Supported by

Carterton-Witney-Oxford Rail Corridor study

Oxfordshire County Council

Strategic Outline Case - Lite

V2-0 FINAL

26 Oct 2023

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Document reference details

Client:	Oxfordshire County Council	*Project and Doc No.:*	2213-410-001
Project:	Carterton-Witney-Oxford Rail Corridor study	*Version and Status:*	V2-0 FINAL
Lead author:	Julian Sindall	*Issue Date:*	26 Oct 2023
Filename:	2213-410-001 CWORC SOC-Lite report v2-0 FINAL.docx		
Disclaimer:	Cadenza Transport Consulting Ltd ("Cadenza") has prepared this *Strategic Outline Case - Lite* for *Oxfordshire County Council* based on a specific brief and information available at the time of preparation. Cadenza accepts no liability for any use beyond the specified brief or by third parties for any use unless expressly agreed with Cadenza in writing.		

Document history

Version	Status / Description	Created	Reviewed	Authorised	Date
V1-0	FINAL	N G Harris	J Sindall	J Sindall	30 Mar 2023
V2-0	FINAL incorporating new data	N G Harris	J Sindall	J Sindall	26 Oct 2023

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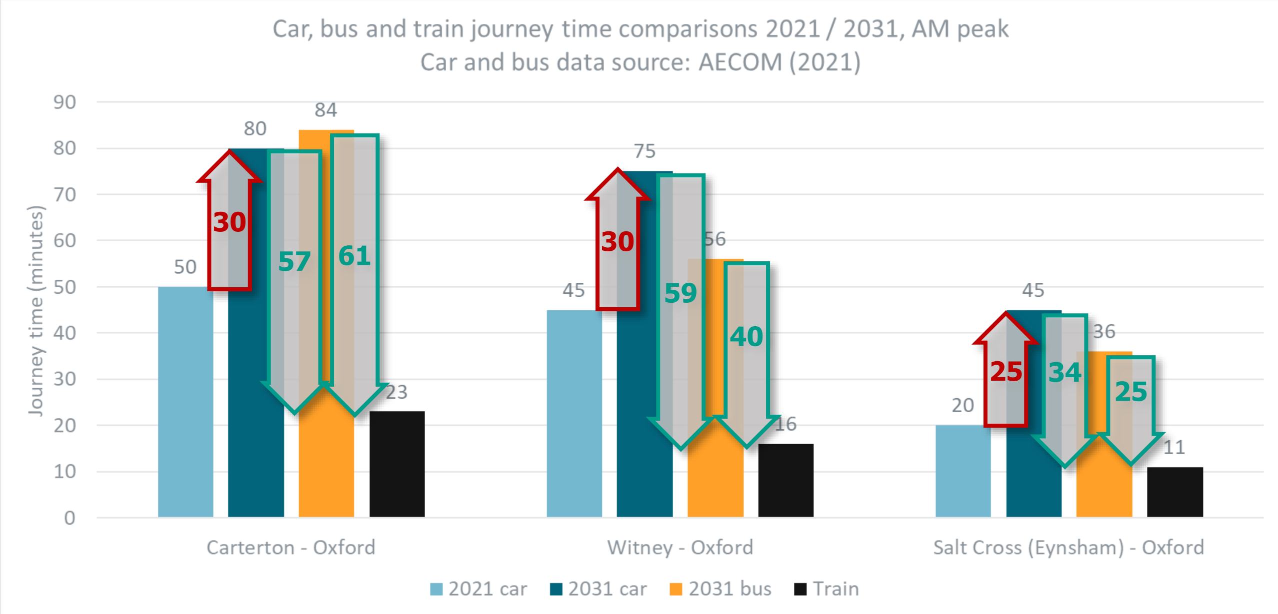
Glossary of terms

Acronym or Term	Meaning
BCR	Benefit : Cost Ratio
CAA	Civil Aviation Authority
Cadenza	Cadenza Transport Consulting Limited
CH	Chiltern Railways
DfT	Department for Transport
DMU	Diesel Multiple Unit
ELNA	Employment Land Needs Assessment
EMU	Electric Multiple Unit
FGW	First Great Western
FLT	Freightliner Trains
GWR	Great Western Railways
HENA	Housing and Economic Needs Assessment
IEP	Inter-City Express Programme (bi-mode) trains
LTCP	Local Transport and Connectivity Plan
NCLTF	North Cotswold Line Task Force
OCC	Oxfordshire County Council
ONS	Office for National Statistics
ORCS	Oxford Rail Corridor Study
SOA	Super Output Area
SOC-L	Strategic Outline Case – 'Lite'
TOC	Train Operating Company
TTW	Travel To Work
WebTAG	Wider Economic Benefits Transport Analysis Guidance
WOTG	Witney Oxford Transport Group
XC	Cross Country

Executive summary

The A40 is the only significant transport link connecting Carterton, Witney, and Eynsham to Oxford. Even with the introduction of the ongoing A40 improvement works, car journey times to Oxford are set to increase over the next ten years, taking nearly 1.5 hours from Carterton and 1hr 15 mins from Witney in the peak (see Figure 1). It is likely this will become unsustainable for residents who wish to work or learn in Oxford, putting further pressure on housing and businesses closer to Oxford.

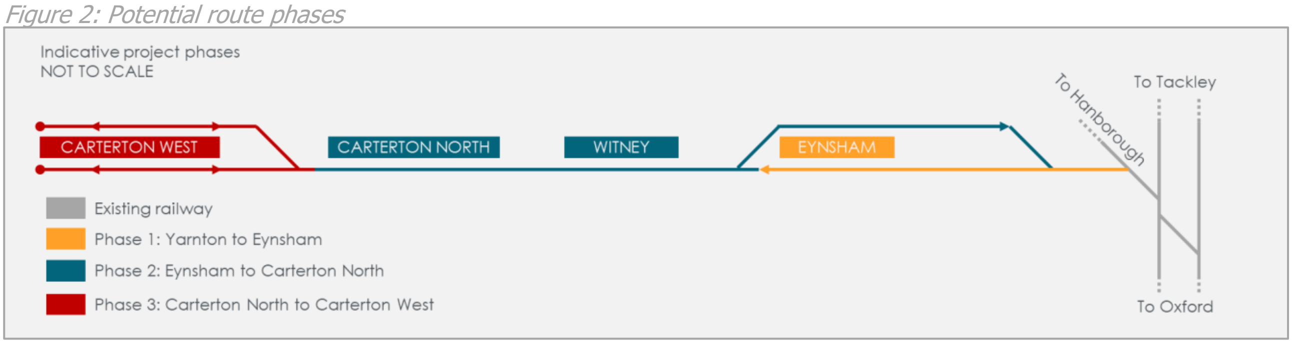
Figure 1: Journey time comparisons 2021/2031 (sources: AECOM; Cadenza)



A heavy railway would provide the capacity and journey times that would make living in Carterton / Witney / Eynsham and working (or studying, etc.) in Oxford a viable and sustainable way of life. Businesses could then invest in Oxford or the three towns knowing that employees could reliably and quickly get to work. In turn, that would unlock land for sustainable development to meet the needs for affordable housing, adding land value which could be used in part to support the delivery of the railway and add economic value to Oxfordshire.

The capital cost of the heavy rail option is anticipated to be between £690M and £890M in 2023Q1 prices, depending on the eventual route selected (see the accompanying engineering report for details). Although these are significant sums, they are in line with expectations for a railway of this type. The benefits would be greatest by delivering the whole scheme as a single package, but it could also be delivered in phases as illustrated in Figure 2. Importantly, operational revenue per annum is expected to exceed the operational costs.

Figure 2: Potential route phases



The Department for Transport's (DfT's) basic transport appraisal process assumes that a 'Do nothing' comparison is a viable option and does not take account of development or job opportunities that would be dependent on the scheme. However, in this situation, the scheme is an *economic enabler* more than a simple transport scheme and 'Do nothing' is not a practical option.

A 'Do minimum' alternative highway scheme at circa £500M-£700M would cost almost as much as a rail scheme, but would not deliver the reliability, environmental or (crucially) the journey time benefits of heavy rail. The rail journey using battery trains is expected to take only 23 minutes from Carterton and 16 minutes from Witney, slashing the travel time to Oxford, delivering sustainable housing development and enabling the creation of new jobs to meet latent demand.

Alternate transport modes including car, bus, tram and tram-train were considered but none could provide both the capacity and journey time benefits that are critical to delivering the economic benefits and transport needs of the A40 corridor.

When compared with the highway 'Do Minimum' alternative, the Benefit : Cost Ratio (BCR) is estimated at about 1.2, but this increases dramatically to 3.0 and beyond when sensitivity tests include estimated Land Value Capture (LVC) contributions of circa £190M and the economic Gross Value Added (GVA) of new/retained jobs worth about £1.1M each in net present value.

Although it is beyond the scope of this study to evaluate the number of jobs that this scheme would generate, we anticipate that the economic Gross Value Added from just 600 new/retained jobs, plus anticipated Land Value Capture contributions for new housing would broadly balance the capital costs even when compared against a hypothetical 'Do Nothing' case.

In summary, therefore, this rail scheme is an *economic enabler*, rather than simply a transport project. It offers the potential to protect the towns and city from economic contraction and to unlock sustainable growth instead. But it comes in the context of being a long-lead project that must cross several election cycles to be delivered before overwhelming congestion on the A40 within the next decade damages the connected and collective economies of Oxford and West Oxfordshire. Given the anticipated timeframe of congestion increase and the duration of the rail project development, time is of the essence.

The next steps should include:

- Quantify the value of the wider economic benefits, such as new jobs and housing, and compare with the negative impact of a 'do-nothing' scenario;
- Carry out a land, environment and planning assessment of the potential route area to establish any high risk locations;
- Optimise the route alignment options and explore the potential for linkages with the ongoing Cowley re-opening project
- Carry out a public consultation exercise on the route options;
- Continue to explore the potential contribution of Land Value Capture;
- Complete an Outline Business Case
- Progress to delivery of the scheme, noting that this would not necessarily be delivered by Network Rail, but could alternatively be packaged for delivery by a Special Purpose Vehicle organisation with a dedicated focus on the success of the scheme.

1 Introduction

1.1 Context

For the majority of people living in Carterton and Witney, personal travel by car on the A40 is often the only practical means of travelling to Oxford, because bus connections, although frequent, are slow, especially at peak times, and there is no realistic alternative.

As housing pressure increases in Oxfordshire in general and the three major towns in the A40 corridor of Carterton, Witney and Eynsham in particular, congestion has been a growing problem resulting in the anticiapted £180 Million upgrade of the 6km of A40 between Eynsham and Oxford to provide a new Park and Ride and additional lanes reserved for buses which will make public transport journeys more competitive. These measures are intended to relieve the pressure on the A40 over the next few years but it will then reach practical capacity again, circa 2031 when another solution will need to be found.

A local special interest group known as the Witney Oxford Transport Group (WOTG) recently developed a proposal for a railway route connecting Carterton, Witney, and Eynsham to Oxford, and submitted an application to the Department for Transport (DfT) for Restore Your Railway funding.

Oxfordshire County Council (OCC) has subsequently commissioned this study to examine the viability and desirability of a railway route connecting these towns to the city, and to understand the likely costs of such a scheme.

To deliver this project, Cadenza has led the development of the engineering technical work including the cost assessment, and has been supported by The Railway Consultancy, which provides specialist analysis in operations, demand and appraisal.

This report is accompanied by the Engineering feasibility report[1] which sets out the development and findings of different viable options to provide inputs into the SOC-L appraisal.

Version 1-0 of this report was produced on 30th March 2023 along with a two-page summary prior to receipt of some operational cost and other data, with the agreement of OCC. This follow-up report now captures the data received since then and addresses review comments kindly provided by the Network Rail 'Restore Your Railway' team and the WOTG. We have also taken the opportunity to provide further discussion on the limitations of the standard early-stage economic assessment approach and suggested potential avenues of investigation that may be more appropriate for this scheme. By agreement with OCC the accompanying engineering costs have not been recalculated for inflation over the last few months, and only minor refinements have been made.

1.2 Brief

OCC has asked Cadenza Transport Consulting Limited ("Cadenza") to "further investigate the concept of a possible new railway line solution from Carterton and Witney to Oxford", preparing outputs in a Strategic Outline Case – 'Lite' format (SOC-L) "to establish if there is a strategic need for the proposed railway line and any resulting investment required. It should clearly explain the drivers for the railway line and how it satisfies OCC long term policy objectives such as to consider how any route/stations fit with interchange opportunities, active travel and accessibility (in particular the Local Transport and Connectivity Plan (LTCP))".

The study is to be informed by the previous work, but not bound to it, so as to enable freedom in the development of ideas and solutions.

1.3 Methodology

The Cadenza project team has:

- reviewed the documents provided as referenced in chapter 9.
- liaised with stakeholders

[1] Engineering feasibility report document reference 2213-410-002.

- carried out site visits
- developed and costed several engineering solutions
- developed a demand and revenue forecasting model
- undertaken operational analysis
- undertaken appraisal of key options using the DfT's methodology

1.4 Purpose and structure of this document

The purpose of this document is to set out the evidence to support the conclusions in response to the brief. The mechanism it uses is the Department for Transport's (DfT's) Wider Economics Benefits Transport Analysis Guidance "WebTAG" appraisal methodology as set out in DfT (2022).

The background of this study is set out in chapter 2, describing the existing transport network, population, employment, policy context, and previous transport proposals.

This is followed by a review in chapter 3 of the problems to be addressed, choice of mode, and the logic for rail intervention to form the Strategic Case.

The demand and revenue forecasts are captured in chapter 4, outlining the theory and practice underpinning the model and testing the outputs.

A brief summary of the engineering feasibility report is included in chapter 5 describing the process by which viable reference routes were developed and costed.

The operability of the proposed scheme in the context of the existing operational railway is addressed in chapter 6 and includes potential service patterns, trainsets required, and operating cost estimates.

The various strands of investigation are brought together in chapter 7 for the appraisal before the conclusions are set out in chapter 8.

1.5 Image credits

All aerial imagery is from Google Earth Pro unless otherwise stated. All photographs are by Cadenza unless otherwise stated.

2 Background

2.1 Transport network

The major transport infrastructure of West Oxfordshire is relatively weak (see Figure 3): one trunk road (the A40) runs west from Oxford, while the North Cotswold Line runs north-west from the city. The A4095 runs north-east from the Swindon direction via Witney to Woodstock and beyond to Bicester, with the A415 running south-east from Witney to Abingdon. However, the latter two roads are only single-carriageway, and the closest railway is only single-track to Hanborough; these corridors are therefore lacking in both capacity and speed.

