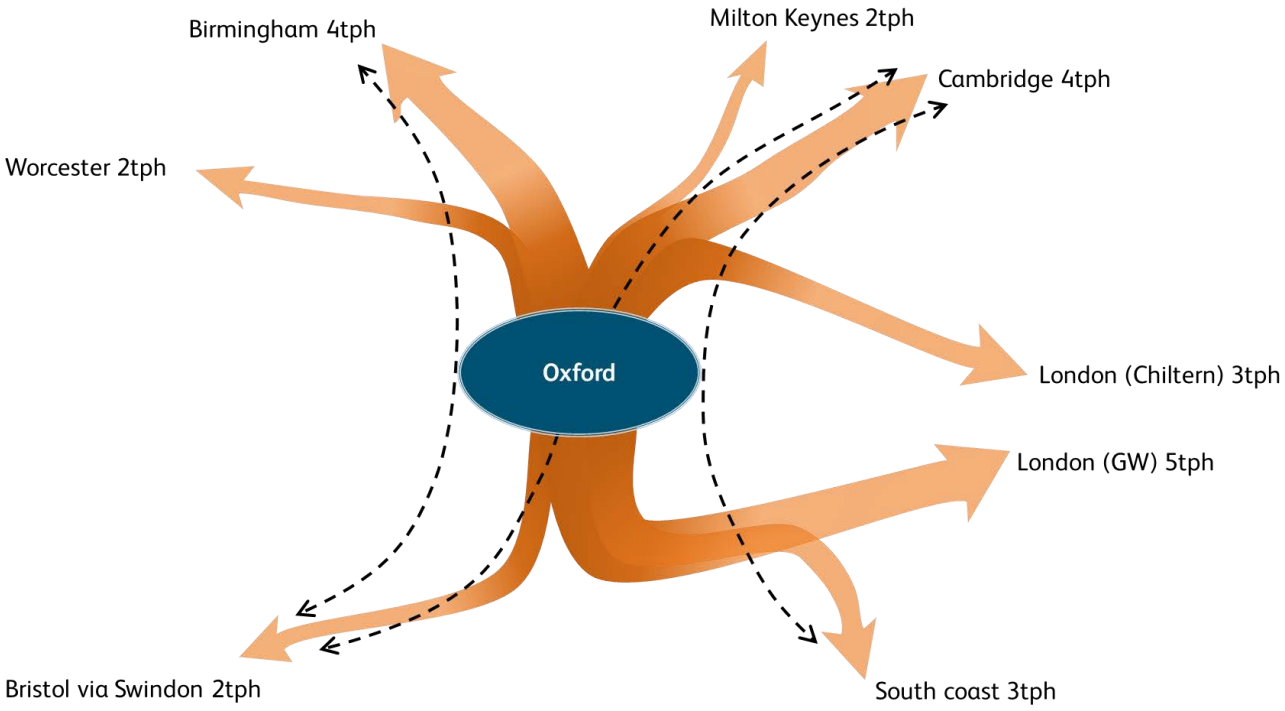


Figure 47 – peak hour inter-regional connectivity in Oxfordshire Train Service Specification 2033

6.7.7. Heathrow Airport connectivity

The connectivity conditional outputs for Heathrow Airport are met by the introduction of Western Rail Link to Heathrow services between the airport and Reading in the 2028 timeframe, and thereafter (Figure 48). The effect of the quarter-hourly direct service from Reading to Heathrow Airport is a major improvement in connectivity from Oxford – since Oxford is well connected with Reading – and is sufficient to meet the specified output. The conditional output is based on a benchmarking exercise identifying the level of connectivity appropriate to the size of flow. There may be substantial benefits to further connectivity improvements between Oxford and Reading including provision of direct connections.

Ref	Conditional Output	Met
PGC049	Improve GJT from Oxford to Heathrow by 30-40 minutes	Yes, 36 minutes GJT improvement
PGC050	Provide a GJT from Oxford to Heathrow of under 100 minutes	Yes, 99 minutes

Figure 48 – Heathrow Airport connectivity conditional outputs met by 2033 specification

The target is not met in the 2024 timeframe. It could only be met by a significant uplift in direct services between Oxford and London Paddington, which is not feasible given the rail system changes necessary to achieve it.

6.7.8. Heathrow Airport outcomes quantified

Oxford and Reading are connected by 8 direct services with a journey time of approximately 25 minutes, whilst WRLtH provides 4 direct services from Reading to Heathrow journey time with a journey time of approximately 25 minutes. Owing to the speed of the journey between Oxford

and Reading it is unlikely that the in-vehicle time could be reduced with direct airport services, and the frequency of both legs means the interchange penalty is minimised.

6.7.9. Passenger capacity

Capacity conditional outputs are specified for each timeframe. The majority of capacity conditional outputs are met by the Oxfordshire Train Service Specifications, through provision of new services (Figure 49). Where provision of new services does not meet capacity outputs lengthening of existing services is recommended.

Ref.	Conditional Output	Met
PGCO1	Provide an additional 5-7 carriages on Oxford inter-regional services by 2024	No – lengthening recommended
PGCO2	Provide an additional 7-9 carriages on Oxford inter-regional services by 2028	*Yes – further analysis required*
PGCO3	Provide an additional 8-11 carriages on Oxford inter-regional services by 2033	*Yes – further analysis required*
PGCO4	Provide an additional 9-12 carriages on Oxford inter-regional services by 2038	*Yes – further analysis required*
PGCO5	Provide an additional 12-16 carriages on Oxford inter-regional services by 2050	*Yes – further analysis required*
PGCO6	Provide an additional 1 carriage on Oxford-London Marylebone services by 2024	No – lengthening recommended
PGCO7	Provide an additional 2 carriages on Oxford-London Marylebone services by 2028	No – lengthening recommended
PGCO8	Provide an additional 2-3 carriages on Oxford-London Marylebone services by 2033	No – lengthening recommended
PGCO9	Provide an additional 3-4 carriages on Oxford-London Marylebone services by 2038	No – lengthening recommended
PGCO10	Provide an additional 5-6 carriages on Oxford-London Marylebone services by 2050	No – lengthening recommended
PGCO11	Provide an additional 1-2 carriages on Oxford corridor stopping services by 2028	Yes – 6 provided
PGCO12	Provide an additional 1-3 carriages on Oxford corridor stopping services by 2033	Yes – 6 provided
PGCO13	Provide an additional 2-4 carriages on Oxford corridor stopping services by 2038	Yes – 6 provided
PGCO14	Provide an additional 3-5 carriages on Oxford corridor stopping services by 2050	Yes – 6 provided

Figure 49 – Passenger capacity conditional outputs met by Oxfordshire Train Service Specifications

The most acute capacity shortfall is for inter-regional services. Additional capacity is provided on these services in 2028, but there remains a shortfall in 2024. The additional capacity does not replicate the inter-regional service pattern – it consists of two different service groups north and south of Oxford – so further analysis is required to identify the impact on required capacity. However, since there is an existing shortfall in capacity on these services lengthening is recommended, and this is required by 2024.

No new London Marylebone services are included in the specification and therefore lengthening of this service group is required for 2033.

The capacity required from 2028 for Oxfordshire local services is provided by the additional local services, which is sufficient for the long term.

6.7.10. **Freight**

Freight capacity conditional outputs are delivered in each timeframe.

Additional freight capacity is included in the off-peak specification alongside a slightly reduced level of passenger services. This is in line with both the base specification and wider system strategy, recognising that the best system solution to the need for more passenger and freight services is to keep freight outside passenger peak hours where possible.

Freight capability conditional outputs are built into the identification of interventions.

7. Oxfordshire Rail System Interventions

The endorsed Oxfordshire Train Service Specifications are subject to analysis to identify system interventions that are required to deliver them. A programme of required interventions to deliver the specifications constitutes an investment portfolio for the rail system in Oxfordshire and is the final ORCS output.

7.1. Method of analysis to identify interventions

Analysis is undertaken to assess whether the Oxfordshire Train Service Specifications for 2024, 2028, and 2033 can be accommodated in Oxfordshire. Where the specifications cannot be accommodated the interventions required are identified. These comprise the fourth and final ORCS key output – the Oxfordshire Rail System Interventions.

Analysis of each specification builds on the previous specification, and considers the busiest peak hour, which is between 07.30 and 08.30 at Oxford station. Interventions identified as required to accommodate the peak specifications are reviewed against the off-peak specifications to ensure that they are sufficient for both.

The train plan developed for each specification takes the 2019 timetable as a base and adds additional services for each timeframe, starting at Oxford station and then working outwards to validate the train plan to the study boundaries, where no timings are changed.

The strategic level of analysis appropriate for this stage of analysis does not consider empty stock movements, or freight volumes beyond those included in the specification. Detailed timetabling analysis and modelling is required as interventions are further developed.

The infrastructure change associated with Oxford Phase 2 is assumed in all specifications. This comprises an additional platform at Oxford; four-minute headways between Wolvercot Junction and Heyford; and 75mph crossovers at Oxford North Junction. If Oxford Phase 2 infrastructure is not delivered the specifications for 2024, 2028, and 2033 cannot be supported.

7.1.1. Assumptions on interventions

The Oxford station masterplan vision recognises the need to enhance the platform capacity at Oxford station as well as improving the station area. The maximum viable platform capacity given the constraints identified throughout masterplan development is five platforms, and it is highly likely that one of the these can only be a north-facing bay platform. Therefore identification of interventions assumes the maximum platform capacity at Oxford station is five platforms.

Previous development work by Network Rail has identified constraints around enhancement of Oxford North Junction. Therefore identification of interventions assumes that Oxford North Junction cannot be grade separated.

Analysis of each scenario applies a standard set of assumptions, appropriate for the level of analysis:

- Services are verified to Charlbury, Banbury, Oxford Parkway, Didcot East Junction, and Highworth Junction
- Passenger services to London Marylebone on the Chiltern Main Line and to London Paddington on the GWML remain in their December 2019 pattern
- Where no Sectional Running Times exist Indicative Running Times are calculated. These are consistent with previous studies where available

7.2. Interventions required to accommodate the 2024 specification

The 2024 specification can be accommodated without interventions beyond delivery of Oxford Phase 2. Any additions to the specification could not be accommodated owing to lack of alignment between limited platform availability at Oxford and paths through the corridor. The specification may not lead to a robust timetable owing to a lack of flexibility and the necessity of some minimum margins between train movements. This is particularly the case with the extension of East West Rail Western Section services to Didcot Parkway. The same statements apply for the off-peak specification.

7.2.1. Key developments

The major change in 2024 is introduction of EWR Western Section services. The impact of these services is confined to the system between Bicester and Oxford station, so is felt at Oxford station and Oxford North Junction. Since there are no changes in the number of services at Banbury, Didcot, or the North Cotswolds Line the 2024 specification has limited impact and requires no interventions at these locations.

Peak / off-peak	Change
Both	2 new East West Rail Western Section services between Milton Keynes and Didcot replacing the Great Western slow services between Oxford and Didcot
Both	1 new East West Rail Western Section service between Bedford and Oxford
Both	1 amended hourly shuttle between Banbury and Oxford
Off-peak	1 additional freight service

Figure 50 – Changes between 2019 and 2024 specification

The changes result in 15 up direction and 13 down direction services through Oxford in the one-hour peak in 2024, against 13 up and 11 down trains in 2019.

The lines between Oxford North Junction and Bicester see the biggest increase in traffic and have to accommodate three EWR trains alongside three London Marylebone services. The extra EWR services are pathed though to Oxford alongside the London Marylebone service timings from the 2019 base. The timings for two EWR services extended to Didcot are consistent with previous studies from East West Railway Company. The EWR services are validated as far as Bicester Gavray Junction and are compliant with Chiltern Main Line services. The extended EWR services are able to dwell at Oxford before taking the paths of the GW slow services to Didcot Parkway.

7.2.2. Oxford station

Extension of two EWR services through to Didcot releases sufficient capacity in the bay platforms (1 and 2) at Oxford to accommodate the five terminating services – three London Marylebone,

one EWR and the Banbury – provided that the Banbury service be shunted to the Up Carriage Sidings. The shunt is required owing to the long dwells of the London Marylebone services (Figure 51).

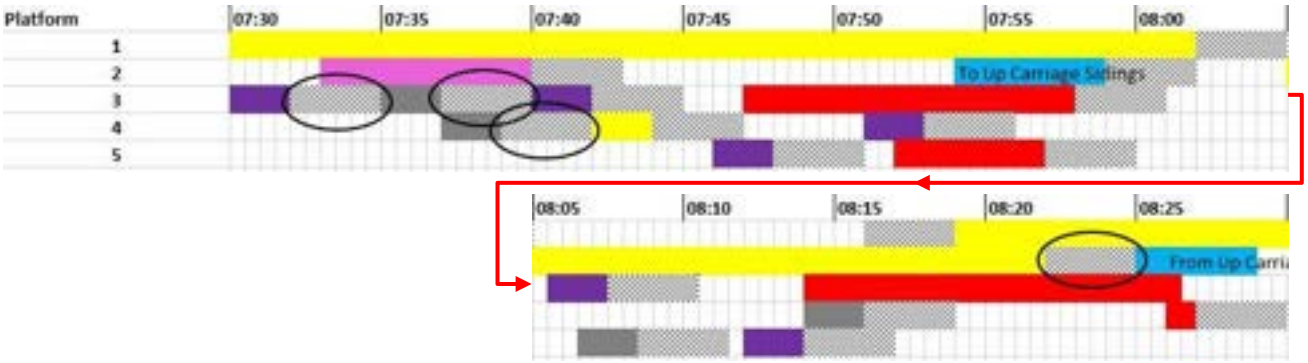


Figure 51 – Oxford platform occupancy 2024. Long dwells of yellow London Marylebone services require blue Banbury service to shunt to Up Carriage Sidings. Circles show minimum margins between services.

Platform 3 is used exclusively by up direction services, whilst platform 4 is used in both directions. Platform 5 is used exclusively by down direction services.

Accommodating the specification results in four minimum margin platform re-occupancy moves, and few opportunities for additional capacity. Platforms 4 and 5 both have spare capacity in the one-hour period, but opportunities do not align with paths further along the route. Therefore, Oxford station can accommodate the 2024 specification, but any additional services would require further intervention.

7.2.3. Oxford North Junction

Three additional movements across Oxford North Junction in each direction make Oxford North the most constrained section of the corridor in 2024.

Accommodating all services involves three minimum margin moves (Figure 52). This means that delay to one service immediately impacts other services.

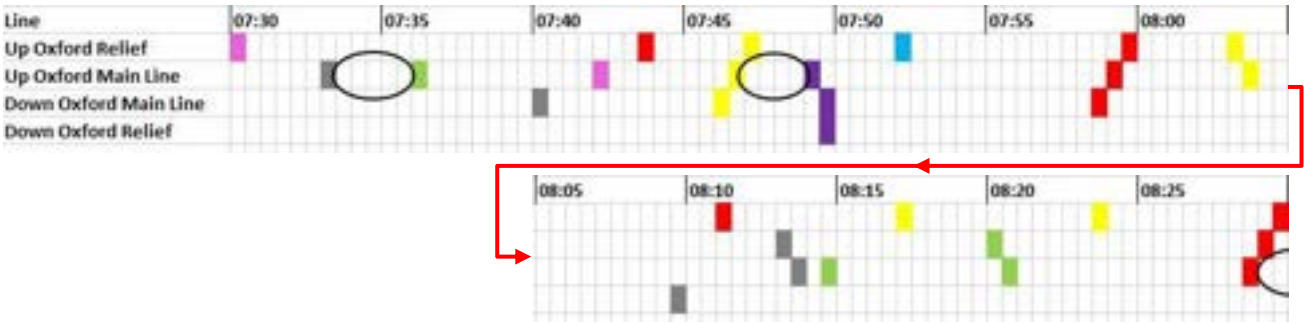


Figure 52 – Oxford North Junction occupancy 2024. Circles show minimum margins between services

7.2.4. Off-peak

The off-peak 2024 specification includes an additional freight service, which can be accommodated as there are fewer GW fast services resulting in lower occupation at Oxford North and Didcot North junctions.

7.2.5. Summary

The services within the 2024 specification support economic growth by delivering as many Conditional Outputs for Oxfordshire's Rail System as possible in 2024. Substantial benefits flow from the services introduced, and particularly through the specific configuration of extending East West Rail Western Section services to Didcot Parkway.

More detailed analysis outside this study has highlighted significant difficulties with the extension of these services. However, the need to deliver against the key ORCS conditional outputs in the strategic short term, and the strategy that these are augmented by further service upgrades accompanied by wider interventions in the medium and long term, mean that the specification should be pursued, despite the lack of robustness in the peak hour. Refinement of Oxford Phase 2 and timetable development work should seek to address this.

Priorities are pursuing development opportunities that could be delivered alongside Oxford Phase 2 to make the specification more robust and working with the East West Rail programme to influence service specification.

Although the service specification for East West Rail Western Section no longer includes the Bedford service as it did at the outset of this study this service is retained for analysis since it is required to maximise the number of Conditional Outputs for Oxfordshire's Rail System that can be met in 2024 and can be accommodated on Oxfordshire's rail system.

7.3. Interventions required to accommodate the 2028 specification

The 2028 specification cannot be accommodated without significant interventions. Whilst it is possible to link new services to specific interventions the analysis reveals that the pattern and quantity of services required to meet growth drives the need for a portfolio of upgrades. Any additional service beyond the 2024 specification requires interventions of a scale that also creates capacity for other additional services. This means that linking interventions with individual new services obscures the full benefit of the intervention and is likely to yoke the new service with an unviable cost. Instead the 2028 specification can be unlocked by a portfolio of upgrades to Oxfordshire's rail system that deliver a portfolio of benefits, by supporting economic growth.

7.3.1. Key developments

The 2028 specification includes a significant uplift in services based on the three major programmes: East West Rail Central Section, Midlands Engine Rail, and the North Cotswolds Line Task Force. These services, in the configuration specified, are necessary to support Oxfordshire's growth, and deliver substantial benefits. The specification also includes a new station at Grove.

Peak / off-peak	Change
Both	2 services between London Marylebone and Oxford extended from Oxford to Cowley Branch Line stations
Both	1 new East West Rail Central Section service between Cambridge and Bristol
Both	1 amended East West Rail service – service between Bedford and Oxford extended at both ends to form service between Cambridge and Southampton
Both	1 new Midlands Engine Rail service between Birmingham and Bristol
Both	1 new NCLTF service between Hanborough and Didcot Parkway
Both	Hourly call at new station Grove in service between Cambridge and Bristol
Peak	1 new NCLTF service between Hanborough and London Paddington
Peak	1 new Midlands Engine Rail service between Birmingham and Oxford
Off-peak	1 amended GW fast service – service between London Paddington and Oxford extended to Great Malvern

Figure 53 – Changes between 2024 and 2028 specification

The changes (Figure 53) result in 20 up direction and 18 down direction services through Oxford in the peak in 2024, against 15 up and 13 down trains in 2024. This large increase is seen on all lines across Oxfordshire and drives the need for interventions on most lines, and especially on the core corridor between Oxford North Junction and Didcot.

New services are added to the 2024 train plan and the impacts analysed by location. Oxford station is considered first, as the hub of the system through which all services pass. Once trains are accommodated at Oxford other key areas are subject to analysis.

7.3.2. Oxford station

The 2028 specification cements a shift in usage of Oxford station with both many more services, and a much higher proportion of through services (Figure 54).

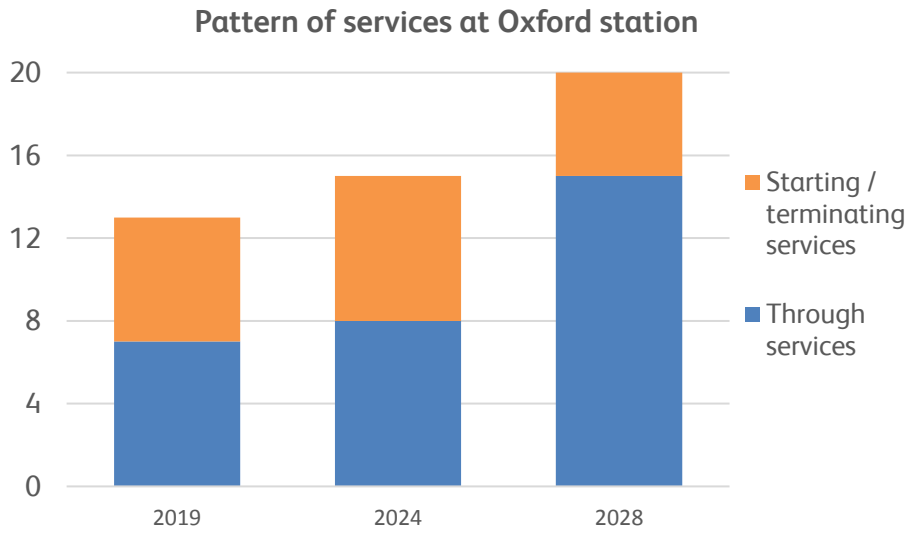


Figure 54 – Through versus terminating services at Oxford station 2019-2028 (in one direction)

These trends necessitate an additional through platform at Oxford station – the number of through services cannot be accommodated on three through platforms. The solution involves conversion of one of the bay platforms, and retention of the other.

There is capacity for all services at Oxford with the additional through platform. However, the timing difference between stopping and non-stopping trains south of Oxford causes conflicts. Some can be resolved by amending the order of trains, but further interventions are required to accommodate all services.

Intervention required: *Oxford station – additional through platform (conversion of bay platform 1 or 2)*

7.3.3. Oxford to Radley

The major uplift in services on an already congested section of infrastructure south of Oxford means that interventions are required between Oxford station and Radley to accommodate the 2028 specification.

The number of trains between Oxford and Kennington Junction almost doubles between 2024 and 2028, from 8 to 15. The differences in calling patterns and train capabilities – which result in large variations in the time required to travel this section – combined with three minute headways between trains (four when following a freight train) and trains crossing at Kennington Junction means that this level of service cannot be accommodated without additional track capacity, in the form of new or extended passenger lines.

Accommodating Cowley services

One of the new service groups in this section is the two Cowley services. These are accommodated at Oxford by the conversion of a bay to a through platform but are a particular issue in this route section in the down direction (from Kennington Junction to Oxford). Cowley services cannot reach platforms 4 and 5 at Oxford because this involves crossing the Up Oxford Main Line to meet a path on the Down Oxford Main Line (Figure 55). There is only one such opportunity in the peak hour. And they cannot use the Up side in the wrong direction owing to numerous clashes with Up services. Therefore intervention is required.

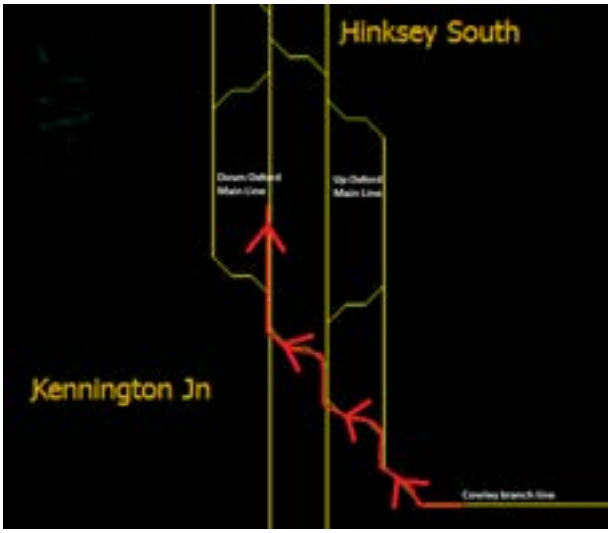


Figure 55 – Movement from Cowley Branch Line to Down Main across Up Main

The minimum intervention required to accommodate the Cowley services is extending the Up Oxford Relief Line between Hinksey North and Hinksey South (Figure 56). This would allow bi-directional running to the Cowley Branch Line independent of the Main Lines.

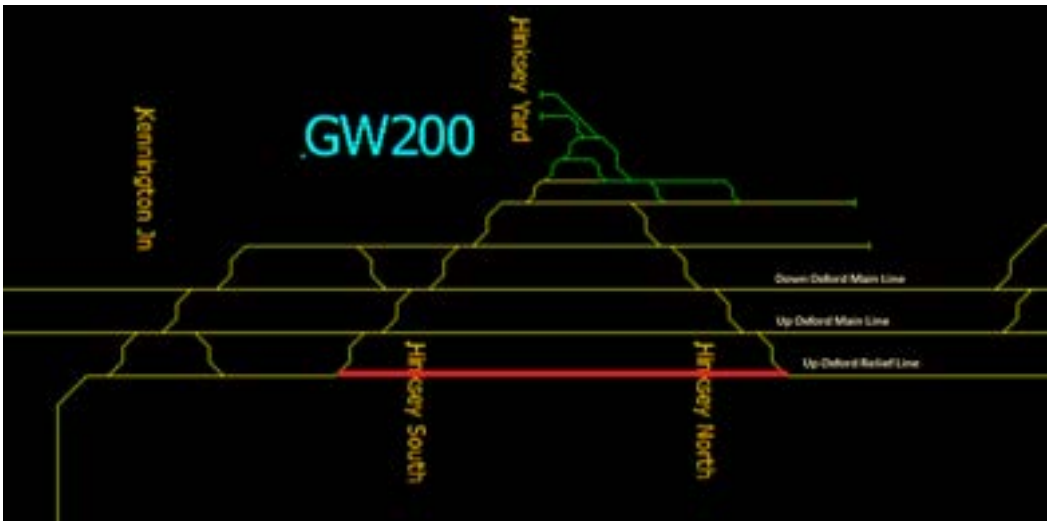


Figure 56 – Up Oxford Relief Line extended from Hinksey North Junction to Hinksey South Junction, providing a direct link to the Cowley branch line independent of the Main Lines

However, this method of operating Cowley services is restrictive as by running bi-directionally it utilises much of the capacity on the Up Oxford Relief south of Oxford station, and is not compatible with the Oxford station operational principle of accommodating up services on platform 3.

Four tracking

The system solution is to create a continuous section of four-track railway south of Oxford station. The four track section should be as long as possible to maximise the opportunities to resolve conflicts between services with different calling patterns and capabilities by allowing faster services to overtake slower ones in both directions, permit simultaneous arrivals and simultaneous departures at Oxford station, create additional opportunities to cross at Kennington Junction, and allow regulation of services.

For maximal functionality junction and crossover speeds at the southern extent of the four track section, at Kennington Junction, and south of Oxford station all need to be maximised.

Four tracking between Oxford and Kennington Junction would have particular benefits in the down, northbound, direction, by reducing conflicts at Kennington Junction, allowing faster services to overtake slower ones south of Oxford, and allowing simultaneous northbound arrivals into Oxford.