Figure 3: Existing transport corridors in study area

Moreover, because major roads (A34) and rail lines run north – south through Oxford, providing access to Birmingham and Reading, and the A40/M40 route to London is also reached via the northern outskirts of Oxford, the predominant demand for travel in West Oxfordshire is towards Oxford.

Given the cramped historic nature of Central Oxford and the few radial routes into it, it is therefore unsurprising that congestion arises in this corridor. As well as congestion on Botley Road within Oxford itself, traffic is stationary on parts of the A40 from Eynsham eastwards. Crowding occurs on both public transport modes listed in Table 1: some buses leave passengers behind, and standing occurs on the hourly train services on the Cotswold line during peak periods.

Table 1: Public transport services within West Oxfordshire

Route	From	To	Frequency (per hour)	Notes
H2	Headington	Witney	1	Via John Radcliffe hospital
S1	Oxford via Eynsham	Carterton	4	
S2	Oxford via A40	Witney	1	Alternate to Cheltenham
210	Wychwood	Witney	3/day	
213	Witney town	Witney town		Not running at present?
214				ditto
215				ditto

Route	From	To	Frequency (per hour)	Notes
233	Burford	Long Hanborough	2	Alternate via Carterton & Minster Lovell
V23	Evenlode	Witney	1/day	Thursdays only
V25	Evenlode	Witney	1/day	Wednesdays only
V26	Stow-on-the-Wold	Witney	1/day	Mon/Tue/Fri only
Cotswold rail line	London Paddington	Great Malvern	1	Alternate to Hereford

2.2 Current population & employment

Although Charlbury and Chipping Norton are notable local centres towards the north of the District Council area, the two main centres of population in West Oxfordshire are Witney and Carterton. The 2021 Census recorded populations of 29,632 and 15,680 respectively for these two settlements. Both towns are therefore already within the range for which a railway station might be considered appropriate at a policy level.

Witney has a range of jobs associated with its function as a market town, plus those on its industrial estate. Employment in the Carterton area is dominated by the RAF Brize Norton site, which employs approximately 6,000 people (both military and civilian).

However, the District of West Oxfordshire is heavily economically-dependent on the City of Oxford, for a wide variety of trip purposes: commuting, personal business, shopping, leisure – and access onwards to other centres. A rail service could therefore function to:

- support the ongoing economic vitality both of Oxford itself and its hinterland;
- reduce social exclusion in West Oxfordshire;
- provide connectivity, at both the local and national levels;
- limit dependence on one congested road (the A40) and provide an environmentally-friendly transport alternative

2.3 Expected development within the area

There are four significant developments of relevance. That at Witney West (c. 1000 houses) is largely complete, that at Salt Cross (2000+ houses) just beginning, that to the west of Eynsham (200+ homes) planned, and that to the north and west of Carterton still at the conceptual stage. These are designed to fulfil West Oxfordshire's strategy to enable the construction of 660 homes per year, in order to address the expected needs of a growing population in the period to 2031; this is detailed in West Oxfordshire's Local Plan (2018). A Local Plan to cover the following decade is currently under consideration.

2.4 Policy context

There is a wide range of policies which relate to transport in the Oxford – Carterton corridor. These are detailed in section 2 of the A40 Transport Corridor report (AECOM, 2021), but briefly summarised below. However, we note that, because the externalities of public transport schemes are generally positive, such schemes (if they achieve their planned outcomes) almost inevitably satisfy general transport, planning and environmental objectives in a manner which does not occur with highway schemes; any issues are likely to be at a more detailed level.

2.4.1 Relevant national policies

- Transport strategies relating to road investment, buses, walking & cycling, transport for the mobility-impaired
- Planning policies, including the National Planning Policy Framework and Planning Policy Guidance
- Environmental policies, including "Decarbonising Transport" (2021)
- Detailed guidance on the design of highways and cycle infrastructure
- Transport Appraisal Guidance (used within the appraisal section of this report)

The shift in emphasis of these over time indicates that further development of a road-based scheme beyond that already being implemented runs counter to wider national policies, within which a rail-based scheme would sit more comfortably.

2.4.2 Relevant county policies

- "Connecting People, Transforming Journeys" (England's Economic Heartland)
- Local Transport and Connectivity Plan (2022), including objectives to deliver a net-zero transport network and to remove 1 in 3 car journeys in the county. Policies 18-23 refer to public transport.
- County economic plan, and "Oxfordshire 2050"
- Climate Action Framework (OCC, 2020)
- Oxford Local Industrial Strategy
- Rail Strategic Statement (OCC, 2023)

We also note that other plans relate to this transport corridor indirectly. For instance, Oxford City is forecasting increases in employment in the city (Lichfields, 2022) and notes that workers will be needed – without specifying from where. Improving access from Carterton (in particular) through a rail service with reduced journey times could help to address that issue. It is also difficult to see how the Local Transport & Connectivity Plan (with its emphases on decarbonisation, road safety, public transport and road congestion management) can be delivered without a significant change in favour of public transport in the Witney corridor, a change enabled by a new/re-opened railway.

2.4.3 Relevant local policies

- West Oxfordshire Local Plan 2031 (2018)
- Eynsham Neighbourhood Plan 2018-2031 (2020)
- Salt Cross Garden Village Area Action Plan

2.5 Previous transport improvement proposals

2.5.1 A40 Improvements

https://www.oxfordshire.gov.uk/residents/roads-and-transport/roadworks/future-transport-projects/a40-improvements

The A40 Improvements project is a £180 Million package comprising of six major schemes, which will deliver a new Park and Ride, an extension of the dual carriageway around Witney, new bus lanes and junction improvements. The proposed plans to address traffic and transport issues will result in better transport links, the creation of new jobs and housing, reduced emissions, and more sustainable travel options.

The six schemes are:

- Scheme 1: A40 dual carriageway extension, a scheme to upgrade the A40 between east of Witney to the Eynsham Park and Ride site into a dual carriageway.
- Scheme 2: Eynsham Park and Ride. A new 850 space Park and Ride in Eynsham will provide easier access to improved and more reliable bus services into Oxford (currently under construction).
- Scheme 3: A40 integrated bus lanes. A 6.5km proposed eastbound and westbound bus priority corridor along the A40 between Eynsham Park and Ride towards Duke's Cut, with improved routes for pedestrians and cyclists.
- Scheme 4: A40 Duke's Cut. A new eastbound bus lane and improved cycling and pedestrian facilities linking together the A40 integrated bus lanes project (scheme 3) with A40 Oxford North (scheme 6).
- Scheme 5: A40 Access to Witney. The A40 Access to Witney scheme proposes improvements to the existing B4022/ A40 junction at Shores Green.
- Scheme 6: A40 Oxford north (now complete). Changes for bus, cycle, and pedestrian routes between the Wolvercote roundabout and the A34 flyover.

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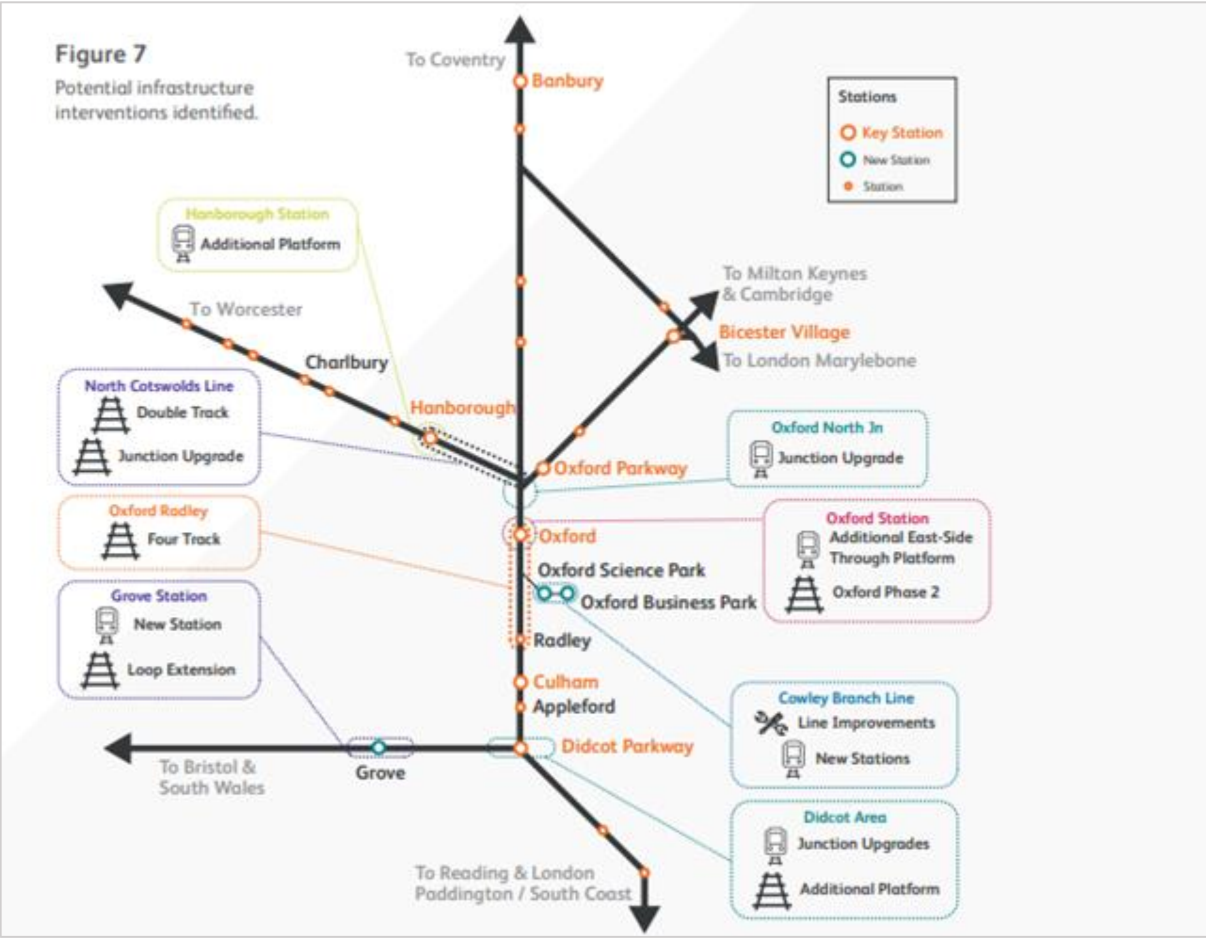
2.5.2 ORCS (Oxfordshire Rail Corridor Study)

The Oxfordshire Rail Corridor Study (ORCS) was a strategic rail study led by Network Rail, which reported in June 2021. It described the economic and rail network background of the area, and the need to enhance rail infrastructure and services, in order to meet the needs of this economically-growing region. Growth scenarios were linked through to specific interventions ("conditional outputs") needed to underpin the selected service improvements (which include direct services from Oxford to Swindon, as well as completion of East West Rail right through to Cambridge). A pictorial summary of the possible interventions is shown in Figure 4 below, but it should be noted that these interventions are as-yet unfunded, and that re-opening to Carterton was not shown, as it was not on the agenda at the time. Uncertainty is compounded by the impacts of Covid on levels and types of passenger traffic.

A rail investment programme 'Oxfordshire Connect' was recommended as the vehicle to be used to progress these schemes through the Rail Network Enhancements Pipeline, although the latter has somewhat fallen into abeyance in the intervening 18 months, and the process of rail investment delivery become less clear.

Figure 4: Oxfordshire Rail System Interventions (Source: ORCS (2021)



2.5.3 North Cotswold Line

A North Cotswold Line Task Force, led by a group of local authorities including Oxfordshire CC, invited SLC Rail to undertake an SOBC for improvements to the Oxford – Worcester line. Key points to note from their 2019 report were:

- the scale of expected development in the SE Worcestershire area
- the operational desire to reduce the number of terminating train movements at Oxford
- demand-led aspirations for an increase in frequency to half-hourly
- the commercial potential for the 2nd hourly service on the line to serve Kidderminster after Worcester

In the short-term, they noted that the hourly terminating fast services from London could be extended to Hanborough, improving its potential for providing a Park and Ride service into Oxford from a hinterland which includes the north side of Witney, though the need to reverse at Hanborough would require extra trackwork to do that (the line is currently single at that point).

Although it would be possible to extend yet further services to turn back at Hanborough in the future, the need to do this falls as more platforms are provided at Oxford (which would enable service reversal without conflicting train movements), and such services are not attractive to residents of Eynsham/Saltcross (for whom using Hanborough involves driving in the wrong direction), the south side of Witney (which is nearer to the A40) or Carterton.

The outer-suburban services currently terminating at Didcot, which are expected to be extended to Oxford upon electrification, are also formed of 8 cars, which provides far more capacity than is needed for the Hanborough Park and Ride function.

We therefore regard the North Cotswold Line developments as very valuable for their medium- and longer-distance benefits in the corridor, but not as providing the solution for the Witney and Carterton corridor.

2.6 Stakeholder liaison

In order to understand the views of those likely to be affected, the study team undertook considerable liaison with stakeholders. This covered local authorities, landowners, and rail industry. Section 3.1.3 of the engineering feasibility study covers the first two categories of these in detail but, since this report focusses on rail industry issues, it is worth noting that we also consulted with:

- Network Rail, as infrastructure owners
  - Strategic Planning, to see how such a rail scheme would fit more widely with rail network development objectives
  - Wales & West route, to gain local input about detailed infrastructure issues of concern
- First Great Western (FGW), as expected train operators
- Department for Transport, Rail Strategic Planning, as potential specifiers and financial supporters of the service

3 Strategic case

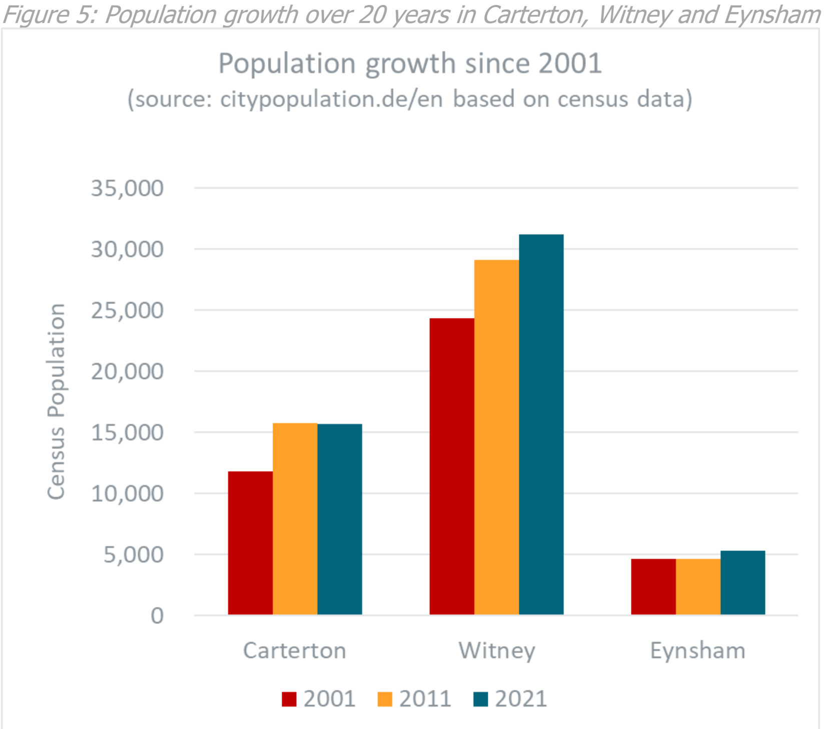
3.1 Problems to be addressed

3.1.1 Quantity of demand

The first issue which has to be addressed for any solution to the transport problems of West Oxfordshire is of the sheer volume of the demand for trips. The population of the West Oxfordshire district is c. 110,000. With the National Travel Survey noting for years that the average number of trips per person per year is nearly 1000 (almost 3 per day), this suggests that the number of trips made in the district is around 300,000 per day.

Although much of West Oxfordshire is rural, there are three urban centres: Chipping Norton, Witney and Carterton. Of these, the latter two are significantly larger. Of the three towns on the A40 corridor population growth slowed between 2011 and 2021 (Figure 5), but this is set to change.

Figure 5: Population growth over 20 years in Carterton, Witney and Eynsham



There has been much recent development on the west side of Witney, whilst a new development is currently underway at Saltcross (on the opposite side of the A40 to Eynsham). The Saltcross development alone is expected to add a further 5000 population). Longer-term housing projections add further demand (for instance, to the north & west of Carterton). Despite the A40 bus improvements scheme now under construction, the problems of providing transport networks in the area are therefore only likely to increase in the longer-term.

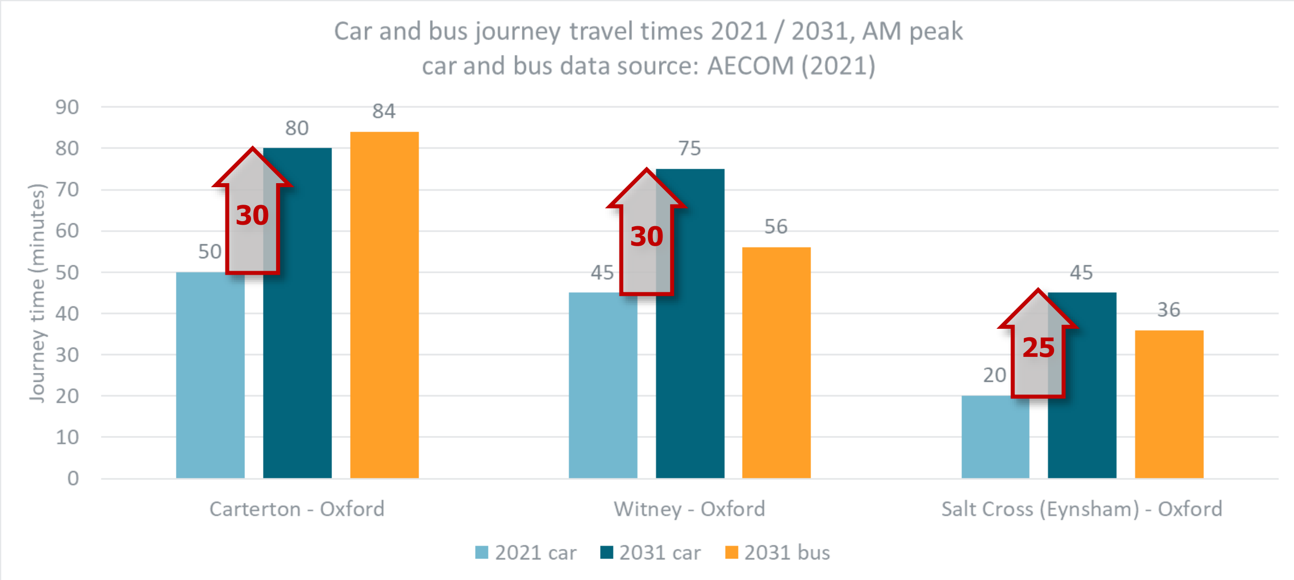
3.1.2 Concentration in one corridor

For various geographical and historical reasons, this demand is focussed in one corridor: along the A40, going east-west to/from Oxford. The existence of three distinct settlements (Carterton, Witney and Eynsham/Saltcross) also helps to make serving the demand by public transport easier than if development were scattered more widely.

3.1.3 Slow and unreliable journey times

The A40 provides connections from Witney and Carterton to almost everywhere other than Swindon. However, with the exception of Westbound traffic towards Cheltenham, almost all other destinations have to be reached by going east, either just to the A34 interchange at Duke's Cut or into Oxford itself. As a result, journey times are already slow: queuing on the A40 is already normal between Witney East and the roundabout at Eynsham, as well as into the A34 junction.

Figure 6: Car and bus journey travel times (source: AECOM, 2021)



The bus-based Park and Ride A40 corridor interventions currently being implemented broadly maintain bus journey times in 2031 at current levels, whilst increasing service frequencies to meet rising demand (AECOM 2021). Peak car journey times between Witney and Oxford are expected to *increase by 30 minutes* from Carterton and Witney, and more than double the car journey time from Eynsham by 2031 (AECOM, 2021). That could create a huge economic cost as discussed in 7.3.

Moreover, operation of the highway network at or close to its capacity means that journey times can easily deteriorate significantly, for instance after an accident or bad weather. This unreliability has a significant disbenefit, both to private transport and the bus services currently provided. The bus lanes being introduced will have some impact in mitigating the latter, but only over the length for which they are provided and not, for instance, in Witney town, through Eynsham village or to/from Carterton.

A bus service which is already slower than a rail option will certainly not provide the level of transport needed, in order to sustain and create employment and business opportunities in the area, particularly if it is also unreliable.

3.1.4 Externalities

Cars operating in congested conditions are a very poor solution to transport problems if environmental issues are considered important, which they increasingly are: Oxfordshire CC declared a climate emergency in 2019. Air pollution, noise and the use of scarce resources are all resultant problems from using a mode which also can lead to social exclusion, as not everyone has access to a car. A public transport-based solution would therefore be more appropriate – the question is which mode.

There are also wider socio-economic issues to consider, especially in Carterton. Parts of the town suffer from social exclusion; in our discussions with them, the RAF noted that they struggle to attract people into the Brize Norton area because of its poor public transport links and that some families won’t move to Carterton because of that:

> “Being in Carterton is quite limiting because the transport links are so bad”
>
> Station Executive Officer, Brize Norton

In addition, the Station Commander described how the majority of commuters (consisting of service personnel, civil servants and contractors) drive to RAF Brize Norton, with very few of the 2.5k commuters each day car sharing. She also noted that the lack of a reliable, frequent, and rapid public transport system limited the opportunities for service families to access jobs and regional amenities. These include regional-level shopping, major hospitals (e.g. the John Radcliffe), higher-skill jobs (in the University, business park and elsewhere) and access to more specialist services.

Moreover, the lack of high-quality transport between Carterton and Oxford is part of a wider significant problem affecting Oxford: enabling its (potential) labour force to access the city easily in order to provide economic output. There is unlikely to be a sensible 'do-nothing' scenario here, because failure to address the issue of labour access to the city will in all probability lead to a poorer economic outcome: companies will move elsewhere, or simply not grow at all. Alternative strategies to enable this economic activity are considered below in section 3.3 and appear to be of similar cost but reduced output.

3.2 Modal choice criteria

The transport needs of the Oxford – Witney – Carterton corridor have been examined on a number of previous occasions, considering the possible modal alternatives.

From the perspectives of both multi-modal transport planning and the latest 'Better Value Railway' principles, it is essential to ensure that the appropriate mode has been chosen for a public transport corridor. The choice of that needs to reflect various criteria, as shown in Table 2.

Table 2: Choice of mode, based on 'Better Value Railway' principles

Criteria	Description	Assessment
Market needs: **Capacity**	The number of passengers to be carried per hour per direction (pphpd). Some form of rail ('heavy rail' or tram-train) will be required for the highest loads, but bus may become operationally difficult/expensive well before then e.g. running an 80-seater bus every three minutes would suggest that a rail-based solution with bigger vehicles was more appropriate	Current demands can be served by bus, albeit with peak crowding. The A40 corridor improvement corridor will enhance the bus offer, enabling it to respond to much of the extra demand expected from new housing developments. However, by circa 2031, even that enhanced service will be challenged by the quantity of demand and only moderate speed
Market needs: **Access**	Is the alignment/service supposed to provide close access (e.g. within 400m) to all residents? Bus services can much more easily stop more frequently and pick up individual passengers than would be appropriate for heavy rail, where the sheer costs of stopping require an expectation of larger numbers of passengers to board/alight	There are three distinct settlements along this corridor (Eynsham/Saltcross, Witney and Carterton) which somewhat aggregate traffic into a limited number of nodes which would serve a large proportion of possible passengers. Design development should enable an integrated transport solution connecting buses with rail for first/last mile public transport opportunities
Market needs: **The importance of speed** (which is an indirect function of distance)	The typical operating speeds of even suburban rail will be significantly higher than for tram and (especially) bus (e.g. 50mph not 30mph or 20mph). This means that a heavy rail service can become particularly effective over longer distances (say 10 miles), where the time savings from faster operation outweigh the disadvantages of poorer access	Carterton is around 17 miles from Oxford, with bus journeys currently taking up to 90 minutes in peak periods. Rail-based solutions would be expected to save significant journey time per person

Criteria	Description	Assessment
Market needs: **Quality, mode preferences and mode constants**	Rail's greater abilities to carry luggage, provide through travel to longer-distance journeys, appeal to a wider range of passengers etc. do make it a better option for inter-urban routes. URS (2015) noted that, whilst having broadly-similar transport impacts, a heavy rail solution would be potentially more attractive to the west Oxfordshire demographic	Especially in a relatively-rich area such as this, tram, tram-train and heavy rail are all perceived more highly than bus, even though the level and quality of bus service in this corridor is high
Physical constraints: **Extent of existing infrastructure**	Clearly, the presence of either extant or disused rail alignments in the corridor of interest reduce the (land-take, physical construction) costs of rail-based solutions; similarly, the existence of light rail facilitates extensions to it which would not be sustainable as a light rail route on their own	A heavy rail solution can easily share tracks with existing train operations between Oxford and the Yarnton area, before adopting a new alignment to Carterton, the historic route having been built upon at key locations. Because of the number of existing train movements, a tram-based solution would not be able to share the heavy rail alignment through Wolvercote Junction, and space constraints (e.g. on the Botley Road) would make it difficult to find another alignment for a tram between Farmoor and Oxford, which does not already have a light rail network
Physical constraints: **Is the route to be shared with freight?**	Dual use of a railway for passenger and freight can in some cases make more use of the railway infrastructure and take HGVs off the public roads. Freight provision also has a bearing on the vertical gradient limits of the alignment, which in turn affect the extent of work that is not At Grade, and hence more expensive.	It is unclear if there is any significant need for freight in this corridor. Discussions with the MOD at Brize Norton suggested there may be a use for freight, but probably only one train per week. This is unlikely to support a business case for any significant route extension, though a freight siding off the route at a suitable point might reduce freight road miles to the last mile of its journey.
Wider stakeholder strategies	A rail solution will need to be supportive of other, wider, stakeholder strategies on transport and related topics such as development and the environment.	Climate change policies are encouraging both Central and local Government to look for lower-energy transport modes, which certainly implies greater use of public transport. It would also tend to discourage public transport based on diesel technologies, in favour of (e.g.) battery or electric solutions. OCC has recently released a Rail Strategic Statement (Oxfordshire CC (2023))

3.3 The tram/tram-train alternative

3.3.1 Overview of tram/tram-train systems

Tram systems are typically adopted as a public transport mode within a city where their ability to carry a high density of passengers per square metre of vehicle in comparison with cars or even buses is beneficial, and their routes are defined by the street network and attractors within the city itself. Although some tram networks have limited sections of segregated running or priority flow through junctions, they are largely integrated within the highway network and are thus subject to highway congestion with consequences on journey times. This is in some ways mitigated for the user by high-frequencies of vehicles, typically between 6 and 20 minute intervals. Since they are designed for street-running, line-of-sight operation and the ability to stop within a braking distance similar to or better than a car, their operational top speeds are relatively low at around 30mph (50 kph).

Some tram systems have extended sections of segregated running where pedestrians and vehicles are banned, which allows the vehicles to be specified to run at higher speeds, typically up to 45-50mph (70-80 kph). However, conventional trams cannot run on heavy rail routes in a mixed-running environment because they do not have sufficient crashworthiness built into the vehicle design to safely protect passengers in the event of a collision with a more robust heavy rail vehicle.

Tram-trains are designed to operate as trams when street running, but faster when segregated off-street and may operate for part of their running on a heavy rail network, with crashworthiness upgraded appropriately. They will also work with the heavy rail signalling protocols and systems while on-network. The increased crashworthiness adds to the weight of the vehicle which still needs to be able to stop rapidly for its on-street running mode.

If the receiving heavy rail network operates with freight trains, then the tram-trains are protected by 'double-blocking', which separates the tram-train from the freight train (and sometimes the heavy rail train) by two signalling blocks, to provide additional protection. Unfortunately, it also reduces the capacity and resilience of the receiving railway by taking up additional space in the operational timetable. Tram-trains also run the risk of importing delay into the mainline railway if their on-street running incurs delays and they arrive late at the heavy rail system.

Whether tram or tram-train system is adopted, it requires a new fleet and associated maintenance / stabling depot facilities, plus its own staff including drivers, management, administration, safety and maintenance teams. All of these require considerable capex and opex investment, particularly for what would be a very small fleet. Indeed, rolling stock manufacturers do refuse to tender for small orders of (say) fewer than 30 vehicles because it is just not worth their development costs. It may be possible to extend an order by another customer, but many tram orders are bespoke to suit the customer's situation and may well not be appropriate for use in Oxford.