It could be achieved by converting and extending Hinksey Reception Line 1 from south of Kennington Junction to join the Down Oxford Relief Line (Figure 57), or – more likely – by providing an entirely new track on the up side from Hinksey South to join the new through platform at Oxford. Both options would be in addition to the Hinksey North to Hinksey South extension. The latter utilises opportunities around structures and land ownership and aligns with the new through platform (not shown in Figure 57), but the effect is the same.

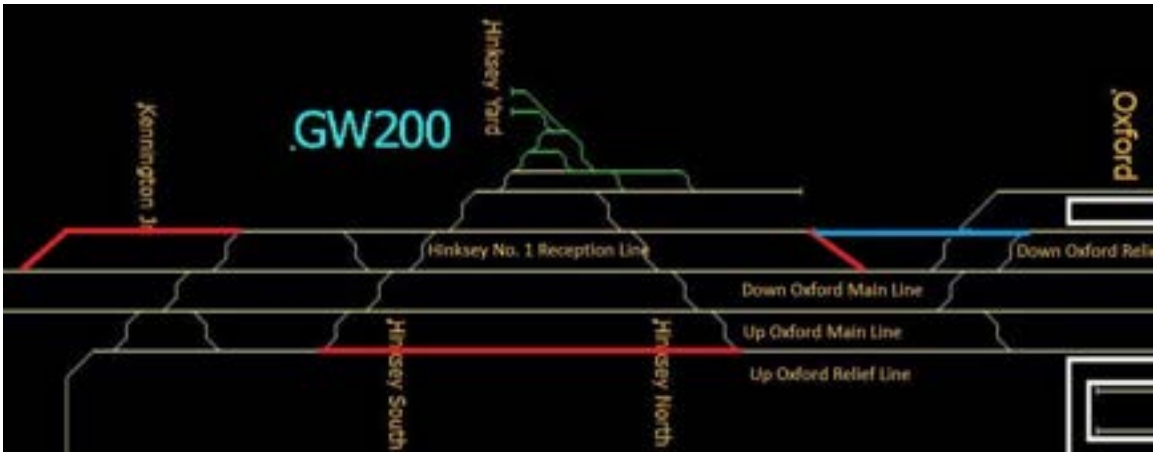


Figure 57 – Four-tracking between Kennington Junction and Oxford Station

Converting any section of the non-passenger infrastructure around Hinksey would impact freight operations and empty stock movements and would need to be mitigated.

Extending four tracking to just north of Radley station (Figure 58) increases the benefits in the down direction by allowing northbound services to be regulated earlier. It has major benefits in the up direction. Southbound services could depart Oxford simultaneously rather than at three minute minimum intervals, and faster services could overtake on the Up Oxford Main Line rather than being stuck behind slower ones from Hinksey North to beyond Didcot. It avoids the need to timetable successive services at minimum margins and allows a significantly more robust timetable.

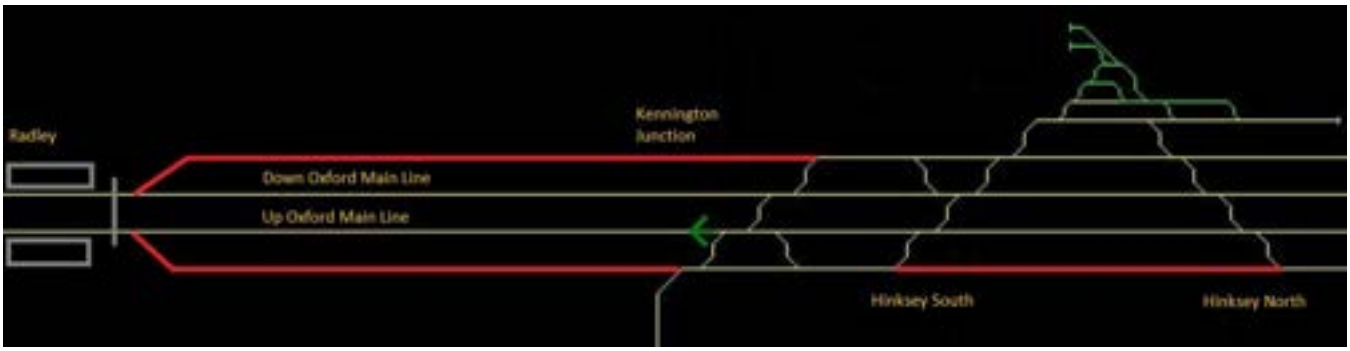


Figure 58 - Four-tracking between Radley and Hinksey North

Four tracking south of Oxford station is required to accommodate the 2028 specification. The volume and varying characteristics of services means that the functionality and flexibility of four tracking south to Radley is the recommended intervention.

Intervention required: *Cowley Branch Line – stations and upgrades for passenger service*

Intervention required: *Hinksey – extend Up Oxford Relief Line from Hinksey North to Hinksey South*

Intervention required: *Kennington Junction – four track to Oxford station and raise crossover speeds*

Intervention required: *Radley – four track from Kennington Junction / Oxford to road bridge north of station*

7.3.4. Didcot East Junction

It is impossible to accommodate the 2028 peak specification at Didcot East Junction without intervention.

Didcot East Junction is critical for the Oxford corridor. The majority of passenger and freight services along the corridor use the junction, and capacity is extremely limited owing to the high levels of demand for services on both the GWML and Oxford corridor. In effect capacity is fully utilised in the baseline.

The principal conflict is between services moving between the Didcot Avoiding Lines and the GWML Main Lines, which cross both GWML Relief Lines and, in the case of down direction moves, the Up Main. The latter stops any departure from Didcot Parkway and leaves only one other simultaneous move possible (Figure 59).

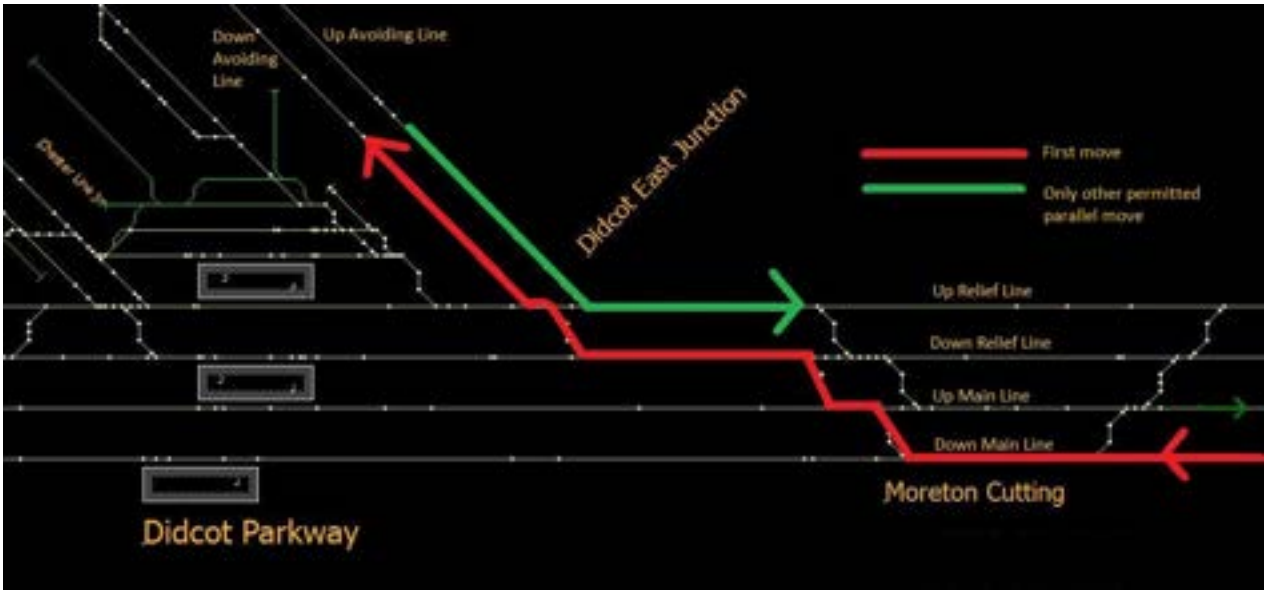


Figure 59 – Impact of move from Down Main Line to Down Avoiding Line at Didcot East Junction

The 2028 specification includes an additional service in each direction using the junction (Hanborough to London Paddington) and another which crosses the junction on the GWML (EWR to Southampton). Allied with the constraints associated with the increased level of service north of Didcot this means intervention is required at Didcot East Junction.

There are three instances (one up, two down) where it is impossible for services to move between the Avoiding Lines and GWML Main Lines.

Necessary intervention

Grade separation of Didcot East Junction is required to accommodate the 2028 specification. This would remove the need for flat crossing moves and allow trains to move between the Avoiding Lines and GWML Main Lines without conflicting moves.

As well as accommodating the new services in the 2028 specification grade separation of Didcot East Junction would have major systemwide benefits including freeing capacity on the GWML, removing a significant source of delay for mainline, Oxford corridor, and freight services, and reducing average journey times for services between Oxford and London Paddington. Previous development work shows that the intervention is required to accommodate any increase in long

distance high speed services on the GWML outside of this study. It would also be beneficial for Didcot Parkway platforming, as more eastbound paths would be available.

Reducing the amount of services at Didcot East Junction

Two of the three services which cannot be timetabled at Didcot East Junction are the new services between Hanborough and London Paddington. Removing these from the 2028 specification would allow some retiming of other services resulting in no intervention being required. In this case opportunities should be explored to deliver the services by extending services that terminate at Didcot Parkway from the east although these would not have the same benefit as new services.

If the services were simply removed and no intervention delivered the resulting train plan would include a significant number of minimum margins moves at this key junction and would fail to meet conditional outputs for the growth hubs of Hanborough, Oxford, and Culham. It would mean no increase in peak commuter services to London Paddington, which effectively require grade separation. It would also mean that the systemwide benefits were not realised.

Intervention required: *Didcot East Junction – grade separation*

7.3.5. Didcot North Junction

The main conflict at Didcot North Junction is between services using the Main Lines and ones using the Avoiding Lines. A bi-directional third line north of the junction would allow a much more robust level of service at Didcot North by allowing a service to be held north of the junction without delaying other services (Figure 60).

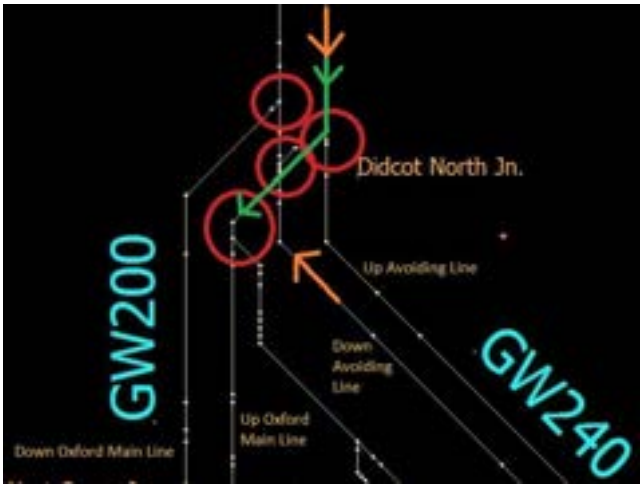


Figure 60 – Didcot North Junction conflict. If delayed the green Main Line service holds up both orange Avoiding Line services. A third line would allow the green service to move out of the way

It would also allow faster trains to pass slower trains heading north before entering the two track section including the stations Appleford, Culham, and Radley. This would be beneficial because there is a seven minute difference in running time between the fastest and slowest services between Didcot North and Kennington Junction. The new line would need to be long enough to accommodate the longest freight train including sufficient space for deceleration and acceleration. Extending the loop north to Appleford is not necessary since there is only a one minute difference in running times in this particular section.

With four-tracking to Radley and grade separation of Didcot East Junction the 2028 specification can be accommodated at Didcot North Junction without intervention, with a number of minimum margin moves. Nevertheless, the third line should be considered as a means of adding robustness.

7.3.6. Didcot Parkway

Additional infrastructure is required to accommodate the 2028 specification at Didcot Parkway station.

The number of trains serving the Oxford corridor that call at Didcot Parkway more than doubles from 2024 to 2028, and the number of services turning around in the station more than trebles with the introduction of the services between Oxford and Bristol (Figure 61).

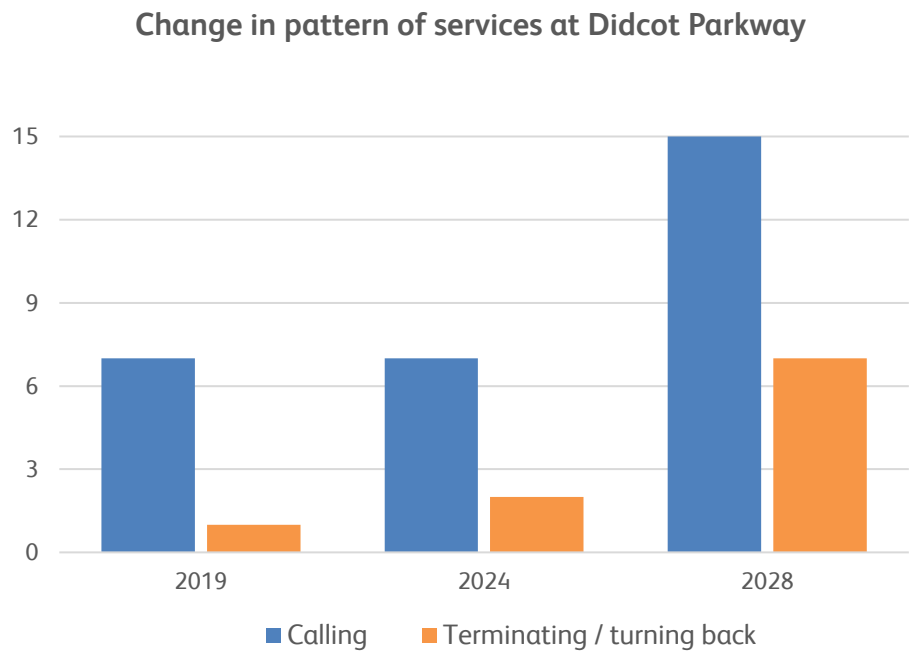


Figure 61 – Number of services using Didcot Parkway, and number turning around (total of both directions)

Turning back at the station uses a disproportionate amount of capacity. At a minimum it requires five to seven minutes if an outbound path is available. In fact, terminating services are likely to spend around ten minutes at Didcot Parkway. With platform reoccupation margins of four minutes this means that the three terminating services will occupy a single platform for 45 minutes leaving no capacity for the services between Oxford and Bristol, which turn back but do not terminate at Didcot Parkway.