Both trams and tram-trains have an infrastructure advantage in that they are capable of handling steeper gradients and tighter curve radii, meaning they can work within the confines of typical street layouts and more easily negotiate other infrastructure constraints such as crossing major roads or railways with shorter structures. These structures can be more lightweight because of the lighter vehicles and are cheaper to construct because of reduced materials as well as reduced length.

However, many tram-based schemes have suffered significant cost and programme overruns due to the extent of utility works that are required to lay the tracks within the city centres. Similarly, the consequential costs of highway modifications for both the temporary and permanent situations can be a hidden cost that is difficult to assess at the early stages.

3.3.2 Consideration of tram/tram-train suitability for the corridor

A tram/tram-train system would likely have sufficient capacity to meet the needs of this route. Indeed, the on-street running capability provided by either of these systems would enable far greater penetration into the city centre and potentially the towns that the corridor serves. The improved route flexibility would reduce the costs of infrastructure on the routes between the towns, and the quality of the system could well attract those for whom buses are never an attractive option.

However, none of the destinations on the route already has a tram/tram-train network, so this means creating one from scratch with all of the overheads described above. The infrastructure savings made between towns could well be lost by the infrastructure modifications within the towns.

One mitigation to this in Oxford could be the use of a tram-train to adopt the existing railway network at Yarnton and access Oxford station, but the likely impact of importing delay to the network through unreliable timetabling of the tram-trains onto the network, and capacity erosion through double-blocking is unlikely to be acceptable to Network Rail. The tram-train would therefore likely have to come into Oxford via on-street running, eroding the benefit of the '-train' part of the tram-train operation, and subjecting the tram-train service to congestion within the city.

An alternate mitigation in the other towns would be to locate the main town stops where the stations are proposed for the heavy rail proposition, which would avoid most of the problems associated with congestion and street utilities, but would rather negate the 'tram' benefit.

But the key disadvantages to either tram or tram/train as a solution are that neither provides the journey time benefits that a heavy rail solution provides, and neither can operate as an extension of the existing operational railway complete with shared vehicle management, an maintenance and overheads.

The primary problem with the A40 as the only viable transport route in the corridor is that the existing congestion will increase over the next decade, leading to unacceptable journey times even with the anticipated A40 upgrade. By this time, bus services would be running at 3-minute intervals, so frequency is not the issue. It is the length of journey time that will be the primary determinant as to whether people conclude it is practicable to remain or base themselves in Carterton, Witney or Eynsham.

A tram/tram-train system that uses street-running in Oxford or any of the towns will have a longer route, at a slower unconstrained run-speed, and get caught in the same congestion that a heavy rail system is avoiding. Neither will therefore provide the fundamental benefit that is needed by the residents and businesses along the route.

The implications of creating a new transport ecosystem to support the tram-train are expensive in both capital and operational expenditure terms. By contrast, a heavy rail system would be operated by the existing rail operator, using vehicles that could be part of a wider fleet and fall within their normal training, operational and maintenance practices using existing facilities.

In summary, neither the 'tram' part nor the '-train' part of the tram/tram-train options offers the benefits that are needed in this particular scenario. That is, the journey time savings and the relatively cheap vehicle capital and operating costs achieved by a heavy rail alternative cannot in principle be replicated by a new tram/tram-train system, and were therefore not pursued.

3.4 The bus/highway alternative

Initial feedback from the stakeholder engagement exercise (see 3.1.3 of the engineering feasibility report) indicated that some stakeholders had a preference for a bus-based solution over a rail-based one, citing concerns about the costs of constructing a railway. However, it is unlikely a bus-based solution could achieve the time savings available with rail-based options.

In order to understand what a bus solution might look like (if it could meet the criteria in Table 2), a useful comparison would be the suite of A40 improvements described in 2.5.1 incorporating 6.5km of widening for bus lanes, and a Park and Ride, amongst other contributing schemes, for £180 Million. At an all-in cost per km, this roughly translates as £27.5 Million per km. The AECOM study in 2021 indicated that by 2031 this will provide for up to 18 buses per hour and direction, each requiring somewhere to turn around at Oxford.

If it were practicable at the same cost rate to address capacity issues beyond 2031 with a highway-only solution, it might reasonably consist of schemes to extend the bus lane widening to Carterton with one or two more Park and Ride sites, plus an additional bus lane on each side of the A40 to the east of Eynsham. Alternatively, an entirely new road could be constructed, or other options could include a blend of widening / new road variants.

A brief review of recent highway projects in the region with similar scale objectives indicates they have significant costs that are not dissimilar to a railway solution:

- Recent A428 Black Cat to Caxton Gibbert dual carriageway (10 miles / 16 km) construction cost at £507M in 2021[2] i.e. £31.7 Million per route km
- A46 Newark Bypass road widening (3.5 miles / 5.6km) estimated at £400M-£500M in 2022[3] i.e. £80 Million per route km

Although each scheme's costs will be weighted very heavily by the type and number of junctions, carriageways and lanes as well as topography, it is clear that a highway solution to the anticipated capacity problem would cost a similar or possibly greater amount than a railway (the costs we set out in section 5.2 below are around £35M/km). Using the A428 Black Cat average route costs per km for a comparable distance of 23km to Carterton West gives a cost of roughly £730M, though in practice a new road scheme might not be the same distance because its starting point could be slightly further west and therefore £500M seems a reasonable initial assumption. However, a road-based scheme would not significantly improve against even today's journey times and would increase pressure on parking around Oxford.

Assuming any new highway solution would provide at least one new lane for buses in each direction, then it might theoretically increase passenger capacity with buses even more frequently than one every three minutes. However, buses would still need to have somewhere in Oxford to turn around, and incur the operational costs of a driver[4] for every additional bus, but would provide a similar journey time to that which will be achieved by the current A40 improvements (because speed limits are unlikely to significantly increase).

If a highway strategy were limited to lane-widening only, car drivers would have limited or no additional capacity beyond that released by others switching to bus. If new lanes were available to car users, then this would provide much more capacity for them but would come at a financial cost as described above, increase emissions, and conflict with OCC's Climate Emergency declaration and path towards Net Zero. It is also unclear how improvements in streetscape and urban design could be achieved with greater road traffic.

Therefore, although the A40 improvement works in progress will release much-needed transport capacity to meet the need over the next 8-10 years, a bus/highway strategy alone has its practical limits and cannot be extrapolated as a solution to meet long term public transport needs. The environmental aspirations of the Local Transport & Connectivity Plan suggest that the road improvements (e.g. in junction capacity) might be achieved by using road to provide first/ last-mile connectivity to/from rail, functioning as the core transport link in the corridor West from Oxford.

A railway solution would provide journey time savings, as well as sufficient and expandable long-term capacity, albeit at a potentially slightly higher initial cost. Nevertheless, the A40 improvement measures will need to remain in place for the purposes of transport resilience, market segregation, and local connectivity to a wider number of destinations for an integrated transport solution, even once a rail service is operational.

3.5 Logic for rail intervention

The logical argument for rail intervention is set out as below:

1. There is currently a shortfall of transport capacity entering Oxford from the west.
2. Public transport services are provided by buses which are frequent, but slow and overcrowded.
3. The quantity of new housing development in the area means that these problems will get worse.
4. Central and local government policies are encouraging a switch to lower carbon-footprint transport alternatives, especially active travel (walking & cycling) and public transport. However, the distances from Oxford to Witney and Carterton are beyond what is reasonable for active travel solutions.
5. The A40 improvement scheme, with its bus lanes, will enable a reduction in bus journey time and an expected increase in frequency, but will only provide a temporary solution to these transport problems, as demand continues to rise.

[2] https://www.cambridgeindependent.co.uk/news/507m-contract-for-a428-black-cat-to-caxton-gibbet-improveme-9192178/ (accessed 29 Mar 2023)
[3] https://nationalhighways.co.uk/our-roads/east-midlands/a46-newark-bypass/ (accessed 29 Mar 2023)
[4] Plus proportional staff cover for sick leave, annual leave, training etc.

6. A failure to provide sufficient transport capacity will have a worsening effect on the ability of residents in the corridor to get to work, health, leisure and retail opportunities. This is likely to result in consequential negative impact on the local economy and magnify pressure on the towns closer to Oxford to provide more housing.
7. The level of passenger demand expected in the near future in this corridor appears to be in a range for which rail is appropriate.
8. A rail solution will be much quicker than bus, providing significant journey time and wider socio-economic savings.
9. A rail service can also attract the local legs of longer-distance journeys, and appeal to a wider cross-section of the community (e.g. business trips, including potentially to/from RAF Brize Norton).

We have therefore rejected a bus option, primarily because of its inability to provide significant time savings nor have the capacity to satisfy the quantity of demand in the longer-term. We have also rejected a light rail option, primarily because the lack of an existing system and difficulties of interworking between Central Oxford and Yarnton means that the marginal cost of implementation and operation would be very high. Car-based options add to parking pressures, fail all the County Council's strategic (e.g. environmental) policies, and continue to exclude those without access to a car.

3.6 Measures of success

It is often helpful to define what 'success' looks like, in order to provide direction during delivery and increase the probability of achieving it. This approach begins with developing the 'Mission Statement', as set out below following discussions with OCC, to:

> "Provide a frequent and reliable rail service between Carterton and Oxford via Witney and Eynsham"
>
> *Project Mission Statement agreed with senior OCC leadership*

This is expected to lead to the following measures of success:

- public transport capacity (extent to which the rail service enables new journeys and modal shift; ability to expand capacity at marginal cost)
- supports climate emergency initiatives (minimises impact on the environment)
- journey times (comparative time savings)
- convenience / attractiveness of service (frequency, quality, accessibility, connectivity)
- supports economic development (increased numbers of employed; increased inward investment creating new jobs)
- enables land value capture (increases land value through enabling strategic development)
- transport corridor resilience (% trains cancelled/late; ability for operations to recover from delay)
- acceptable transport network interfaces (does not result in unacceptable impacts on the existing network)
- improved accessibility to/reduced social exclusion from regional economic centres for jobs, healthcare, shopping etc. (increased numbers of employed; increased inward investment creating new jobs; improved indices for social welfare measures)
- operating cost-effectiveness (financial shortfall)
- capital cost (affordability)
- transport safety (low risk transportation)

4 Demand and revenue forecasts

4.1 Methods of demand forecasting

4.1.1 Theoretical background

Transport planning is sometimes described as four separate problems:

1. Trip generation (how many people are there, and how many trips do they each make?)
2. Trip distribution (where do they want to go?)
3. Mode choice (which mode of transport are they going to use?)
4. Traffic assignment (which route are they going to take?)

This section summarises how these issues have been addressed in this project.

There is a range of established processes for forecasting the demand for local rail services, but there is a balance to be struck between data availability and the level of sophistication of the method involved.

Trip rate methods are based on the concept that the underlying population is a useful starting point for assessing demand. They are of the form:

$T = f(P_i)$

where T is the number of trips, P_i is the population in the catchment area around place of interest i.

Ideally, this also requires some information about the corresponding attractiveness of places (such as the number of local jobs), in order to assess incoming trips.

Unfortunately, trip rate methods do not take into account the geographical direction of trips. This does not generally matter for road networks, which are dense, but is a critical limitation for a rail network, especially when (as here) one is trying to understand just one station on one line.

This is where it can be more helpful to use a gravity model formulation of the type

$$T_{ij} = \frac{k \times P_i \times P_j}{{d_{ij}}^2}$$

where D_{ij} is the distance between origin $_i$ and destination $_j$

These at least give the potential demand along a corridor, but for a potential train operator one also needs to understand what proportion of that demand might use the train. That necessitates an understanding of the relative attractiveness of different modes, in which the concept of generalised cost is used to enumerate that attractiveness. In simple terms, "generalised cost" is an index of travel difficulty, formulaically shown as something like:

$$gc = F + b_1 \cdot A + b_2 \cdot W + b_3 \cdot R + n \cdot I + b_0$$

where F = fare

b_1,b_2 & b_3 are weightings

A = access time W = waiting time

R = running (in-vehicle) time (although some of this may also be used for other activities such as working or eating)

n = number I = interchange

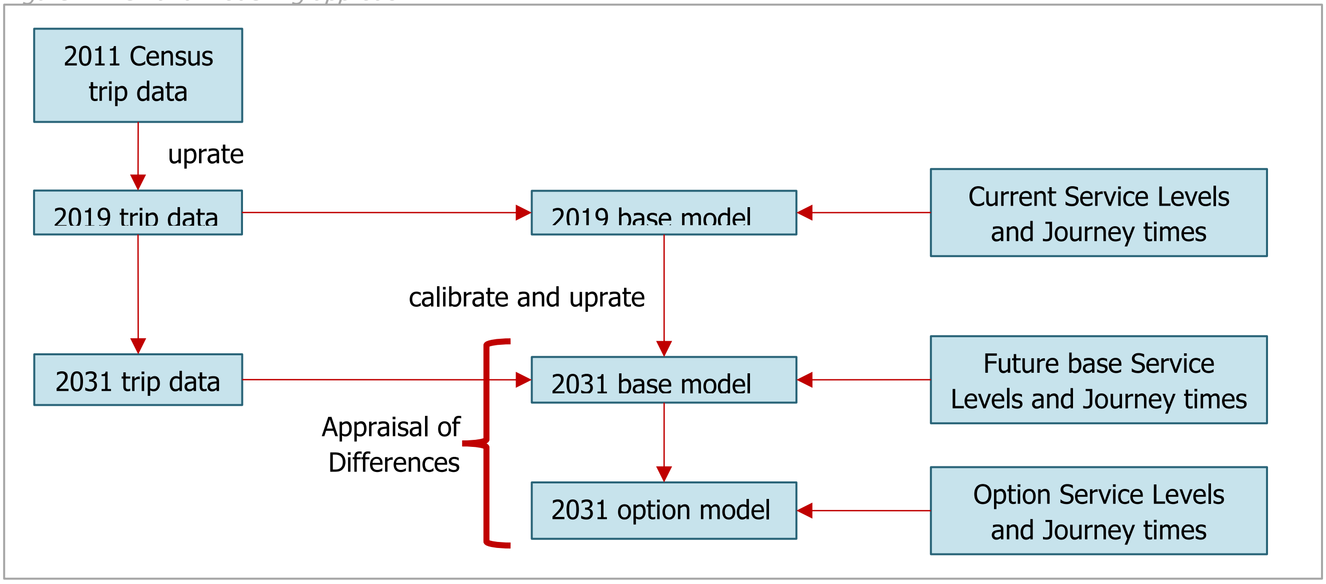
This can be calculated for different modes of transport and (because generalised cost is a 'negative' concept) traffic is allocated to the mode with the smallest generalised cost. For technical reasons beyond the scope of this report, a probabilistic approach is used, so that some traffic is allocated to apparently weaker alternatives, provided that they are not substantially worse than the 'best' one.