Two platforms are required for turning back services at Didcot Parkway. Platforms 1 and 2 are fully occupied with GWML services and are not accessible from Oxford. Platforms 3 and 4 accommodate the 15 total through services to/from the Oxford corridor and cannot accommodate turnback moves. Therefore a new platform is required.

Necessary interventions

A new platform 6 would accommodate all terminating services and free platform 5 to be used exclusively for eastbound services towards Reading. Platform 3 would be used for all down

services towards Oxford. This would allow platform 4 to be used for the services between Oxford and Bristol that must turn back. This solution would require a crossover between the Didcot Goods Line and platform 5 and would require the Goods Line to be upgraded to passenger status (Figure 62). Creation of the new platform would lose part of the sidings.

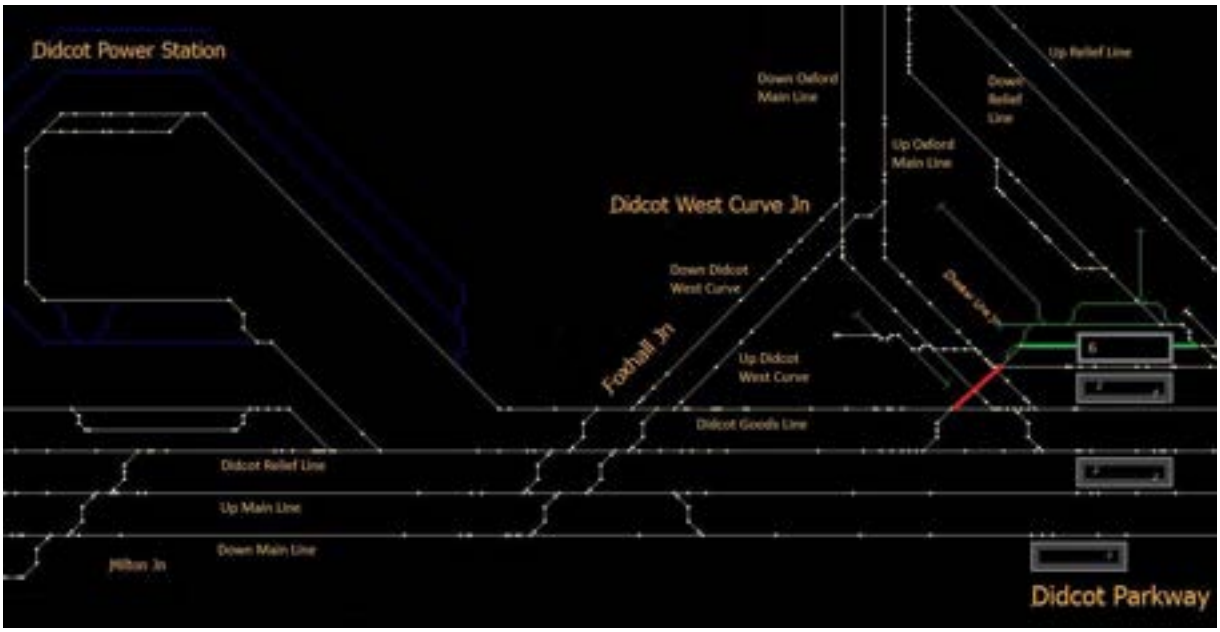


Figure 62 – New platform (6) at Didcot Parkway showing the new crossover (red) and loss of sidings (green)

Reducing the number of services stopping at Didcot Parkway

The specification could be accommodated at Didcot Parkway without the need for intervention at the cost of services between Oxford and Bristol not calling at Didcot Parkway, travelling on Didcot West Curve instead. This would result in conditional outputs not being met and a key growth hub and Oxfordshire's second busiest station missing out on the growth benefits of these local and inter-regional connections.

Intervention required: *Didcot Parkway station – additional platform (6)*
Intervention required: *Didcot Goods Line – upgrade to passenger standard*

7.3.7. Extending services to the West

The services between Oxford and Bristol require paths on the GWML west from Didcot Parkway.

The December 2019 peak hour timetable features seven down and eight up GWML high-speed services via Didcot Parkway. This leaves paths available on the main lines in the peak hour (Figure 63). These have very tight margins and further development should consider whether these are feasible for this operationally and strategically vital section of the GWML.

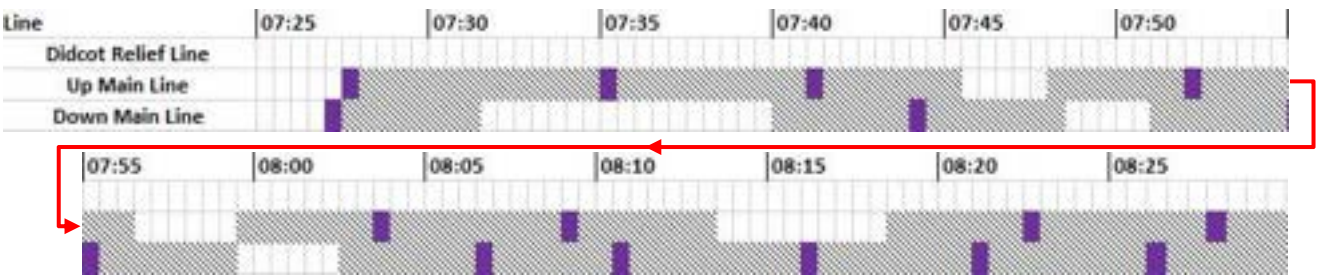


Figure 63 – GWML peak hour occupancy at Milton Junction showing paths between GW high-speed services (purple, headways hatched)

Assuming that services that couldn't access platforms at Didcot Parkway could dwell on the upgraded Didcot Goods Line there are enough paths to accommodate the additional trains.

To reduce the risk of conflict where up and down services arrive into Didcot Parkway at a similar time down trains should move to the Down Main Line at Foxhall Junction (Figure 64). High-level running times calculated to validate these paths are 1½ minutes Didcot Parkway to Foxhall Junction (accounting for slow turnout speeds from the platforms), two minutes from Foxhall Junction to Milton Junction and two minutes from Milton Junction to Steventon.

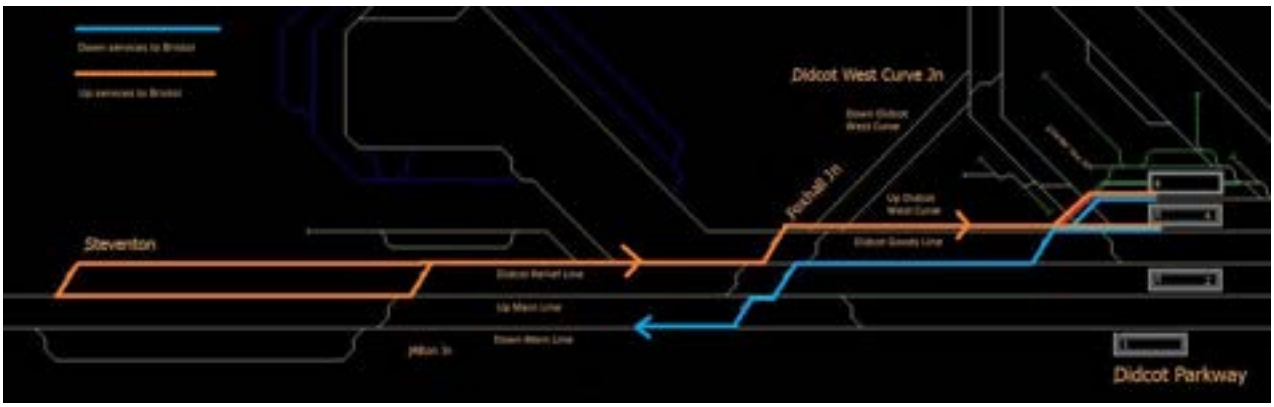


Figure 64 – Preferred paths west of Didcot Parkway for up (orange) and down (blue) services between Oxford and Bristol

7.3.8. Hanborough and Wolvercot Junction

To accommodate the significantly improved North Cotswolds service interventions are required at Wolvercot Junction, the single line to Hanborough, and at Hanborough station.

The 2028 specification sees an uplift from three trains using this line to seven trains in the peak hour. They cannot all be accommodated on the single line, or by the single platform at Hanborough.

Necessary interventions

A second platform is required at Hanborough to accommodate the services that start and terminate there in 2028. The track between Wolvercot North Junction and Hanborough station needs to be doubled and crossovers installed between the newly doubled track immediately east of Hanborough station (red items in Figure 65).

Additionally, the Down Oxford Relief Line should be extended between Wolvercot South and North Junctions to link directly with the Cotswolds Line to produce a more robust level of service, and to avoid the need for interventions towards Banbury (green item in Figure 65). Services to the Cotswolds could then use the Down Oxford Relief Line only and be completely isolated from freight and passenger trains towards Banbury using the Down Oxford Main Line.

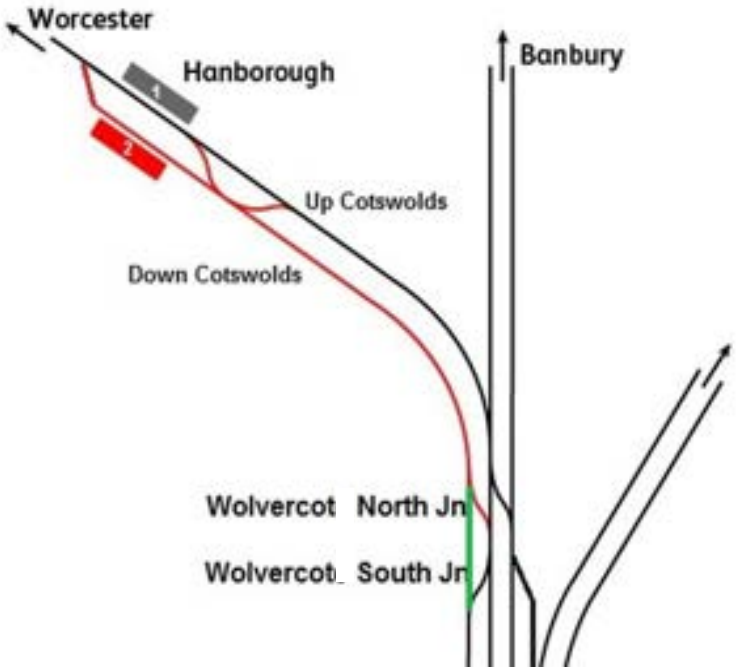


Figure 65 – interventions required on North Cotswolds Line – additional platform and crossovers at Hanborough station and double track to Wolvercot North Junction (red), and extension of Down Oxford Relief Line between Wolvercot South and North Junctions (green)

Extending the Down Oxford Relief Line also improves running times for services towards Hanborough by eliminating the restrictive junction allowance from the down main to the North Cotswolds line. Raising the speed of the crossover to the Up Oxford Main Line from 40mph should also be considered to reduce journey times.

These interventions use planning assumptions for Hanborough station in line with similar stations – minimum ten minute turnaround times; minimum three-minute margins between arrivals and departures; minimum three-minute platform re-occupation; and four-minute headways between Hanborough and Wolvercot North Junction.

These interventions are sufficient to accommodate the North Cotswolds services in the 2028 specification.

Intervention required: *Wolvercot Junction – extend Down Oxford Relief Line to join Cotswolds Line*

Intervention required: *Wolvercot Junction – crossover from Down Oxford Main Line to Down Oxford Relief Line at Wolvercot North*

Intervention required: *Cotswolds Line – double track from Wolvercot Junction to Hanborough*

Intervention required: *Hanborough station additional platform and crossovers*

7.3.9. Oxford North Junction

Oxford North Junction sees a large increase in traffic volumes in 2028, on top of the increase in 2024 (Figure 66).

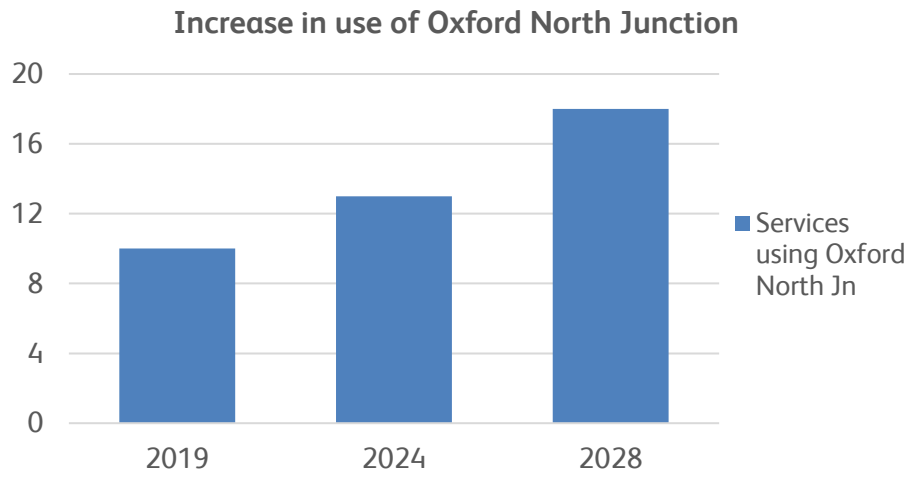


Figure 66 – Number of services using Oxford North Junction 2019-2028 (in one direction)

The 2028 specification can be accommodated at Oxford North Junction without the need for intervention. However, this involves minimum margin moves on the Up Oxford Main Line and Up Oxford Relief Line (Figure 67). Successive services at minimum margins mean that there is a high risk of delays to multiple services.