Ideally, analysis separately needs to take into account those with and without a car available (because their choice set is different), and peak and off-peak periods (because road speeds and public transport frequencies often differ between these). This is the basis of the GCOST™ model developed by the Railway Consultancy and applied here. It takes a trip distribution from the Census, and analyses the potential of rail to compete against other modes for trips to a range of destinations. A more complete description is included in Appendix A.

4.1.2 Summary of approach used here

The demand forecasting approach used in this study may be summarised as below. The Oxfordshire situation is further complicated by the existence of various 'Park and Ride' options (e.g. bus via Seacourt, future bus and rail via Eynsham/Saltcross).

Figure 7: Demand modelling approach



Construction of a demand model as described below should, however, be noted as providing a framework for a structured understanding of the transport flows that people make, rather than simply estimating the number of potential passengers. We therefore include in our description below the insights garnered through our analytical process.

4.2 Data requirements

4.2.1 Population and trip distribution

Some form of data is needed on the quantity and characteristics of local population, and where they are trying to travel to and from. Several data sources have been used in order to compile a trip matrix to enable demand and revenue forecasting for this study.

The steps behind the creation of a background trip matrix for this work are as follows:

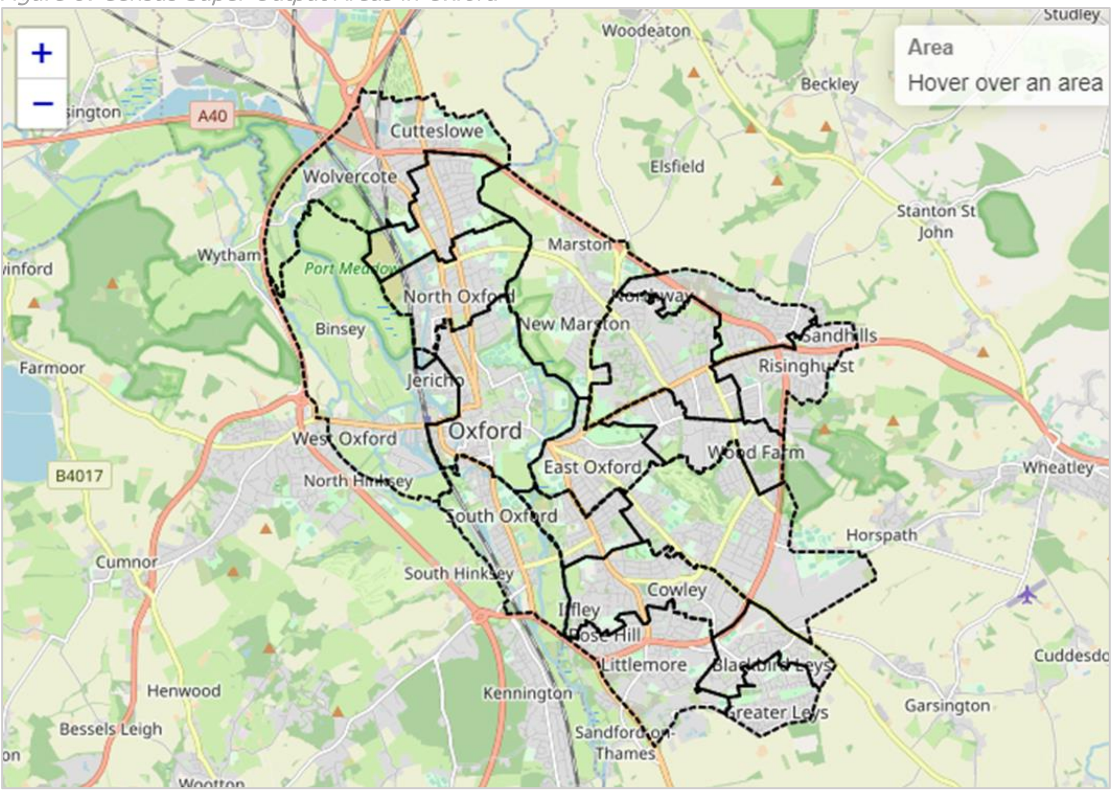
1. Derive a trip distribution from Census Travel To Work (TTW) data;
2. Scale up to 2019 on the basis of mid-year population estimates;
3. Add to that air travel trips between Oxfordshire and Heathrow, derived from Civil Aviation Authority (CAA) surveys of the distribution of air passenger origins, to enable calibration (since these are not included in TTW data, but have potential for transfer to rail);
4. Scale up to 2031 on the basis of Oxfordshire forecasts, based on known developments where possible, described as follows:

4.2.1.1 Derivation of a trip distribution

The Census tabulations include various tables providing comprehensive and disaggregated data on travel to work behaviour, which (at least in terms of its trip patterns) we have used as a proxy for all trips. Whilst this is not strictly true at the very disaggregated level, this is not an unduly poor assumption for this corridor: Oxford might reasonably be assumed to be the dominant regional centre for all trip purposes.

For each of the areas defined as zones (see section 6.3 below) we therefore used data from Table WF01BEW from the Census. This contains detailed information on the local of usual residence and place of work for all respondents, and has been used both for local residents travelling out of the area, and for others travelling into it. Unfortunately, the latest data still relates to 2011, since full details of the 2021 Census had not been made available at the time of this study. It is, however, possible to interrogate the TTWs dataset through the nomisweb portal, from which we have downloaded data at the Super Output Area (SOA) middle layer, as an appropriate level of disaggregation: this typically includes several wards lumped together. Different groupings of SOAs were used, depending upon the proximity to the proposed station site.

Figure 8: Census Super Output Areas in Oxford



Settlements in the immediate vicinity of the line have been analysed at individual SOA level (e.g. Witney West), with those nearby (e.g. Oxford, South Oxfordshire) using data from several of these aggregated, and much broader groupings for more distant areas. For the more distant demand in other regions, data relating to entire council areas or even several counties was added together. For instance, just one zone was used for the whole of Reading, and only one zone for the entire Basingstoke – Bournemouth corridor. This approach balances accuracy where it is needed against the time-efficiency of extracting the data and compiling it into a trip matrix.

This data was manually transferred into a trip matrix corresponding to the origins and destinations of trips being analysed. It should be noted that, as this trip distribution is applied (albeit in different proportions) to peak and off-peak trips, one should not directly infer that trips are exactly matched on a day-to-day basis between all traffic pairs (least of all by the same individual passengers every day), but rather that the level of interaction between these origins and destinations is representative of overall travel behaviour.

4.2.1.2 Scaling to 2019

The Office for National Statistics (ONS) provides mid-year estimates at the District level, and these have been used to scale up 2011 Census data to 2019.

4.2.1.3 Heathrow trips

The CAA produces ongoing datasets about Britain's airports, including the total number of non-transit passengers, and their origins by county. In 2019 (the latest 'normal' year), 53.376m Heathrow passengers were estimated to have used the airport for outbound journeys (Table 4.1b of their passenger survey tabulations), of which 1.474m started in Oxfordshire (Table 5.8). Although we have taken the exact values in our calculations, dividing the Oxfordshire total by the relevant West Oxfordshire SOAs gives about 1% to/from each SOA. Assuming that these trips are spread evenly through the year gives around 50 trips every day, although it must be remembered that this figure needs to be divided by two, to reflect inbound and outbound journeys.

This data has then been added to the TTW data, to provide a base trip matrix used for calibration of the model to 2019 conditions.

4.2.1.4 Scaling to 2031

It was felt important to reflect distributional changes in population and employment in the coming decade, especially since these might lead to more (or fewer) trips being in the proximity of stations and hence convenient for rail use.

There are different views in the public domain about the expected level of population increase in Oxfordshire in the coming years. The County Council's increase of +20% between 2020 and 2030 substantially exceeds the ONS estimates of only +4% (Oxfordshire CC, 2022). Being based on greater local detail, we have taken on board Oxfordshire CC's forecasts, which are disaggregated between the three urban centres along the route.

Although the dates do not exactly match the timescales used for modelling here (2019 and 2031), the West Oxfordshire [JSNA] District Summary (Oxfordshire CC, 2021) noted a 19% increase in population in West Oxfordshire between 2018 and 2028. This was helpfully disaggregated between Witney (+14%) and Carterton (+22%), although that leaves further assumptions to be made about the impact of Salt Cross from a zero base. As a starting point, however, the initial 2,200 homes as noted in the West Oxfordshire DC Local Plan might be expected to contain a similar number of residents (5,411) as the existing Eynsham & Stanton Harcourt parish in 2011. That is easily modelled by assuming that our Salt Cross zone has the same number and distribution of trips as the Eynsham zone in the base.

For employment growth, the 2022 ELNA (Employment Land Needs Assessment) (Lichfields, 2022) was used as the basis for understanding the expected relative growth in jobs in different parts of Oxford city. There were around 130,000 jobs in Oxford city in 2019 (Figure 2.1), with about 12,000 more expected over the next 10 years (say half of the 24,000 increase expected over 20 years) (Table 4.1). Overall, that would be a 9% increase.

However, paragraph 4.43 notes that Oxford West has been given almost 40% (say 33%) of the total extra office floorspace (which, proportionately, would imply 4,000 extra jobs) with the Science and Business Parks expected to attract about 60% (c. 7,000 jobs).

The 2019 matrix has therefore been factored up to a 2031 base using these population and employment factors, with a 1% increase assumed elsewhere in the country as a default.

4.2.1.5 Scaling to 2041

During February 2023, Oxford City Council issued a consultation on a Housing and Economic Needs Assessment (HENA) to 2040, as part of work on the Oxford Local Plan work. This considered a number of scenarios:

- The standard method set out by Central Government (based on 2014 population projections);
- A Census-adjusted standard method (based on the 2021 Census);

- A baseline trend developed by Cambridge Econometrics; and
- An Economic Development-led plan.

The Cambridge Econometrics scenario was selected as being most appropriate; we note that it noted a need for 564 extra houses in West Oxfordshire by 2040, in order to support the expected increase in jobs.

Simplistically assuming straight-line growth, the ELNA forecasts imply another 12,000 jobs are likely to be created in Oxford between 2031 and 2041.

4.2.2 Elements of Generalised Cost

The GCOST™ model is based on the manual assembly of trip data by the three key modes of car, bus and train between the zones selected. Data includes that on all the main elements of generalised cost, including access and egress (e.g. to/from bus stops and stations), waiting time, in-vehicle journey time, the number of interchanges required, the fare paid, and a mode constant reflecting typical preferences for one mode over another (usually, car preferred to train preferred to bus). The parameters used for these (e.g. the weightings of elements of time) are consistent with those given in RDG's Passenger Demand Forecasting Handbook (2020) and DfT WebTAG guidance. Google maps is used to collect data regarding the car mode (journey time and fare) whilst National Rail and Traveline journey planners were used to collect public transport data (bus and train). Trips requiring paid car-parking (e.g. at Hanborough station) have had half the appropriate car-park charge assigned to each journey leg. However, there are a few general subtleties worth mentioning:

4.2.2.1 Car

For car journeys, we have historically adjusted for actual road conditions by increasing the quoted off-peak timings by a standard factor (typically of around 1.2 for peak and 1.1 for offpeak conditions). Because more accurate data was available here, we have reduced both factors to 1.05, merely to reflect the impacts of journey time unreliability (e.g. from occasional accidents).

4.2.2.2 Public transport

For local rail journeys, the choice of what to assume for average peak fares has become more difficult in recent years, as the Covid pandemic reinforced previous trends away from the purchase of season tickets. However, without O:D-specific yield data, it is difficult to see what other readily-available information could be used. We have therefore continued to use it, accepting that it may artificially reduce the generalised cost/ increase the attractiveness of rail travel, but noting that the calibration process (see below) should help to reduce the level of error introduced, which could be addressed by adjustment of mode constants.

For off-peak conditions, we have continued to assume average fares as half the off-peak return. Since the development of Advance fares, and given the huge season ticket taper for longer-distance journeys, however, typical average fares yields for both peak and off-peak are both around the level of half the off-peak return.

During this project, however, we found one of many discrepancies in the National Rail fares system which have led to calls for improvements to it. In this case, some non-restricted fares from Hanborough to the south are actually cheaper than the equivalent fares from Oxford, even though passengers to/from Oxford could use the cheaper to/from Hanborough fares. We have endeavoured to reproduce this anomaly in future scenarios, so that there are no alleged benefits or disbenefits accruing to this project from the correction of the current fares anomaly.

4.3 Model development

4.3.1 Zoning

The model needed to cover the potential for travel between a range of local origins and anywhere across Britain. However, given the limited local population, only tiny numbers of each trip would be expected, and so a zoning system was set up, to group trips together into a manageable level of complexity. The zones were separated into "Local" and "Destination".

The three main settlements along the route (Carterton, Witney and Eynsham/Saltcross) are all large enough that possible rail sites to serve them would provide very close access for some areas, but rather more distant for others. As part of the demand forecasting for the new line, we needed to understand the impact of access time to stations, and so each of these settlements has been sub-divided into several zones (2, 3 and 2 respectively), to enable us to do this. Similarly, Oxford, as the prime destination, needed to be disaggregated, in order for us to understand the competitiveness of rail v bus differentially for the city centre and other key traffic destinations (e.g. the John Radcliffe Hospital). 6 traffic zones have been used to cover Oxford (including Kidlington, which may be served by a new station at Begbrooke as well as that at Oxford Parkway); a further 22 zones enable us to examine the potential rail offer to a range of destinations across Britain.

The model also importantly considers different categories of people, being disaggregated between peak and offpeak passengers, and those with and without a car available for their journey.

Reliance on the Census necessarily means that demand data must be based on the zones used in the Census. These include output areas (the lowest level of disaggregation, typically containing 125 households), wards, district and county council areas. As noted above, we have used a mix of these, depending upon the relevance to the project.

4.3.2 Construction of Generalised Costs

In order to undertake the appraisal of this project, it is important to establish the 'do minimum' scenario against which the project (here, rail options in the Witney corridor) will be assessed. However, there are significant changes expected to all modes in the intervening years.