Figure 67 – Oxford North Junction occupancy 2028. Circles show minimum margins between services

The majority of these involve services moving towards Oxford Parkway. They occur because through services from south of Oxford towards Oxford Parkway must use platforms 4 and 5 at Oxford, which involves crossing three lines to reach the Down Bletchley Line.

Potential interventions

To produce a more robust level of service an intervention reducing conflicting movements at Oxford North Junction would be required. Since grade separation is not feasible this would involve an additional line connecting the Bletchley lines and the Up Oxford Relief, in effect bypassing the junction (Figure 68). Coupled with using platforms on the up side of the station for services towards Oxford Parkway this would remove moves across Oxford North ladder and reduce conflicts.

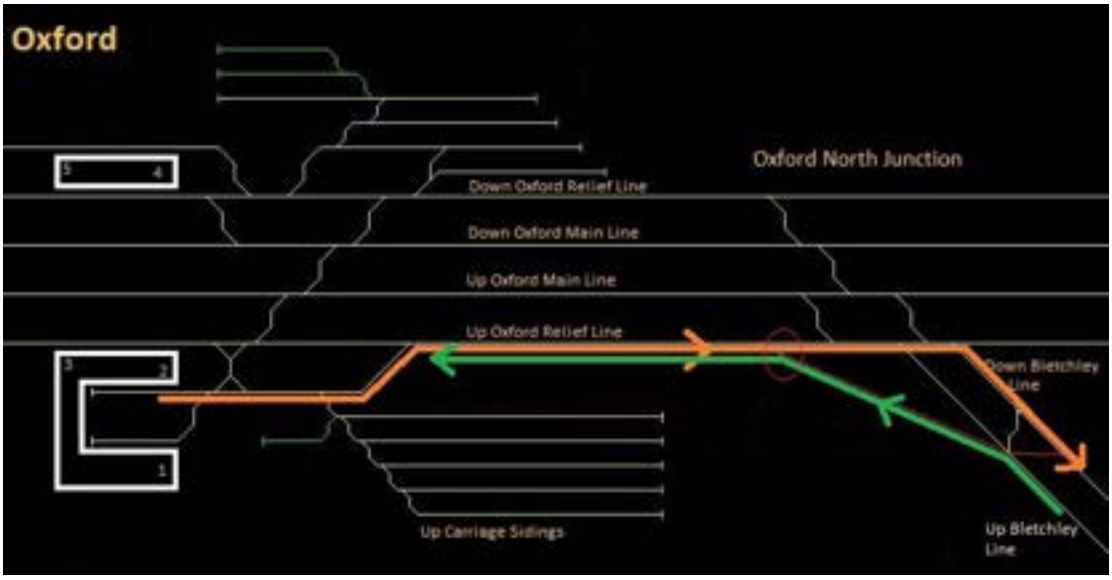


Figure 68 – Additional connection between Up Oxford Relief Line and Up Bletchley Line – an arrival (green) would have to wait until a departure (orange) to clear new junction (circled red)

More capacity would be created if the new connection bypassed the Up Oxford Relief and fed directly into the platform 1/2 turnout and was paired with a connection between the Up and Down Bletchley lines (Figure 69).

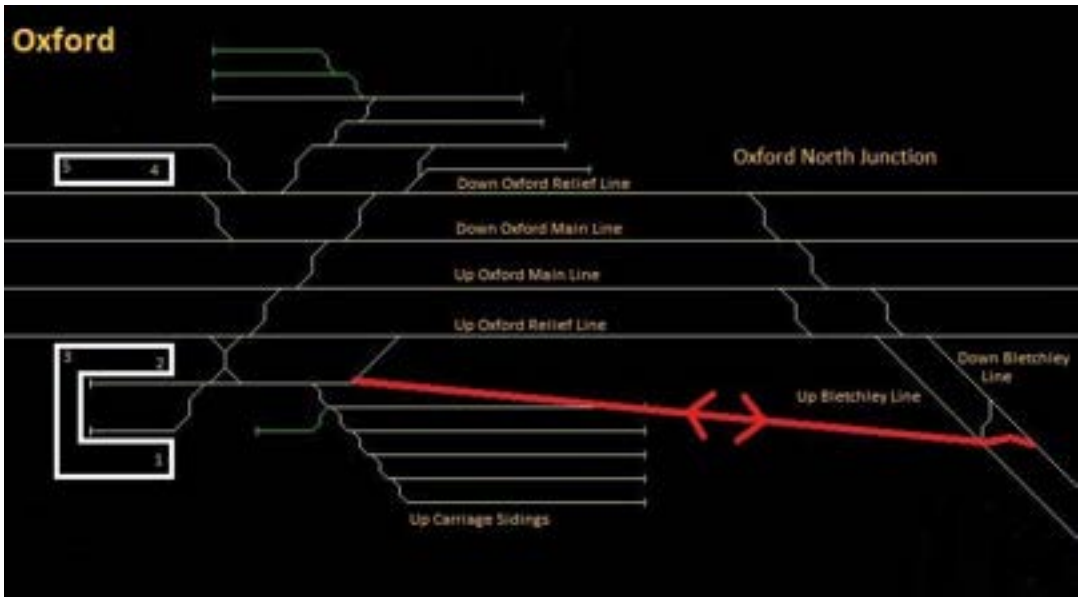


Figure 69 – New line between platform 1/2 turnout and Down Bletchley Line, bypassing Oxford North Junction

Comparison using high level estimates for running times and assuming minimum one minute between platform 1/2 departures and arrivals suggests that a new connection to the Up Oxford Relief reduces running time between the station and Oxford North Junction by two minutes, whilst a new connection directly to the platform 1/2 turnout reduces running time by five minutes (Figure 70).

Option	Departure from Oxford towards Oxford Parkway			Arrival from Oxford Parkway towards Oxford			Reduction
	Oxford	New junction	Oxford North Jn	Oxford North Jn	New junction	Oxford	
No new line	07:30	07:31	07:32	07:35	07:36	07:37	-
Up Oxford Relief	07:30	07:31	07:32	N/A	07:34	07:35	**2 mins**
Platform 1/2 turnout	07:30	07:30:30	07:32	N/A	07:31:30	07:32	**5 mins**

Figure 70 – Comparison of indicative timings of potential Oxford North Junction interventions

In theory conflicts at Oxford North Junction could be avoided by reconfiguring operations so that services are segregated at Oxford station by destination, with those to and from Banbury and the North Cotswolds Line using Platforms 4 and 5 and those to and from Bicester using Platforms 1, 2 and 3. However, such segregation would result in worse conflicts south of Oxford, so is not viable.

Therefore, whilst intervention at Oxford North Junction is not required to support the 2028 specification it should be considered to add robustness. The necessary intervention would involve an additional line connecting the Bletchley lines and either the Up Oxford Relief or platform 1/2 turnout. Further development should seek to identify if either of these is required and which is preferable.

7.3.10. Grove station

The new station at Grove is assumed to be located between Steventon and Uffington, near the site of the former Wantage Road station, and to have two platforms, on the Up and Down Relief lines. It is assessed as an hourly call in the East West Rail service between Cambridge and Bristol.

The station is on a four mile section of four track, the only four track section in the 20 miles between Steventon and Highworth Junction. Building the platforms on the Relief Lines would mean that services could potentially stop at Grove without disrupting traffic on the Main Lines – an essential requirement.

However the Relief Lines perform a key strategic function as loops for freight services, which need to be preserved. Therefore at a minimum the station requires intervention to lengthen the relief line loops to provide enough space to retain the current capability to loop freight and the required capability to call at the station without disruption to the Main Lines (Figure 71).

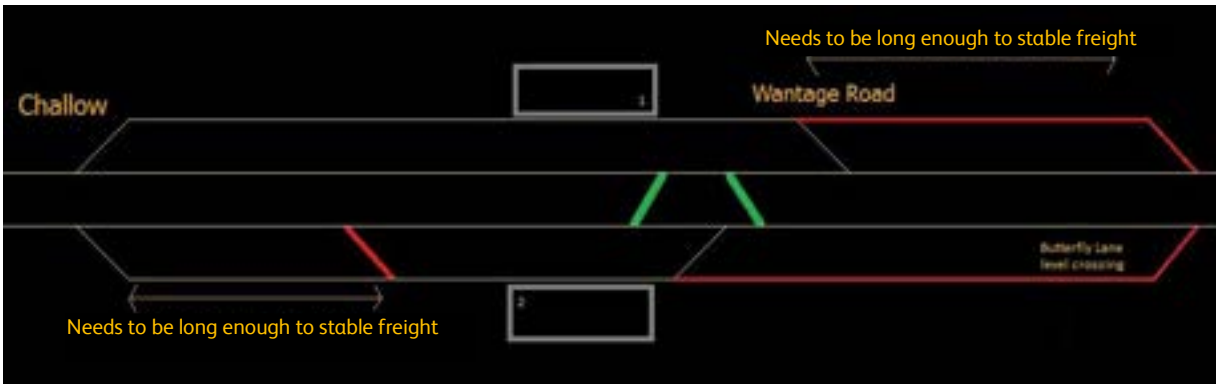


Figure 71 – Grove station with required track extensions and new (red) and removed (green) crossovers

The loops would need to be extended eastwards by at least one kilometre. They need to allow the majority of deceleration and acceleration for freight and stopping passenger services to be on the loops rather than Main Lines, and for these services not to impinge one another.

This intervention would allow hourly calls at Grove in Cambridge Bristol services, but only with some retiming of GW fast services.

In the up direction the stopping service conflicts with the following train when the one minute dwell and deceleration and acceleration time is included. In the down direction the stopping service is compliant leaving Grove but is caught up by the following train by Highworth Junction. Retiming GW fast services by removing their allowances allows the stopping services to be timed compliantly.

However the resulting train plan is very close to maximum capacity utilisation with many services at minimum headways. This may not be viable on this operationally and strategically vital section of the GWML. It also should not be assumed that GW fast services in the section can be retimed, or will follow the same pattern in 2028 as in 2019, which is a necessary assumption for this analysis.

Intervention may therefore be required to shorten the two track section between Highworth Junction and Challow to robustly accommodate the new stopping services alongside high speed and freight traffic. Further development should focus on understanding this requirement – and the same for the two track section between Wantage Road and Steventon – alongside developing the strategic case.

Intervention required: *Grove – new station*

Intervention required: *Grove – loop extension and additional crossovers*

7.3.11. Off-peak

The interventions required to accommodate the 2028 peak specification are sufficient to accommodate the off-peak specification.

Compared to the peak there is one more freight service in the off-peak specification. This is offset by two fewer GW fast services, one fewer London Marylebone service, and one fewer NCLTF and Midlands Engine Rail service respectively. This means that capacity utilisation is reduced at all key junctions and stations and the extra freight can be accommodated.

The pattern of Great Western fast services to London Paddington is very similar from the peak to off-peak. There are additional freight trains in the off-peak hour between Didcot and Swindon but if all services follow the same timing patterns the Oxford Bristol services could still find paths on the Main Line.

The requirement for loop lengthening to accommodate Grove station is driven by the increased volume of freight on the GWML in the off-peak.

7.3.12. Summary

In order to accommodate the 2028 peak specification significant interventions are required. The system is operating close to capacity in 2019 and in 2024 after delivery of Oxford Phase 2 and the 2024 specification. Therefore the substantial service uplift in 2028 requires interventions

across the rail system in Oxfordshire. Some are essential to accommodate the specification and others would yield a more robust level of service and should be further explored.

The interventions required are summarised in Figure 72, with the services in the Oxfordshire Train Service Specifications that drive the need for them. This emphasises that the major interventions cannot be tied to individual new services, and that their benefits extend to multiple services.

Intervention	2024	2028	2033	Services driving intervention
Oxford station – additional through platform (conversion of bay platform 1 or 2)				Various – +8 through services
Cowley Branch Line – stations and upgrades for passenger service				Cowley services
Hinksey – extend Up Oxford Relief Line from Hinksey North to Hinksey South				Cowley services
Kennington Junction – four track to Oxford station and raise crossover speeds				Various – +8 services; more stops south of Oxford
Radley – four track from Kennington Junction / Oxford to road bridge north of station				Various – +8 services; more stops south of Oxford
Didcot East Junction – grade separation				Various – +2 passenger services using junction; freight benefits; unlocks GWML service uplifts
Didcot North Junction – third line north of junction				
Didcot Parkway station – additional platform (6)				Various – +1 terminating & 1 through; +2 Ox-Bristol services
Didcot Goods Line – upgrade to passenger standard				Oxford – Bristol services calling Didcot Parkway
Wolvercot Junction – extend Down Oxford Relief Line to join Cotswolds Line				NCLTF services
Wolvercot Junction – crossover from Down Oxford Main Line to Down Oxford Relief Line at Wolvercot North				NCLTF services
Cotswolds Line – double track from Wolvercot Junction to Hanborough				NCLTF services
Hanborough – additional platform				NCLTF services
Oxford North Junction – additional line bypassing junction on Up side				
Oxford Canal Junction – crossover between Up and Down Bletchley Lines				
Grove – new station				Grove station call
Grove – loop extension and additional crossovers				Grove station call

Essential to accommodate specification

Not essential but would yield more robust service

Figure 72 - Interventions required to accommodate 2028 specification

7.4. Interventions required to accommodate the 2033 specification

The 2033 specification cannot be accommodated without intervention. Although the changes seem minor compared to 2028 each breaches a capacity threshold and drives the need for major interventions. Further development should consider the relative value of the increments specified for 2033 against the level of intervention required.