4.3.2.1 Future car

Section 8.3 of AECOM's (2021) A40 Smart Corridor Scheme Transport Assessment report notes that the expected increase in a.m. peak journey travel times for cars between Witney and the A40 Wolvercote roundabout to is as much as 35 minutes. Whilst the expected impact in the evening peak is rather less, at around 6 minutes extra for car traffic, we suspect that a.m. conditions will determine mode choice. In an attempt to reflect this within our model, we have therefore increased a.m. peak car journey times from Carterton and Witney by a round 30 minutes, and (as the bulk of the congestion is approaching Oxford) by 25 minutes from Eynsham/Saltcross.

4.3.2.2 Existing public transport

Base bus service levels in 2021 are as shown in Table 1 above, and dependent upon the key S1 4tph service from Oxford to Carterton via Eynsham village.

4.3.2.3 Future bus

The A40 bus priority project is expected to limit the congestion-driven increases in road journey time to around 3 minutes, the same as for off-peak car journeys.

By 2031, the A40 bus priority project is expected to be delivering a service of the following type: (source: AECOM, 2021, Tables 5-1 and 5-2)

- S1 via Eynsham village/Botley: 6 bph from Witney
- S2 via A40/Summertown: 3 bph from Carterton, +1 bph from Witney, +4 bph from Eynsham P&R
- S7 to/from Eastern Arc: 2 bph from Carterton + 2 tph from Eynsham P&R

We note that this significantly improves the bus service offer to both Oxford city centre and the JR Hospital area, but Carterton would no longer have any direct buses to Botley or Oxford station. On the other hand, the frequency increases to the north side of Oxford (e.g. the Summertown area) also present opportunities for significant bus travel time reductions to destinations such as Kidlington and Bicester, by enabling bus passengers to avoid the (congested and longer) route via the city centre.

Peak journey times from Oxford to Eynsham P&R, Witney Market Place and Carterton town centre are expected to be 42, 52 and 80 minutes respectively. Whilst these show marginal rises from now, these are mitigated by increases in frequency and much greater increases in journey times for private car users.

The above analysis makes it clear that any future rail scheme will be competing in quite a different market from now, with a much stronger bus product but even worse car congestion.

4.3.2.4 Future rail

Given the present funding uncertainties in the rail industry, rail developments over the next decade are perhaps more difficult to pin down. However, works are about to begin at Oxford station, in order to create a further platform face for northbound traffic, thereby removing part of the constraint surrounding current operations there.

As noted in the review of earlier work, several rail studies affect the future of rail in the Oxford area, notably ORCS and the North Cotswold Line study, as well as background planning work e.g. by the Network Rail Wales & West team. Re-opening to Cowley, four-tracking between Radley and Oxford, and electrification from Didcot to Oxford have also all been studied in detail. All these studies have made assumptions about future service levels and the infrastructure interventions needed to support them. Unfortunately, at present, owing to several changes of Government and a consequent lack of updating of the Rail Network Enhancement Pipeline, rail development and funding is particularly uncertain. Whatever the desirability of any of the schemes, it is not clear whether the specific proposals in any of those studies are either (a) still valid or (b) likely to be funded within the next 10 years. Some of these projects may be considered to be competing either for rail funding (within the same economic region) and/or train slots at Oxford, so the order of their delivery could matter.

Liaison with rail industry stakeholders (see section 2.6 above) confirmed that the following was a sensible base scenario for a nominal forecast year of 2031:

- extension of electric London – Didcot semi-fast services to Oxford
- transfer of London – Oxford/Worcester/Hereford fast services from diesel to electric traction between Didcot and Oxford (although we have not assumed that this has any journey time impacts)
- East – West Rail services to Milton Keynes and Bedford (but not beyond)

Whilst considerable planning work has been undertaken in restoring rail services to the Cowley branch, that project was (at the time of this study) still not funded, so the DfT advised that it should not be included in the base scenario. Extension of the hourly London – Oxford fast service to Hanborough is similarly not included.

For future service levels, section 6 of this report explains how operating concepts were developed. These led to the basic assumption of a future half-hour service with the following journey times:

- Oxford - Eynsham 11 minutes
- Oxford - Witney 16 minutes
- Oxford - Carterton 23 minutes
- Oxford - Cowley 10 minutes (plus a further 2 in the stop at Oxford, for Witney branch passengers)

For trips to or via Oxford, future rail fares for Eynsham, Witney and Carterton have been assumed to be the same as for Hanborough, Charlbury and Shipton respectively, since those stations are at very similar distances from Oxford and the equivalent data is already available.

4.3.3 Calibration

No model should be applied without it being calibrated to local conditions. Transport models use a number of parameters, including the Value of Travel Time, people's weightings of it when walking or waiting, and often (including here) a special ("logit") parameter which determines the proportion of trips made using the apparently-second-best option relative to the best one.

As well as deriving a full set of data for Carterton, Witney and Eynsham, we therefore also collected a full set of data for nearby Hanborough, to see if we could reproduce the number of rail trips recorded there by the ORR. The latest appropriate figures (for the pre-Covid financial year 2019-20) show around 275,000 trips using the station, including for both journeys originating there and those ending there.

Analysis of data from the (admittedly-somewhat-dated) National Rail Travel Survey showed that only 84% of the users of Hanborough station were accessing it from areas contained within our model (which does not cover, for instance, Woodstock). Adjusting the 275,000 down to account for this led to our 2019 base trip estimates for Hanborough being within 1% of those estimated by our model, on the assumption that rail trips towards London from Witney and Eynsham accessed the rail network at Hanborough, and all others (including all trips from Carterton) did so via Oxford. This confirmed that our model calibrated, and was therefore likely to provide reasonable estimates of future service scenarios.

This element of the modelling showed that the use of Hanborough as a railhead for destinations other than central Oxford was currently particularly attractive, because of the significant savings in access time (neither bus nor car are affected by road congestion in reaching Hanborough from Witney), and Hanborough's direct train services to Reading, Slough and London. That attractiveness of course would of course increase if train services were to be improved at Hanborough.

4.4 Model output

The key outputs required for a rail business case, and available from the GCOST™ model, are journey time savings and increases in public transport revenues. It is also possible to estimate newly generated traffic, and to provide guidance on the number of car-miles saved (from which can be calculated some elements of the environmental benefits).

4.4.1 Insights from modelling

There is considerable uncertainty associated with forecasting demand for a completely new train service. As a structured way of analysing the transport choices, however, modelling enables insights to be gained into the different local trip markets, and we present some of these before simply presenting summary figures.

Access to stations is clearly key. It is difficult to locate Carterton station as near into the town as would be ideal, which does not help its competitiveness: some potential passengers may need to access it by bus or car, rather than on foot. Similarly, if the Witney station were to be south of the A40, a combination of its distance from most of the town, and the perceptual barrier of the A40 bypass (which is elevated) will reduce its attractiveness.

Travel choices for passengers on some flows will be very finely balanced between alternatives, which makes demand forecasting particularly difficult. Table 3 gives an example of future flows between North Witney and Central Oxford. Road congestion between Witney and Eynsham is predicted to make the Eynsham Park and Ride site slower to access than Witney station, even if the latter is on the Ducklington Road. However, at this level of similarity, choices in practice are going to be determined by modal preferences, the ability to link trips with those of other members of the family or other trip purposes, how many times per week people travel, the exact location of bus stops, and whether it is raining or not. We have therefore ensured that our model forces some traffic to use each of the alternatives.

Table 3: Possible generalised costs of travel options between North Witney and Central Oxford, 2031

	Car access	**Wait**	**In-vehicle**	**Interchange**	**Egress**	**Fares & parking**	**Total**
weightings	*x2*	*x2*	*x1*	*x10*	*x2*	*£10/hr*	
Via Hanborough station	16	11.25	12	10	15	22.5	128.5
Via Witney station	11	11.25	17	10	15	24	126.5
Via Eynsham station	18	11.25	12	10	15	12	122.5
Via Eynsham bus p&r	18	4	36	10	15	14	126.5

All figures expressed in generalised cost minutes, after weighting as shown. Access by car might reasonably be weighted by less than 2, but this is compensated for by the lack of petrol costs in the above table. No parking charges have been included for either the Witney or Eynsham options.

We have observed from our modelling that rail services are unattractive from Eynsham village into Oxford, because access to the station is in the 'wrong' direction whilst the S1 bus runs right through the village, providing very easy access to a string of bus stops close to almost all houses within the village. (For the avoidance of doubt, this argument does not apply to Saltcross, since the Park and Ride site (either for bus or rail) is in the 'right' direction towards Oxford, and it does not appear possible to offer the same level of bus access within the new development).

It is worthwhile observing that there is a particularly wide choice of potential routes for rail travellers from this corridor – provided that they have a car available. We noted during analysis that the provision of direct train services from Hanborough to Reading and London will continue to be attractive, even if the Carterton branch is re-opened, because use of the latter will require a change of train at Oxford. This is particularly the case for residents of North Witney (north of the River Windrush bridge), for whom access to the A4095 to Hanborough is as easy as to the A40 (and for whom the 233 bus provides a reasonable service). Our model shows that, whatever the train service at a Witney station, these flows remain via Hanborough. However, of course, Reading, Slough and London are only three possible destinations, and clearly less important in this corridor than accessing Oxford itself.

It is possible that some Saltcross residents might also choose to use Hanborough for trains to/from London. However, that would also involve 'going in the wrong direction' and the 411 bus service is very limited (5 per day, MF only), so this option is only available to those with a (spare) car. Our analysis shows this to be a very finely-balanced decision in the base case, so we have not assumed it, although the proposed doubling of rail service frequencies on the North Cotswold Line would encourage more demand via Hanborough. There are also some physical constraints of the site there: access is down a narrow lane, and there is only one platform, which is shorter than a single 5-car IEP trainset.

It is also possible that some car-owning residents of this corridor might currently be accessing the rail network by driving to Didcot Parkway. Although much further away (around a 40-minute drive), Didcot enjoys 4 fast trains per hour to London and (obviously) at a lower price than Oxford. We have not assumed this travel behaviour, although it might be convenient for a limited number of households at present, providing a further small market as potential users of the re-opened Carterton branch. Interrogation of the (somewhat ageing) National Rail Travel Survey database suggests that there are about 40 such trips per day at present.

More-distant residents (e.g. from the Burford area) are expected to use the rail service via the Eynsham Park and Ride site, rather than trying to access the railway further west. This is because road congestion on the A40 only becomes severe nearer Saltcross, from where rail fares into Oxford and beyond will also be cheaper.

4.4.2 Model results

Results from the constructed model span a number of variables as set out below, emphasising that any assessment of the scheme will need to be made across a range of criteria.

Table 4: Base Model results, Carterton North - Oxford, 2031

	Passenger Trips	Passenger Revenue	Travel Time Savings	Car miles saved
	'000 p.a.	£m p.a.	£m p.a.	m p.a
2031 base	570	3.9	1.2	1.4

We have also made a very preliminary estimate of CO_2 savings, through the replacement of car trips by those made in a battery-operated train. Current CO_2 emissions from cars are around 150g/km but, by 2031, perhaps half of the car fleet may be electric, leading to an average emission rate of 75g/km. Our modelling of the full scheme suggested that 1.9m car-kms should be saved, but one might reduce this slightly (say to 1.7m) to reflect higher car occupancies (greater car sharing might be expected in the future). The total emissions of a full scheme in 2031 would therefore be around 1.7m km x 75g/km, or around 125t per year.

At the time of writing, we still had not received detailed operating information about battery trains. On the basis of our work elsewhere, we would have assumed that diesel train operation of a Carterton service would have emitted about 75t of CO_2 p.a., but the battery equivalent will clearly be much less – say 25t. If that was the case, then the full scheme would appear to save around 100t of CO_2 in a full year (as well, of course, as removing other pollutants (such as NOx) which contribute to greenhouse gas emissions).

Table 5 below summarises the results from the demand and revenue model constructed by RCL and compares them with annual operating costs, noting that the costs are exceeded by the revenues, which is an important consideration for Government funders. However, although the passenger revenue comfortably outweighs the cost of service provision, it and other transport benefits are not at a level to pay off the capital cost within any reasonable timeframe.

Table 5: Base Model results summary, Carterton North - Oxford, 2031

	Passenger Trips	Car miles saved	Travel Time Savings	Passenger Revenue	Operating costs	Operating Profit
units	`000 p.a.	m p.a	£m p.a.	£m p.a.	£m p.a.	£m p.a.
2031 base	570	1.4	1.2	3.9	2.4	1.5

4.4.3 Sensitivity tests

As well as noting the comments shown above, we have also undertaken some formal specific sensitivity tests, as below.

4.4.3.1 Through-working to Cowley

On the demand side, this leads to a removal of a bus:rail interchange in Oxford and a saving of around 8 minutes in journey time (bus time = 20 mins less rail time of 10 mins and 2 mins whilst through train sits in Oxford station) against an increase (we have assumed 5 minutes, weighted) in egress time in the Business and Science Park areas (because there are multiple bus stops providing better local penetration).

4.4.3.2 Staging of the project: Eynsham only

As one of the key issues for this project is the sheer scale of the required capital investment, one might consider developing the project in stages. Providing a higher-quality/faster public transport alternative from the Eynsham Park and Ride site by means of a rail service could be a sensible first step towards reaching Carterton, especially since the engineering works involved are more straightforward than the route section through Witney.

However, it should be noted that we have not, at this stage, attempted formally to model the impact of people from the Witney area driving to the Eynsham Park and Ride site to use the rail service from there, so the results shown are worse than would be expected in reality. Especially for passengers travelling on to the rest of the rail network, using the train (rather than the bus) into Oxford would provide an advantage. Indicative manual analysis suggests that total rail demand at a (temporary) Eynsham Park and Ride terminus might be double that from just local people from Saltcross and Eynsham.

4.4.3.3 Eynsham – Cowley

This scenario combines the previous two, to provide, at an early stage, a cross-Oxford local rail service.

4.4.3.4 Comparison of 2031 options

Comparison of the results from the different tests highlights the relative benefits and weaknesses of different options. Extension of services through Oxford to Cowley, as well as making the service operationally-easier, clearly adds notable trip, revenue and time-saving benefits.

Our modelling of only running as far as Eynsham suggests that it provides for over 1/3 of the demand, but the shorter-distance nature of the traffic means that those passengers only provide perhaps ¼ of the time savings and 1/8 of the revenue. However, that is likely to be an under-estimate, since some people from Witney might also be expected to drive to it, and such traffic could be encouraged by promoting Park and Ride at Eynsham.

Table 6: Base Model results, 2031

	Passenger Trips	Passenger Revenue	Travel Time Savings	Car miles saved
units	'000 p.a.	£m p.a.	£m p.a.	m p.a
2031 base	570	3.9	1.2	1.4
Carterton-Cowley	620	4.2	1.8	1.45
Eynsham only	210	1.2	0.6	0.9
Eynsham-Cowley	170	0.48	0.5	0.9

4.4.3.5 Future Demand to 2041

Further housing development (and hence population growth) is expected in the period 2031-2041. This will naturally increase both the total demand for travel, and road congestion/journey times, both of which will make rail a better option. However, forecasts of population and employment for Oxfordshire in that period are still being developed. We have therefore examined a notional further increase of 10%, noting that this is potentially much less than expected in this corridor.

However, it is widely-recognised that providing public transport options *before* the completion of housing is more likely to lead to the use of sustainable modes than waiting until afterwards, by which time many residents will already have bought a car.

5 Engineering feasibility

Note: This section is a very brief summary of the accompanying report '2213-420-002 CWORC Engineering'.

5.1 Methodology

The engineering work began with a review of previous relevant documents and reports, and developing the project 'Mission Statement with OCC senior leadership as to "Provide a frequent and reliable rail service between Carterton and Oxford via Witney and Eynsham". From this mission statement, supporting high-level requirements were derived to provide focus and structure to the investigations.

Some of the key requirements were operational – in particular, a Carterton to Oxford journey time of 23 minutes to facilitate an hourly round trip using battery trains. Although the railway should be designed with passive provision for overhead line electrification, the capital costs of introducing the related infrastructure are significant and hence could make it harder to secure funding.

A wide range of local authority and railway-related organisations were contacted for initial views on the concept of a railway connection indicating broad support in principle, but concerns around the detail – notably potential costs and consequential funding impacts such as additional housing.

The engineering team undertook a site visit and developed technical working assumptions to frame the design development. Using these inputs, the design team identified possible station locations and indicative routes before filtering down to a short list based on practical viability or compliance with the project mission statement.

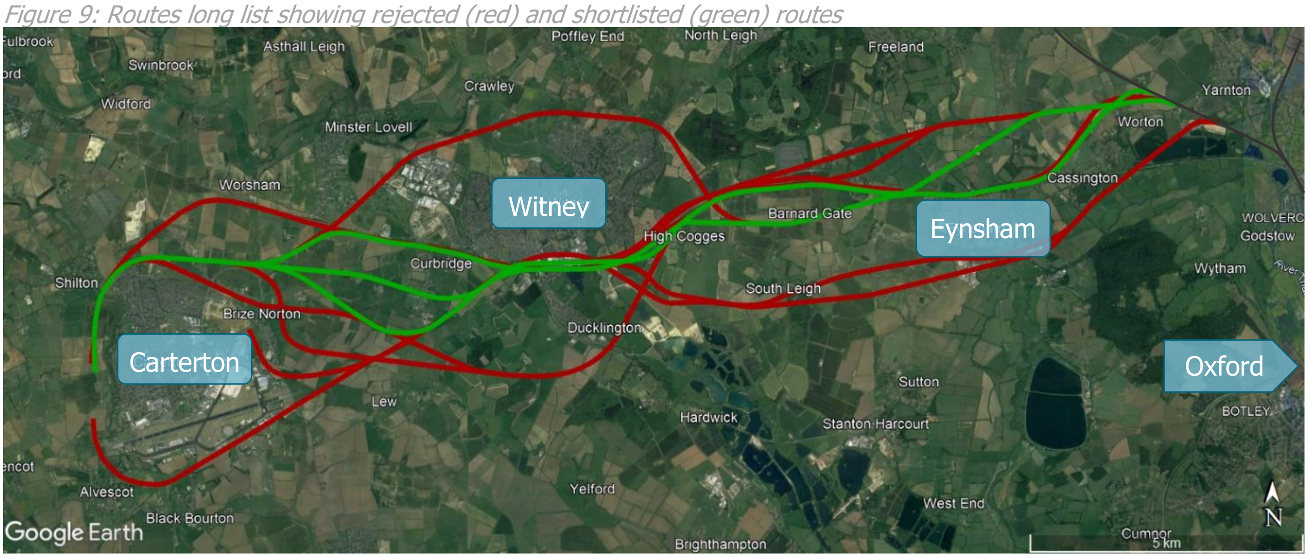
The short-listed routes were broken up into short sections for engineering and cost analysis, before being re-assembled into different combinations to assess the longest/shortest routes, and least/greatest cost routes.

The least/greatest cost routes were reconsidered as part of a three-phase delivery proposal with a cost assessment for each phase and indicative delivery programme.

5.2 Engineering outputs

Figure 9 illustrates the long list of routes considered, with those rejected in red, and those shortlisted in green. Each route was intended to test a different conceptual strategy, rather than show every conceivable variation. The routes that were rejected were typically on the basis that they didn't really serve all three A40 corridor towns, or were so circuitous as to add journey time for no obvious commensurate benefit. Some were rejected on the basis that they could only serve station locations where it was unlikely to be possible or desirable to provide suitable access or development to serve the station.

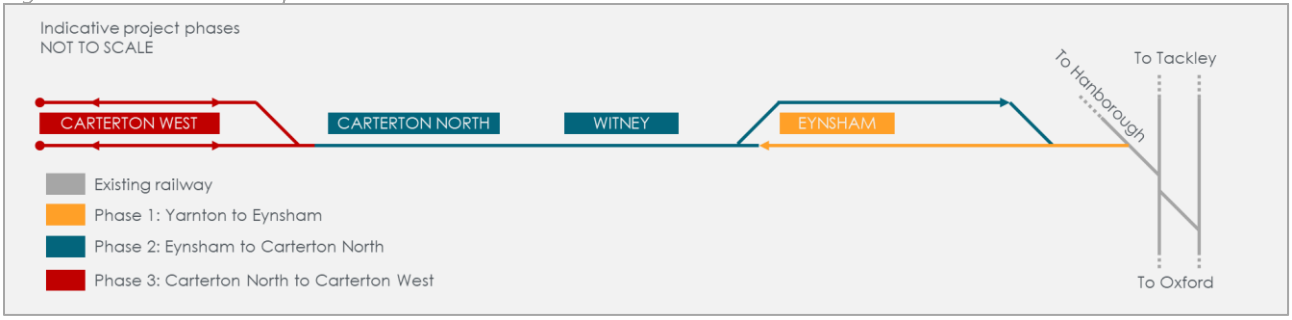
Figure 9: Routes long list showing rejected (red) and shortlisted (green) routes



The proposed project incorporates four stations (from the Oxford end) at Eynsham, Witney, Carterton North, and Carterton West, each station serving its own catchment and purpose.

The initial operational assessment indicated that the turnout from the Cotswold Line at Yarnton could reasonably be a single track lead into a dual track section running to the west side of a station at Eynsham. Thereafter the route could be single track all the way to a point between Carterton North station and Carterton West station, where it would become dual track again. This would give sufficient capacity and service resilience as to support a reliable half-hourly service to/from Oxford.

Figure 10: Potential route phases



A project of this scale would need to attract different funding sources, and this could be assisted by a phased approach to delivery, shown in Figure 10 with indicative costs and delivery timeframes in Table 7.

Costs were developed in line with typical railway industry methodology for early-stage projects, though risk factors were limited to an average 33% uplift (though factored by discipline) because the majority of the route would be in greenfield conditions rather than adjacent to an operational railway. More details of these are set out in the separate engineering report.

Table 7: Phased route costs at Medium risk level (@ 2023Q1 price base, rounded to £10M)

Potential phases	Least cost route	Greatest cost route	Mid-point route cost	Delivery
Phase 1: Yarnton to Eynsham (5.6km)	£180M	£250M	£220M	2033H1
Phase 2: Eynsham to Carterton North (12.4 km)	£420M	£540M	£480M	2036H2
Phase 3: Carterton North to Carterton West (3.9km)	£100M	£100M	£100M	2036H2

Note that these costs do not include allowances for land costs beyond that of the actual railway footprint itself, or inflation beyond 2023Q1.

It is clear that Phase 2 is substantially more expensive than the other two routes. This is because it forms the bulk of the route, but also because the section through Witney is on lengthy viaduct (whichever option is chosen) and incurs an accordingly high cost per km in construction.

However, the all-in cost per km comes to around £35.6 Million per route km, which is in the same order of magnitude as the A40 works package described in 2.5.1.

5.3 Risks & dependencies

The following key risks / dependencies have been identified as:

- Oxford station remodelling
- North Cotswold Line doubling & service enhancements
- BEMU charging capability
- A40 improvements (for its impact on demand)

5.4 Summary

The approach taken in the engineering feasibility report has been appropriate for a high level study of this nature and has been able to conclude that:

- There are viable route options for a resilient half-hourly service using battery trains
- The whole route costs are substantial but in line with comparator projects
- The whole route may be delivered in useful phases with Phase 1 in operation by 2033H1

6 Operability

6.1 Train movements

6.1.1 Oxford station

Oxford is a busy rail hub, with lines currently radiating to Worcester, Birmingham, High Wycombe via Bicester, and London via Reading. Junctions at Didcot and Reading respectively provide access to Bristol and Southampton, whilst the East-West rail project currently under construction will re-establish a link between Bicester and Milton Keynes (and later, it is hoped, Cambridge).

There are also plans to provide passenger rail services on the branch line to Cowley, in the south-east of the city. Known typical service frequencies are set out in Table 8, although we are also aware of aspirations (e.g. from Midlands Connect) for further services, including Birmingham – Bristol via Oxford. Further empty train movements, which currently shunt across the track layout, are associated with services terminating at Oxford from London/Didcot.

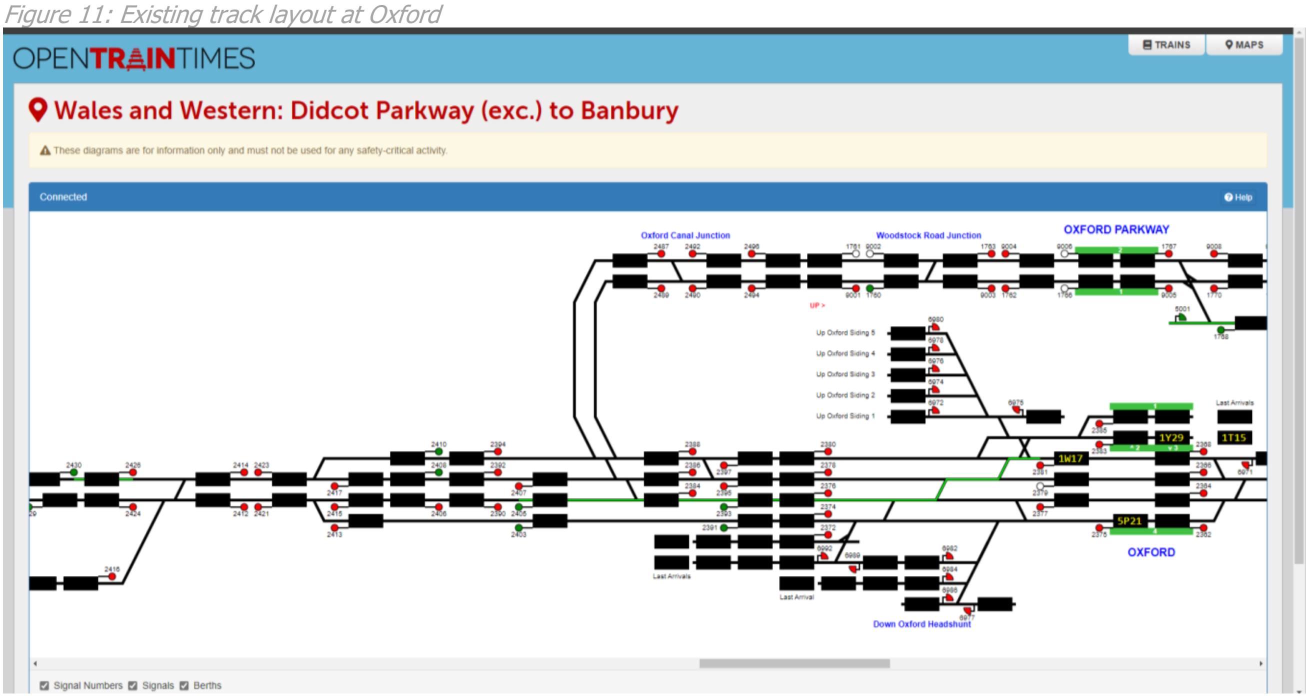
Table 8: Typical train service frequencies at Oxford

Operator	From	To	Frequency (trains per hour)	Normal rolling stock
FGW	London Paddington	Great Malvern/Hereford	1	5-car IEP
FGW	London Paddington	Oxford (fast)	1	5-car IEP
FGW	Didcot	Oxford (local)	2	2-car DMU
FGW	Oxford	Banbury (local)	1	2-car DMU
XC	Bournemouth	Manchester Piccadilly	1	5-car DMU
XC*	Reading	Newcastle	1	5-car DMU
CH	London Marylebone	Oxford	2	4-car DMU
FLT	Southampton Docks	Birmingham/Manchester	1	Diesel loco + 30 container wagons
various	Mendips	various	1	Diesel loco + 15 aggregates wagons
CH+	Oxford	Milton Keynes	2	4-car DMU
CH+	Oxford	Bedford	1	4-car DMU
various+			occasional	freight

Note: Services shown asterisked have not yet, at the time of writing, recommenced after the Covid pandemic. Those shown with a '+' are expected to start in 2025

Oxford station is currently something of a bottleneck. The two-track section from Didcot does widen out into four tracks through the station, but there is only one platform for trains in each direction, the other tracks being 'through' lines without a platform.

Figure 11: Existing track layout at Oxford



Source: OpenTrainTimes: Live map of Didcot Parkway (exc.) to Banbury

Ongoing rail planning work has included the Oxford Rail Corridor Study (Network Rail, 2021), designed to address current and future operating problems with a programme of investment. Budgetary authorisation was recently received, so that works to convert the existing northbound platform 4 into an island platform will take place during 2023. That will enable terminating services arriving from the south to do so between other northbound and southbound trains, eliminating some of the shunting conflicts that occur. Completion of these works is also likely to facilitate the electrification of the line from Didcot, enabling Intercity Express Programme (IEP) operated services to run in electric mode to Oxford, and local services to/from Didcot to be run using Electric Multiple Units (EMUs) and/or to be extensions of the existing London – Didcot semi-fast services (which ran to Oxford before electrification to Didcot).

The extra platform being provided is critical to the re-opening of the Carterton line, as it removes one of the key operating restrictions.