7.4.1. Key developments

Whereas the 2028 specification represents a step change from 2024, the 2033 specification is similar to the preceding specification. The only additional services are two further East West Rail services between Cambridge and Oxford. Hourly calls at a new station at Begbroke are also included in the 2033 specification (Figure 73).

Peak / off-peak	Change
Both	1 new East West Rail + service between Cambridge and Oxford
Off-peak	1 further new East West Rail + service between Cambridge and Oxford
Both	Hourly call at new station Begbroke in service between Banbury and Oxford

Figure 73 – Changes between 2028 and 2033 specification

These changes are added to the 2028 train plan and the impacts analysed by location. it is assumed that the interventions identified as required to accommodate the 2028 specification are delivered. Oxford station is considered first. Once trains are accommodated at Oxford other key areas are subject to analysis.

7.4.2. Oxford station

The additional East West Rail+ services cannot be accommodated in the five platforms at Oxford station as there is insufficient platform capacity for them to turnback. They could be shunted to the Up Carriage Sidings with minor retiming of other services. There may not be a robust means of operation for this move, which requires that there is usable capacity in the sidings each hour that these services can utilise.

Otherwise they could not be accommodated without a further, sixth platform at Oxford station, on the city side. This would create five through platforms and one bay platform.

The sixth platform could accommodate the 2033 specification and would have system benefits including regular intervals between EWR services, and fewer conflicts at Oxford North Junction as more services are platformed on the city side of Oxford station, but it breaches the established vision of the station footprint in the masterplan and is unlikely to be feasible with surrounding highways, waterways, and property.

7.4.3. Oxford North Junction

Whilst there are paths for additional services on the Bletchley Lines these do not align with opportunities at Oxford North Junction.

The intervention at Oxford North Junction that should be considered to accommodate the 2028 specification – section 7.3.9 – is essential for the 2033 specification. This is a means of bypassing Oxford North Junction with an additional line between the Bletchley Lines and either the Up

Oxford Relief or Platform 1/2 turnout. Given the further increased level of service the direct connection to the Platform 1/2 turnout the latter would likely be required for 2033 (Figure 74).

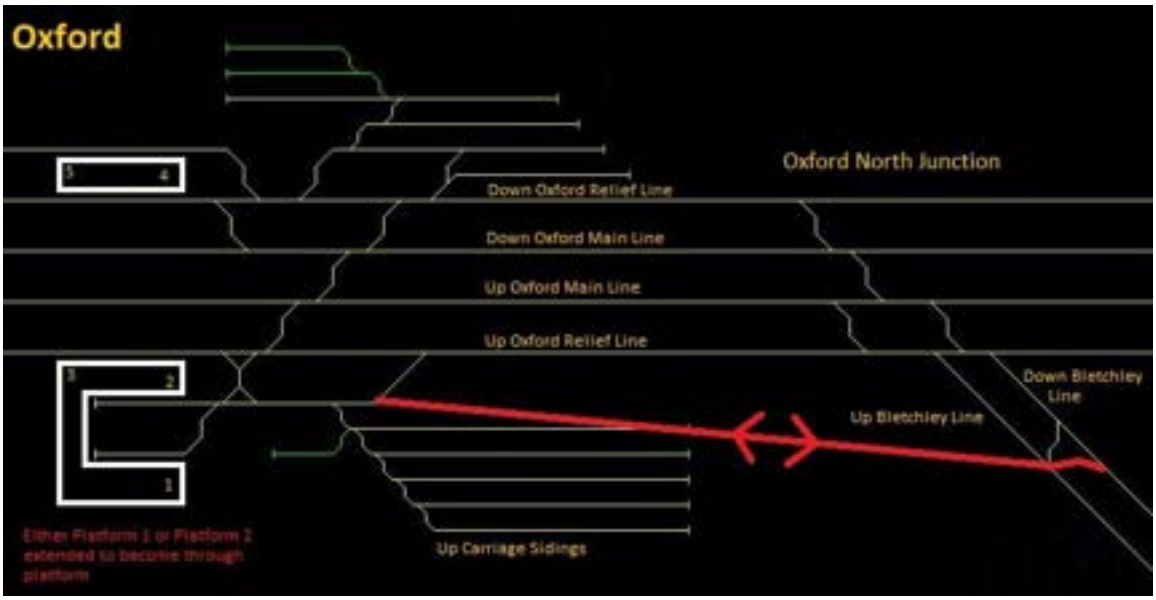


Figure 74 – New line between platform 1/2 turnout and Down Bletchley Line, bypassing Oxford North Junction

Coupled with using platforms on the up side of the station for services towards Oxford Parkway this would reduce moves across Oxford North ladder and reduce conflicts. This is discussed in detail in section 7.3.9.

Intervention required: *Oxford North Junction – additional line bypassing junction on Up side*

Intervention required: *Oxford Canal Junction – crossover between Up and Down Bletchley Lines*

7.4.4. Begbroke station

The new station at Begbroke is assumed to be located north of Wolvercot Junction, near the site of the former Kidlington station and to have two platforms, on the Up and Down Cherwell Valley Lines.

It is assessed as a call in the hourly shuttle service between Banbury and Oxford. Stopping at Begbroke causes additional running time in this service, which causes knock on impacts on other services in the corridor and consequently impacts timings at Oxford North Junction. Without the intervention identified for an additional line at Oxford North Junction – which frees capacity across the junction by reducing the number of moves and allows the shuttle services to be retimed to accommodate the extra journey time whilst remaining compliant with other trains in the corridor – this knock on impact cannot be accommodated.

Therefore Begbroke station is dependent on intervention at Oxford North Junction. This is the case whether the station is delivered in the 2028 or 2033 specification.

Intervention required: *Oxford North Junction – additional line bypassing junction on Up side*

Intervention required: *Begbroke – new station*

7.4.5. Off-peak

The interventions required to accommodate the 2033 peak specification are not sufficient to accommodate the off-peak specification.

The 2033 specification includes three more freight services (1.5 in each direction) compared to the peak. There are two fewer GW fast services, one fewer London Marylebone service, and one fewer NCLTF, Midlands Engine Rail, and EWR service respectively.

The volume of traffic and characteristics of freight services in the specification and wider off-peak train plan mean that intervention is required at Didcot North Junction to accommodate the 2033 off-peak specification.

The intervention at Didcot North Junction that should be considered to accommodate the 2028 specification – section 7.3.5 – is required. This is a bi-directional third line north of the junction to allow a service to be held without delaying other services. One southbound freight service would need to be stabled there to allow a faster service to pass.

Intervention required: *Didcot North Junction – third line north of junction*

7.4.6. Summary

In order to accommodate the 2033 specification interventions are required at Oxford North Junction, Didcot North Junction, and between Didcot and Swindon. Other interventions would yield a more robust level of service and should be considered given the volume of services across the rail system in Oxfordshire.

The interventions required are summarised in Figure 75, with the services in the Oxfordshire Train Service Specifications that drive the need for them. This again emphasises that the major interventions cannot be tied to individual new services, and that their benefits extend to multiple services.

Intervention	2024	2028	2033	Services driving intervention
Oxford station – additional through platform (5 total – conversion of bay platform 1 or 2)		Essential		Various – +8 through services
Oxford station – additional platform (6 total)			Not essential	EWR+ services
Cowley Branch Line – stations and upgrades for passenger service		Essential		Cowley services
Hinksey – extend Up Oxford Relief Line from Hinksey North to Hinksey South		Essential		Cowley services
Kennington Junction – four track to Oxford station and raise crossover speeds		Essential		Various – +8 services; more stops south of Oxford
Radley – four track from Kennington Junction / Oxford to road bridge north of station		Essential		Various – +8 services; more stops south of Oxford
Didcot East Junction – grade separation		Essential		Various – +2 passenger services using junction; freight benefits; unlocks GWML service uplifts
Didcot North Junction – 3rd line north of junction		Not essential	Essential	2033 off-peak freight services
Didcot Parkway station – additional platform (6)		Essential		Various – +1 terminating & 1 through; +2 Ox-Bristol services
Didcot Goods Line – upgrade to passenger standard		Essential		Oxford – Bristol services calling Didcot Parkway
Wolvercot Junction – extend Down Oxford Relief Line to join Cotswolds Line		Essential		NCLTF services
Wolvercot Junction – crossover from Down Oxford Main Line to Down Oxford Relief Line at Wolvercot North		Essential		NCLTF services
Cotswolds Line – double track from Wolvercot Junction to Hanborough		Essential		NCLTF services
Hanborough – additional platform		Essential		NCLTF services
Oxford North Junction – additional line bypassing junction on Up side	Not essential	Not essential	Essential	EWR+ services
Oxford Canal Junction – crossover between Up and Down Bletchley Lines	Not essential	Not essential	Essential	EWR+ services
Begbroke – new station			Essential	Begbroke station call

Essential to accommodate specification

Not essential but would yield more robust service

Figure 75 – Interventions required to accommodate 2033 specification

7.5. Interventions required to accommodate further specifications

The only change after the 2033 specification is an additional freight service every other off-peak hour in the 2038 specification. This can be accommodated by the interventions required for the 2033 specification. Accommodating the 2028 and 2033 specifications requires significant interventions across Oxfordshire's rail system. These transform the level of services and support growth in the long term without further intervention in the study period.

8. Conclusions

Oxfordshire is one of the most productive economic regions in the United Kingdom outside London and will enjoy uniquely high growth over the next fifteen years. Housing and employment growth must be supported by transport infrastructure. Oxfordshire's rail system – which functions as a strategic hub for local and national services – has accommodated significant growth in the last ten years but has little further capacity and does not link important and growing hubs within Oxfordshire. The Oxfordshire Rail Corridor Study assesses the impacts of planned growth on Oxfordshire's rail system and identifies the role the system has to play to support growth (***2 – The need for the Oxfordshire Rail Corridor Study***).

The Oxfordshire Rail Corridor Study brings a range of organisations including the Department for Transport, Oxfordshire County Council, Oxford City Council, passenger and freight train operating companies, and Network Rail into partnership to deliver four outputs: the Oxfordshire Planned Growth Scenario; Conditional Outputs for Oxfordshire's Rail System; Oxfordshire Train Service Specifications; and Oxfordshire Rail System Interventions, that build sequentially to describe the role of rail in supporting Oxfordshire's growth (***3 – The Oxfordshire Rail Corridor Study*** approach).

Planned growth in Oxfordshire delivers increases in population and employment well above the national average and these drive similarly large increases in forecast rail demand. The **Oxfordshire Planned Growth Scenario** accommodates growth allocated in Local Plans into the recognised forecasting framework to produce locally sensitive forecasts that reflect the precise pattern and scale of growth. These show that demand for rail in Oxfordshire will increase significantly more than would otherwise have been forecast. Growth sites largely follow the rail corridor, with the biggest allocations in or near large settlements already served by stations. There are seven growth hubs in the Oxfordshire rail system: Banbury, Bicester Village, Culham, Didcot Parkway, Hanborough, Oxford, and Oxford Parkway. Supporting growth at these hubs is a key requirement of Oxfordshire's rail system. The market for rail freight in Oxfordshire is also forecast to grow and Oxfordshire's rail system will continue to have a vital strategic role (***4 – The market for rail services in Oxfordshire***).

Conditional Outputs for Oxfordshire's Rail System define specifically what is required from the rail system to support growth and can be used to assess the strategic fit of train service specifications. Capacity improvements are required on inter-regional services and two other service groups, whilst substantial connectivity improvements are required between Oxfordshire's seven growth hubs. Improved connectivity is also required between Oxford and priority inter-regional locations, including Heathrow Airport. Analysis of potential new stations suggests that two stations on the Cowley Branch Line, in particular, have a role to play in supporting growth. Conditional outputs for freight services involve providing capacity for more services, enhancing access to the network, and accommodating changes in the rail freight industry (***5 – Conditional Outputs for Oxfordshire's Rail System***).

Major improvements to rail services in Oxfordshire are required to deliver the conditional outputs. 70 % more services are required, along with amendments to calling patterns and coverage. The recommended pattern of services form the **Oxfordshire Train Service Specifications**. New services are based on existing programmes, in particular East West Rail, Midlands Engine Rail,

and North Cotswolds Line Task Force, reconfigured where necessary to meet the conditional outputs. Major reconfigurations are proposed for East West Rail services, especially Central Section. As a result of this study these should be progressed with promoters and funders, but may not prove acceptable. The majority of new services are required by 2028 to support growth, which is front-loaded in the study period (***6 – Oxfordshire Train Service Specifications***).

The 2033 specification improves direct connections between Oxfordshire's growth hubs by 160 % and between Oxford and priority inter-regional connections by 106 % . This level of improvement is required to deliver the conditional outputs. Improvements to inter-regional connections will have economic benefits beyond Oxfordshire.

A key feature of the specifications is that the majority of services are extended through, rather than terminating at, Oxford to provide direct links between the growth hubs. Without widespread extensions through Oxford the conditional outputs cannot be met. A Cowley Branch Line passenger service is recommended. Another key feature is provision of new direct services to Bristol and Swindon and strengthening of connections with Birmingham, Worcester, and the South Coast to support Oxfordshire's economic growth. Increases in freight services are also accommodated.

New services do not meet capacity shortfalls for inter-regional and London Marylebone services so lengthening of these services is recommended.

In order to deliver the Oxfordshire Train Service Specifications a number of **Oxfordshire Rail System Interventions** are required. Delivery of Oxford Phase 2 is critical to support the 2024 specification and all subsequent specifications. A portfolio of interventions is required to deliver the 2028 specification. Some can be associated with individual service enhancements, such as interventions at Wolvercot Junction and the North Cotswolds Line for North Cotswold Task Force services, and Cowley Branch Line infrastructure for Cowley services. However the majority represent a system upgrade between Oxford North Junction and Didcot that is required to unlock the portfolio of new services necessary to support growth in Oxfordshire. Essential interventions include Oxford station, which should be developed following the principles of the existing masterplan, four tracking between Oxford station and Radley, and grade separation of Didcot East Junction. Alongside interventions that are essential to deliver the specifications, interventions are identified that may need to be delivered to provide a robust train service. The identified suite of interventions comprise a system that supports growth in the long term (***7 – Oxfordshire Rail System Interventions***).

9. Recommendations and next steps

The Oxfordshire Rail Corridor Study establishes a compelling rationale for significant improvements to rail services in Oxfordshire. The four principal outputs of the study form a robust analysis that can be used to establish a comprehensive strategic vision and to develop investment cases for the rail interventions recommended.

The suite of interventions identified sets out an extremely ambitious investment programme as well as an approach to how this may be aligned with other investment programmes so that growth in Oxfordshire can be fully supported. This offers significant benefits both to Oxfordshire and far beyond. Further development of the proposed interventions will require active engagement with all beneficiaries.

9.1. Use of ORCS outputs

The four principal outputs and the strategic vision they establish should be adopted as the bases for strategic planning for the rail system in Oxfordshire.

The **Oxfordshire Planned Growth Scenario** offers a robust, evidence-based, locally sensitive demand forecasting framework that should be considered for strategic case development and as a sensitivity scenario alongside a required central case in government funding appraisals.

The housing and employment data that underpin the OPGS should be refreshed as local plans are confirmed and revised, and, in the longer term, when further plans become available.

The OPGS should be used as the basis for further detailed analysis on the role and likely demand for new stations, and for requirements for existing stations – in particular their function, size, and service provision.

The OPGS should be shared with industry planning partners and with programmes in development – in particular East West Rail, Midlands Engine Rail, and the North Cotswolds Line Task Force – to allow assessment of their interdependencies, wider benefits, and strategic alignment.

The **Conditional Outputs for Oxfordshire's Rail System** should be considered as an objective statement of service requirements in Oxfordshire. Decisions involving changes to the service specifications as schemes develop should be assessed against impact on the conditional outputs. This should include exploring opportunities to meet the outputs that are not met by the Oxfordshire Train Service Specifications. The freight capability conditional outputs should inform priorities for freight strategic planning and improvement schemes.

The key principles established by the conditional outputs – that the pattern of growth in Oxfordshire creates seven growth hubs and better links are required between these hubs to support economic growth, and that Oxfordshire's growth is restricted through lack of direct connections to nearby economic hubs – should be endorsed as fundaments within the strategic vision for the rail system Oxfordshire.

The **Oxfordshire Train Service Specifications** should be endorsed and established as the proposed strategic baseline for rail system planning and the development of services within and through Oxfordshire. The fundamental underlying principles – that the majority of services are

proposed to go through rather than terminate at Oxford, and that service groups that are envisaged as independent should be connected – should be recognised.

The specifications should form the basis of development work on interventions – both individual and portfolio – and should also be used to inform and influence the development of the output specifications of major programmes proposing new services in Oxfordshire and strengthen their strategic cases.

The specifications should inform the franchising process as the basis of advice on priorities for service development and specification. Equally the capacity conditional outputs that are not met by the specifications should be pursued through consultation on franchise specification. That is lengthening of both inter-regional (CrossCountry) and London Marylebone (Chiltern) services.

The **Oxfordshire Rail System Interventions** should inform industry enhancement priorities and funding requirements as the investments required in order to deliver the strategic vision for Oxfordshire.

It should be recognised that system constraints in Oxfordshire mean that most new services depend on a portfolio of interventions comprising a systemwide upgrade and that therefore individual services cannot be solely associated with single interventions. Interventions identified should therefore form the basis of a programme for rail investment in Oxfordshire.

Further development should be undertaken to strengthen the link between interventions and benefits and to support the development of an investment case for a programme of rail interventions in Oxfordshire.

The interventions and the case established for them should directly inform programme development for existing major programmes and into business case development for new programmes.

The strategic vision for developing Oxfordshire's rail system should be used to inform local planning processes. ORCS outputs should inform updates to both the Oxfordshire Infrastructure Strategy and the Oxfordshire Rail Strategy, and through them the Oxfordshire Plan 2050 (the Joint Statutory Spatial Plan for Oxfordshire). The Oxfordshire Plan 2050 will set out where growth beyond that identified in Local Plans may be located. Whilst this report focuses on how rail can support planned growth the outputs will also inform how rail investment can influence the location of growth up to 2050.

9.2. Development of interventions

Analysis of interventions required to deliver the Oxfordshire Train Service Specifications shows that it is not possible to isolate interventions to deliver single outcomes, either new services or new stations. For example whilst it appears that interventions at Hanborough unlock NCLTF services in fact these would be stymied by a lack of capacity at Oxford North Junction and Oxford station. This case is repeated for every new service, so whilst it is possible to link some specific interventions to specific services – for example those Hanborough interventions are driven only by NCLTF services – it does not mean that delivering those interventions alone secures those services. In fact, significant systemwide upgrade is required.

The existing utilisation of available capacity means that a series of isolated interventions targeted at outcomes is not feasible. Similarly, the scale of systemwide interventions required means that no single outcome would be likely to represent sufficient value. The rail system between Oxford North Junction and Didcot, which all new services impact, should be recognised as in need of significant upgrade.

Therefore the highest priorities for development work through ORCS should be twofeasibility studies considering system infrastructure between (1) Oxford North Junction and Appleford; and (2) the Didcot area to Swindon east. These should be assumed to involve the enhancements identified inFigure 75. Development work should adopt the Oxfordshire Train Service Specification as the required output for development of intervention options. Amongst the other new services this should include a Cowley Branch Line passenger service formed by extension of services between London Marylebone and Oxford.

The priority for further developing the Cowley Branch Line stations should be to understand the intervention required on the mainline between Kennington Junction and Oxford station and support development of this intervention.

The next priority should be to consider the interventions required to deliver the North Cotswolds Line services. However, this should be through an integrated approach with the North Cotswolds Line Task Force programme. Oxfordshire County Council, as the lead organisation in both programmes, should take responsibility for this integration.

Any further development of the new stations at Begbroke and Grove should be based on the interventions identified as necessary in this study. It should be recognised that each involves significant infrastructure beyond the building of the station in order to fit with the Oxfordshire Train Service Specifications. Grove should be included in the Didcot area to Swindon east study, and the likelihood that interaction with fast GWML services will drive more significant interventions should be recognised.

Identification of interventions establishes those that are essential to accommodate the specification and those that are not essential but would yield a more robust level of service. It should be recognised that as cases develop the latter may be deemed essential to meet rail industry priorities and therefore revise the categorisation as non-essential at this stage of analysis.

9.3. Development of business cases

Delivering the strategic vision for Oxfordshire's rail system depends upon a portfolio of interventions which will deliver a transformational change. This systemwide upgrade should be further developed into a programme for strategic rail investment for Oxfordshire.

The case for investment should consider other separate but related work underway such as Network Rail's decarbonisation and accessibility workstreams.

This Oxfordshire rail investment programme should be considered for entry into the Rail Network Enhancements Pipeline and a Decision to Initiate should be submitted to secure funding from central government to commence the work (Figure 76).

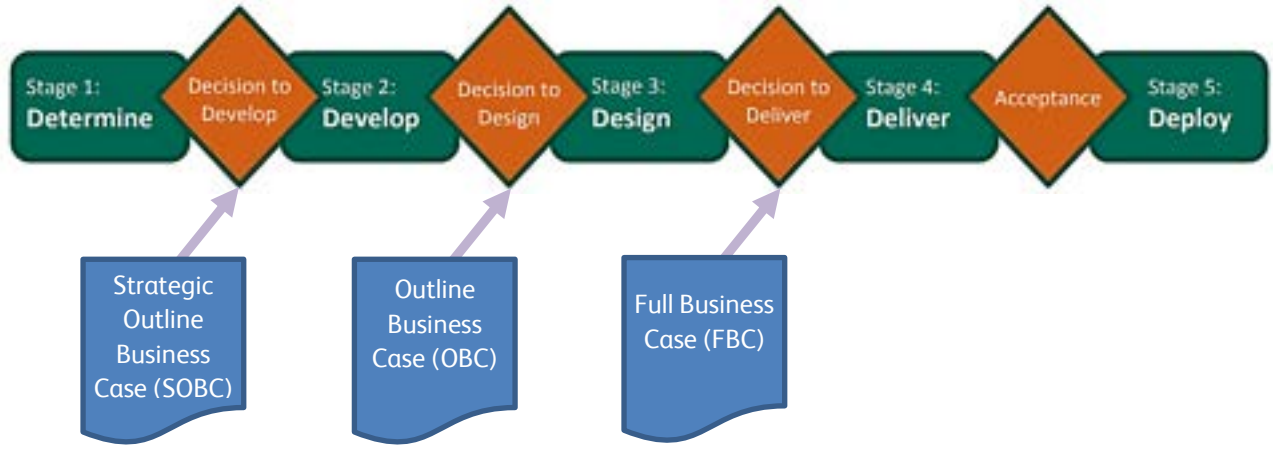


Figure 76 – The Rail Network Enhancements Pipeline process, with business case development stages

The large majority of information required for the programme strategic case is contained within the ORCS outputs and development work should focus on assembling this evidence base. The other four cases should be developed as the programme is established (Figure 77).

Case	Sufficient information?
Strategic	Yes – can be assembled from ORCS outputs
Economic	No – intervention development required
Financial	No – programme development required
Commercial	No – programme development required
Management	No – programme definition required

Figure 77 – Status of five cases that should comprise the Oxfordshire rail investment programme SOBC

The programme strategic case should consider the programme benefits and how interventions identified can be separated and identified as priorities for progression within RNEP. Integration with other programmes and schemes should also be considered to ensure that benefits cab be apportioned appropriately.

Since the premise of ORCS is supporting Oxfordshire's economic growth close engagement with partner organisations outside the rail industry who have interests in supporting that growth should continue. The Oxfordshire rail improvement programme should function as an investment portfolio for all beneficiaries of the rail system taking on an explicit role in supporting housing and employment growth. The programme should engage with potential funders and make the study information available to facilitate the development of business cases outside the RNEP process.

ORCS appendices

A. Technology extract
B. Oxfordshire Train Service Specification (detailed)

Appendix A

Oxfordshire Rail Corridor Study

How can technologies be used to improve the operation and attractiveness of the rail system in Oxfordshire?

> *Whilst we are unable to predict the future, we can be sure that Great Britain will need a railway that can adapt to technological developments and broader social and economic changes at a similar pace to other transport modes, to be fit-for-purpose for tomorrow's passengers.*
>
> *Rail in the future transport system,* Williams Review evidence paper, May 2019.[1]

The Oxfordshire Rail Corridor Study analyses the potential case for infrastructure and service enhancements to meet forecast growth in demand. Increasing capacity of the network remains the most likely approach to meeting demand, but as well as the development of new and improved stations, lines and services, there is also a need to consider whether there are alternative ways of achieving the outputs of the Study.

Significant developments in technology such as autonomous vehicles and Mobility as a Service have the potential to fundamentally change travel patterns and the way in which the transport network is managed, including demand for and access to rail services.

Although it is difficult to anticipate and quantify the impact of these influences, a number of principles have been identified that should be considered as the outputs of the work are taken forward.

The case for the development and introduction of infrastructure and rolling stock that optimises alternative power technologies, electrification and regenerative braking

Digital Railway

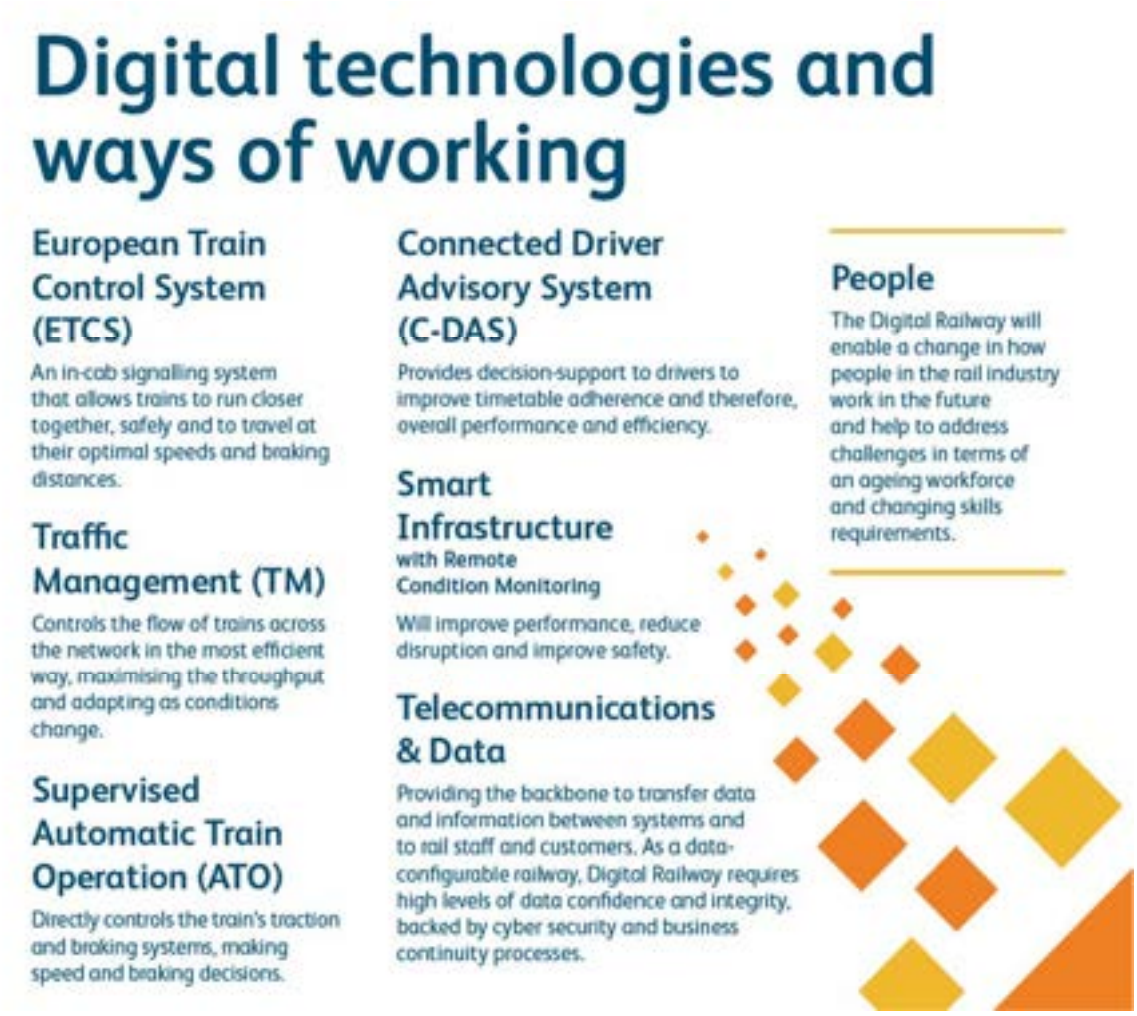
There are several reasons why moving to a digital railway is necessary. As well as overall benefits such as capacity and performance, the key reason to deploy digital signalling across the network is reduced whole life costs compared to conventional signalling.

Detailed analysis has shown that conventional signalling is becoming unsustainable. Given the amount of signalling renewals needed in Control Period 7 (2024-29) and beyond, it creates a bow wave of renewals that is undeliverable without the use of digital signalling. However, using current volume and cost estimates for European Train Control System (ETCS), it is possible to deliver the volumes necessary to meet the upcoming bow wave over 40 years.

Network Rail's Digital Railway Programme is a pan industry programme leading the transformation of the railway through digital train control and signalling. This programme consists of the implementation of systems shown in the diagram below, all of which remove the necessity for lineside signals and allow the train service to be run more efficiently.

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[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/802472/rail-in-the-future-transport-system.pdf



These technologies enable benefits such as enhanced safety for passengers and workforce, increased capacity to meet demand, better performance for passenger and freight customer journeys, less disruption from renewals, maintenance and upgrades, better asset sustainability (lower whole life cost), and enabling data connectivity for passengers and freight customers as well as real time monitoring of asset conditions, increasing the overall reliability of the railway.

To address this issue, DfT commissioned Network Rail to produce a Long Term Deployment Plan (LTDP) to set out how ETCS should be introduced across the network. The LTDP is based on renewals, rather than train fitment or franchises because the infrastructure is the bulk of the cost.

The recommendation is to steadily introduce ETCS across the network where the signals are expired. This plan is currently unfunded and will affect the balance between enhancements and renewals. Some train fitment will need to be done in CP6 if the LTDP is to be realised.

Rolling stock

Modern rolling stock is far more efficient owing to lighter vehicles, more efficient traction and braking systems, and the ability to regenerate under braking and feed back into the power supply.

The advancements in vehicle weight and traction systems has enabled much increased acceleration and brake rates, allowing for headways to be reduced and a higher train throughput across infrastructure. These benefits are much better realised when they are used in conjunction with a modern signalling system that has been optimised upon installation.

The limiting factor on infrastructure is the safety distances, which is governed by the maximum braking rate of a vehicle, freight usually having the worst and therefore largest safety distance. With an intelligent signalling system, such as ETCS, trains are able to reduce safety distances between them, for trainsets which have increased brake rates, increasing the throughput of trains by allowing them to run closer together.

How better digital connectivity can be delivered and allow train users in Oxfordshire to employ their travel time effectively and increase productivity.

Engagement with passengers frequently highlights that on-train wi-fi is unreliable because of poor mobile connectivity, including 'not spots' in mobile signal along routes. Better connectivity is essential to enable the promotion of rail travel as a mobile office that provides a tangible advantage over car travel. Mobile network operators do not however have a commercial business case to build infrastructure in areas of low density of people.

The Department for Transport continues to seek improvements to on-train wi-fi and mobile connectivity through rail franchising, and the Department for Digital, Culture, Media and Sport (DCMS) are leading on the development of a new rail connectivity policy. This is currently in the early stages of development. Network Rail's Rail Innovation and Development Centre at Melton Mowbray has also been upgraded to allow 5G technologies to be tested and made railway-ready in a controlled environment.

https://cdn.networkrail.co.uk/wp-content/uploads/2019/05/Enabling-5G-for-the-rail.pdf

Enhancing the passenger experience through improved operations such as the provision of smart ticketing and better accessibility and travel information.

Passenger information Systems / Station Management Systems

Modern passenger information systems can display information to passengers that allow for a more comfortable and efficient journey, including car or bus loading data for approaching vehicles, allowing passengers to find available seats or luggage storage. This information can complement station management systems, aiding staff on the transport modes to effectively control the flow and distribution of passengers, something which is particularly useful during periods of high demand.

Wayfinding

Modern wayfinding technology allows people in need of assistance, such as visually impaired people, to navigate the transport network without the intervention of operational staff. These are becoming more and more common, often integrating with mobile phone technology, allowing fully independent and accessible travel across the network. These technologies can be included as part of new infrastructure or retrofitted into existing stations and vehicles, often being based around beacons.

Developing innovative approaches to station parking provision

Provision of station parking can be a paradoxical issue, with balance needed between encouraging people to access rail services sustainably whilst not discouraging those who might otherwise not use them at all, preferring to undertaking their journeys entirely by car. There is also a need to minimise rail-heading, whereby rail travellers choose not to use their nearest station but instead drive a further distance to a station that offers them a better service frequency, or preferential parking cost and availability.

Future provision of parking at Oxfordshire's stations will need to be tailored to meet the anticipated level of demand, optimising the rail network's ability to provide access to employment and leisure opportunities and

reduce congestion on the County's roads. This includes a range of measures from more integrated bus provision, greater levels of drop off, cycle access and, in time, driverless vehicle access.

Consistent with this is Oxfordshire's desire to making the most of available technology to create "smart corridors" that prioritise walking, cycling and public transport, contributing to the aims of the Oxfordshire 2050 strategy. This may include consideration of facilities at stations for autonomous vehicles, mobility services (referred below) and technology based parking innovations.

https://www2.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/roadsandtransport/transportpoliciesandplans/Oxfordshire2050.pdf

Integrating rail services [digitally] with other modes to support user-friendly door-to-door mobility services and sharing data with other transport services to be a key component of mobility packages, thereby embedding the principles of Mobility as a Service / Pay as you Go multi-modal travel for journeys within Oxfordshire.

Mobility as a Service (MaaS) is a term used to describe digital transport service platforms that enable users to access, pay for, and get real-time information on, a range of public and private transport options (Government Office for Science, 2018) . MaaS can be perceived as a one-stop online ICT interface comprising:

- an intermodal journey planner (providing combinations of different transport modes: car-sharing, car rental, underground, rail, bus, bike-sharing, taxi, etc.) that operates in real-time
- a single payment portal like that for smartphones, whereby users can pay as they go or else buy a 'service bundle' in advance
- a booking system incorporating the entire end-to-end journey stages[2].

Development of MaaS and Pay as you Go (PAYG) for the Oxfordshire rail network and wider sustainable transport networks will not in itself stimulate or accelerate housing and employment growth. It will however support more sustainable transport patterns if developed alongside enhancements to service frequency, choice of destination and journey times, especially where a change of service or mode is required.

Engagement with Oxfordshire stakeholders to deliver innovations to the railway network.

The rail industry does not hold the monopoly on new ideas to tackle these issues to make rail services better and more widely accessible.

Oxfordshire stakeholders are invited to bring forward ideas to invest in rail research, innovation and technologies to enable the growth that is expected over the coming decades to be developed in a sustainable way.

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2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766759/Mobilityasaservice.pdf

Appendix B

New services to be added to the December 2019 baseline timetable

Year	Tph	Source	Origin	Destination	Timing Load	Oxfordshire calls	Notes
2024	1	EWR2	Milton Keynes Central	Didcot Parkway	Cl 185	Bicester Village, Oxford Parkway, Oxford, then current shuttle pattern *with all calling at Culham*	
2024	1	EWR2	Milton Keynes Central	Didcot Parkway	Cl 185	Bicester Village, Oxford Parkway, Oxford, Culham	
2024	-1	*Remove GWR slow*	*Oxford*	*Didcot Parkway*	Cl 165/1		
2024	-1	*Remove GWR slow*	*Oxford*	*Didcot Parkway*	Cl 165/1		
2024	1	EWR2	Bedford	Oxford	Cl 185	Bicester Village, Oxford Parkway	
2024	0.5	Chiltern	Birmingham Moor Street	Oxford	Cl 168	Banbury	
2024	0.5	Banbury stopper	Banbury	Oxford	Cl 165/1	Kings Sutton, Heyford, Tackley	
2024	0.5	Freight	*Didcot North jn*	*Oxford North jn*	1400t	additional 0.5 tph (each direction) *to total 2.5ftph in each direction*	OFF PEAK ONLY
2024	0.5	Freight	*Didcot North jn*	*Oxford North jn*	1600t	additional 0.5 tph (each direction) *to total 3ftph in each direction*	OFF PEAK ONLY
2028	1	Cowley	Oxford Business Park (Cowley)	London Marylebone	Cl 168	Oxford Science Park, Oxford, then *current CR pattern*	
2028	1	Cowley	Oxford Business Park (Cowley)	London Marylebone	Cl 168	Oxford Science Park, Oxford, then *current CR pattern*	
2028	1	NCLTF	Hanborough	Didcot Parkway	Cl 165/1	Oxford, Culham	
2028	1	NCLTF	Hanborough	Didcot Parkway	Cl 165/1	Oxford, Culham	*OFF PEAK ONLY - replaced by Paddington service in peak*
2028	1	NCLTF	Hanborough	London Paddington	Cl 800	Oxford, Culham	*PEAK ONLY - replaced by Didcot service off peak*
2028	1	NCLTF	Great Malvern	London Paddington	Cl 800	Hanborough, Oxford, then *current Oxford fast pattern*	OFF PEAK ONLY
2028	1	EWR3	Cambridge	Bristol Temple Meads	Cl 185	Bicester Village, Oxford Parkway, Oxford, Didcot Parkway, (Grove)	
2028	1	*EWR3*	*Cambridge*	*Southampton*	Cl 185	Bicester Village, Oxford Parkway, Oxford, Didcot Parkway	Extension of EWR2 Bedford Oxford
2028	-0.5	*Remove Chiltern*	*Banbury*	*Oxford*	CL 168		
2028	0.5	Banbury stopper	Banbury	Oxford	Cl 165/1	Kings Sutton, Heyford, Tackley	
2028	1	Midlands Engine Rail	Birmingham Moor Street	Bristol Temple Meads	Cl 170	Banbury, Oxford, Didcot Parkway	
2028	1	Midlands Engine Rail	Birmingham Moor Street	Oxford	Cl 170	Banbury	
2028	0	*Grove new station*	-	-	-	*Added to 1tph Cambridge - Bristol*	*New station at Grove (MLN1, 60.36mp) added into 1tph EWR3 Cambridge-Bristol service*
2033	1	EWRX	Cambridge	Oxford	Cl 185	Bicester Village, Oxford Parkway	
2033	1	EWRX	Cambridge	Oxford	Cl 185	Bicester Village, Oxford Parkway	
2033	0	*Begbroke new station*	-	-	-	*Added to 1tph Banbury - Oxford stopper*	*New station at Begbroke (DCL, 69mp) added into 1tph Banbury stopper service*
2033	0.5	Freight	*Didcot North jn*	*Oxford North jn*	1400t	additional 0.5 tph (each direction) *to total 3.5ftph in each direction*	OFF PEAK ONLY
2038	0.5	Freight	*Didcot North jn*	*Oxford North jn*	1400t	additional 0.5 tph (each direction) *to total 4ftph in each direction*	OFF PEAK ONLY

Note on freight

Freight uplifts in 2023, 2033 and 2038 are on top of the Dec 19 2ftph (each direction). From 2024 freight opportunities *must include* 0.5 ftph (in each direction) from Didcot West jn and 1ftph (in each direction) from Gavray jn; the remainder should all be Didcot East jn to Aynho jn