Despite the busyness of Oxford, the waiting times implied by only having an hourly service would be a significant deterrent to usage, so we have assumed that trains to Carterton would generally be at half-hourly frequencies. Greater service frequencies are unlikely to be warranted by the expected traffic, not least because of the capacity of even only 2-car trains.

6.1.2 Wolvercote Jc – Yarnton area

The line from Wolvercote Junction (c. 3miles north of Oxford) towards Charlbury was singled many years ago. This constrains the train service, in only permitting one train to be travelling from Wolvercote to Charlbury OR vice versa at any time. Including the time taken for the station call at Hanborough, this takes about 12 minutes, and therefore at first sight limits the line's capacity to one train per hour in each direction. However, there is an intermediate signal in the Hanborough area, which provides some flexibility now, and is a key enabler of operation to Carterton, as discussed below. In particular, however, it should be noted that the running time between Wolvercote and Yarnton is only a few minutes and does not include a station stop, so the impact of Carterton branch services on the single line to Hanborough is rather more about operational flexibility than simple line capacity.

Nevertheless, one must recognise that the layout of Wolvercote Junction also causes some further constraints. Although there are four tracks between Oxford station and Wolvercote, there are only two tracks under the A40 overbridge at this point. This means that, without further investment at this junction, it is not possible for potential trains to/from Carterton to operate in and out of Oxford station without conflicting with (at least northbound) trains on the main line.

Nevertheless, we note that (as in the screen grab shown in Figure 11 above), 'up' (London-bound) trains from the Worcester line can run 'in the wrong direction' on the down main line between Wolvercote and Oxford station. This enables other parallel train movements e.g. to/from Bicester and/or northbound services on the down relief line.

6.2 Operating options

6.2.1 Possible service patterns

Consideration of the requirements for this line has already showed that a half-hourly service is likely to be needed, in order to provide a rail service which is competitive with the private car. However, given budgetary pressures, it is also important to provide a cost-effective transport solution, which implies using assets efficiently. Primary amongst these are the trains needed to run the service. Not only are trains relatively expensive (their leasing costs being based on purchase costs of c. £1.5m per carriage) but rolling stock leasing costs are also a proxy for the other costs of service provision, including maintenance, cleaning and traincrew.

There is a range of options for operating trains to/from Carterton. Operating a shuttle-type service independently of other services should enable a high level of punctuality to be achieved, as it would minimise the number of delays imported from elsewhere on the railway network. Given the variety of existing train services at Oxford, and the complexity of operation there, it might be difficult specifically to time Carterton trains to connect with any other service group (e.g. fasts to/from London).

However, it can sometimes be operationally efficient to link the train workings of one route with another, since this may enable a saving in the number of trains required to operate both routes together, even if it also requires both trains to be of the same type (e.g. diesel v electric) and passenger demands to be similar i.e. needing the same number of carriages and frequency. A further advantage of through-running is that it removes an interchange penalty for passengers, which stimulates further demand (see section 4 above).

Nevertheless, whilst it would minimise the amount of platform occupation at Oxford, linking Carterton trains through to Cowley (to provide cross-Oxford services) would necessitate their crossing all tracks and all other services, which could lead to operating conflicts and reduce line capacity. On the other hand, this might still be preferable to the extension of trains from London Marylebone to Cowley, since these would be unnecessarily long and of unnecessarily high specification. Moreover, both the Cowley and Carterton branches would be suited to the same type of rolling stock; we note that battery traction is currently being trialled between West Ealing and Greenford, and that could become the 'norm' for Thames Valley branch lines in future. We have assumed that the Oxford station area will be electrified within the next 10 years, which could provide one source of power; should batteries need topping-up, this could also be undertaken through a fast-charge mechanism during the turnround at Carterton. VivaRail's latest equipment appears to be able to provide a 60-mile range from a charging period of less than 10 minutes; whilst the Carterton branch train is only likely to be in the platform there for 8 minutes, the branch-line is only about 15 miles long, so a full charge would not be needed.

Linking Carterton trains through to Didcot (for similar reasons) would need to take into account any differences in traction: although bi-mode trains could be used for this, it seems possible that local stations between Didcot and Oxford may once again be served by extending the London – Didcot slow trains (now operated electrically) through to Oxford. The engineering analysis set out in section 5.1 notes that the case for re-opening the Carterton line will be easier if electrification works can be avoided.

There have also been proposals to extend the hourly London – Oxford terminating service to Hanborough, the prime motivation for this being the release of platform capacity at Oxford and the avoidance of the need to shunt from one side of the track layout to the other. Provision of a third platform track at Oxford should reduce the need for this. Extension of the London services through to Carterton would be possible instead, but would complicate matters, since this would only cover one of the expected two train paths per hour. Moreover, whilst the provision of a through train would provide an (lack-of-) interchange benefit, this would not need a train as large as the 5-car minimum IEP train-length, which would increase operating costs unnecessarily.

Table 9: Summary of operating options

From	Comments	Rolling stock type	Number of carriages	Comments
Oxford	shuttle	Battery MU or bi-mode	2	Simplest option, if turnround capacity available at Oxford
Cowley	Joint shuttle	Battery MU or bi-mode	2	Would reduce platform occupancy at Oxford but interacts many other services
Didcot	slow (extension of existing shuttles)	Battery MU or bi-mode	2-3	Sub-optimal: Didcot trains better linked with Banbury shuttles on south – north axis
London Paddington	semi-fast (extension of Didcot terminators)	Bi-mode	5	Inefficient: provides capacity in excess of that needed
Swindon	Future service	Battery MU or bi-mode	2-5	Unlikely: service would be better provided as an electric service and/or linked to East-West Rail; roundabout route not likely to serve demand
Milton Keynes	Extension of East-West Rail	unclear	3-4?	Unlikely: Would necessitate crossing entire layout at Oxford; these inter-urban services better suited to continuation towards Didcot/Swindon etc.

Note: For the avoidance of doubt, all the above are assumed to run at half-hourly intervals

One might expect electrification to Oxford to lead to conversion of the existing Didcot shuttle to electric operation, but that removes one operating possibility. It also leaves two possible shuttles from the north (Banbury and Carterton) but only one from the south (Cowley). From an operating efficiency perspective, it might appear better to link the Banbury service to Cowley, since the running time to/from Banbury is 28 minutes (which, after inclusion of turnround time, does not fit easily into an hourly pattern) whereas that to/from Carterton is 22 minutes (which does fit). However, critically, the Banbury local service only operates hourly, whereas both the proposed services to Carterton and Cowley are expected to run half-hourly (although ORCS noted that the latter might not run at weekends, as it largely serves an employment area). Such local services to both destinations might also have cross-Oxford traffic potential (for both residents and employees) to/from the Cowley branch, further stimulating demand.

We have therefore taken a stand-alone Carterton service as the base for this study, with through-working to Cowley analysed as a sensitivity test.

6.2.2 Timings on the branch

Preliminary estimates of Oxford – Carterton journey time produced by the Witney Oxford Transport Group suggest an end-to-end time of around 23 minutes. The minimum acceptable time for planned turnrounds on the British railway network for a short train is generally 7-8 minutes, reflecting the c. 4 minutes actually needed for all the activities required, plus an allowance of 3 or so minutes to help recover from delays. This would then enable a trainset very efficiently to complete a return trip in an hour. Two trains could therefore provide a half-hourly service.

Our initial disaggregation of the proposed 23-minute Oxford - Carterton running time is set out in Table 10 below. If a half-hourly service is to be run, then we can also deduce that trains must pass each other en route.

Table 10: Expected running times Oxford - Carterton

From	To	Running time (mins)	Stop time (mins)	Cumulative time (mins)
Oxford	Wolvercote Jc	5		5
Wolvercote Jc	Jericho Farm Jc	2		7
Jericho Farm Jc	Eynsham	3	1	11
Eynsham	Witney	6	1	18
Witney	Carterton	5	7	30

Although minimising platform occupation time at Oxford is an objective, so is the need to maintain reliability. In theory, it would be possible to have a longer turnround time at Carterton, and a shorter one at Oxford, but that might jeopardise reliability, since one would expect the more complicated nature of operations at Oxford to be more likely to generate delays. If the Carterton service were to operate as a shuttle, seeking something like a 6-minute turnround at Oxford therefore seems sensible. If the Carterton service ran to/from Cowley, then trains would need to pass somewhere in the vicinity of Oxford station.

This leads on to a consideration of the optimum location on the branch at which trains might pass. We note that:

(i) undertaking works on a greenfield site will be cheaper than those involving the operating railway;
(ii) best practice for regular-interval timetabling is for trains to depart each end of the line at the same time;
(iii) getting trains to pass at (or in the vicinity of) a station, where they are running at lower speeds, reduces the magnitude of any knock-on delays, as trains will not have to spend so much time braking and re-accelerating (with all the concomitant energy implications).

All of these principles suggest that a location just off the existing Oxford – Worcester line would be appropriate for trains to pass. In particular, it would be ideal if that section of double-track could include the station to serve Eynsham/Saltcross. Should trains have to wait to pass an opposing one, they could do so in the platform, enabling passengers to continue boarding. The timings above show that this should be possible at Eynsham, being 11 minutes' running time from each end of the line.

The Carterton end of the line is obviously unconstrained regarding other train movements. The timetable can therefore be designed around two slots at Oxford station, half an hour apart. At present, this works with departures at xx:00 and xx:30 from each of the line, but obviously changes to train services may affect this; nevertheless, an increase in the number of platforms available should make platforming easier. We also note a specific suggestion that the need for platforms at Oxford to take long InterCity trains might even offer an opportunity for them also to take two shorter local trains e.g. the Carterton branch train at the north end of a platform, and a local to London at its southern end.

6.2.3 Train service performance

Ideally (and certainly later during the business case development process) one would want to model train services in the Oxford station area, in order to be more confident of high-quality operation. Unfortunately, at present, there is not even agreement about the expected future base level of service (excluding Carterton), never mind at what times past the hour that services might run. However, any indication that there is at least one possible timetabling solution would give confidence that a robust service might be operated in practice.

Table 11: Possible timetable

Minutes past the hour	Northbound train	Minutes past the hour	Southbound train
08-09	XC to Birmingham 4 DM	02	Paddington starter 3
13-16	Terminate from Padd 4 DM	07	Local to Didcot 4
18-20	Banbury 5 DR (from siding)	13-16	XC to Southampton 3
21-24	Terminate from Didcot 4	23-26	Carterton – Cowley UR

Minutes past the hour	Northbound train	Minutes past the hour	Southbound train
24-30	Cowley – Carterton 5 DR	24	Freight TL
27	Freight TL	27-32	Worcester – Paddington 3
38-39	XC to Birmingham 4	37	Local to Didcot 4
42-45	Worcester 5 DR	39-40	ex Banbury 3 – siding
51-54	Terminate from Didcot 4	43-46	XC to Southampton 3
54-00	Cowley – Carterton 5 DR	50	Freight TL
58	Freight TL	53-56	Carterton – Cowley 3 UR

DR = Down Main; DR = Down Relief; TL = through line

6.3 Trainsets required

The above analysis demonstrates that the business case for any re-opening options for the Carterton branch should be based on having two trainsets in service. Whilst it would be sensible to make passive provision for physical infrastructure to accommodate longer trains, the operating costs developed below are on the basis of 2x2-car trains.

6.4 Operating costs

6.4.1 Development of operating cost assumptions

The determination of appropriate operating costs is a key element in understanding scheme viability, since these need to be significantly lower than expected revenues, if the latter are (over time) to pay off the capital costs. This is where assumptions about the type of train to be used matter significantly. Key amongst these is train length: many costs (e.g. capital repayment, track access) are broadly a direct function of the number of carriages. It is therefore helpful if these can be minimised – subject to providing sufficient capacity for the expected demand even in the peaks, although limited standing may be acceptable.

At this point, it becomes clear that use of 5-car IEP trains would be significantly more expensive than shorter local trains, whilst their enhanced on-board facilities are not really needed for such relatively-short journeys. Longer trains would require longer platforms with associated increases in capital and maintenance costs, and although Selective Door Opening could be used to prevent doors opening that are not at a shorter platform, this would result in a very poor customer experience if used in this way on a permanent basis.

Discussions with rail industry stakeholders confirmed that this study should assume 2-car operation. The existing costs of operation with Class 165 diesels were available, but there was also emerging evidence of the trials from the operation of Class 230 units on the Greenford branch.

Unfortunately, the time-period of this study coincided exactly with the demise of Vivarail, the company negotiating to provide branch-line trains for the Thames Valley area. Their two-car Class 484 battery trains based on ex-London Underground 'D' stock are ideal for operating the proposed service to Carterton. Whilst Vivarail's assets were subsequently bought by GWR (the TOC expected to use them), that purchase took place only a few weeks before the end of our original study, and detailed data on their expected operating costs was still not available.

We have therefore had to make assumptions about train operating costs based on data received from FGW in respect of branch line operations with Class 165 DMUs. These assumptions should be revisited once better data is available on battery-type operation e.g. of the ex-Vivarail trains. All the calculations below are based on an expected extra 1000 vehicle-miles per day for a half-hourly operation to Carterton; this is the product of an 18-mile journey, 2 directions and about 28 return trips per day (averaged over the week – say 30 Mondays – Fridays, 28 on Saturdays and 16 on Sundays). Given an allowance for Bank Holidays, engineering works etc., 51 operating weeks per year have been assumed, giving a total of 356,000 extra vehicle-miles p.a.

6.4.2 Infrastructure maintenance costs

We have assumed that, once constructed, the new infrastructure becomes the responsibility of Network Rail and that the relevant Train Operating Company (TOC), expected to be Great Western Railways (GWR) would recoup NR's costs through the payment of mileage-based track access charges. Based on existing track access charges as set out by the Office of Rail and Road (ORR) for the current control period, a 2-car train of motored vehicles would be expected to be charged around 15p/ vehicle mile. As an order of magnitude, that is around £50,000 p.a.

6.4.3 Station costs

These are expected to be limited to the direct costs of cleaning and minor maintenance. In addition, further annual costs arise from overheads, relating to back-office costs such as insurance, fares-setting, lost property, customer correspondence, periodic safety inspections etc. FGW advised in April 2023 a typical figure of £100,000 per station per year.

6.4.4 Train leasing costs

These might vary considerably, dependent upon the outcome of the negotiations between the DfT/GWR and the Vivarail administrators, as to the actual current residual value of the Vivarail fleet. However, it is usual for leasing costs to be of the order of £10,000 per vehicle per month. Although only 2x2-car trains are needed for service, a contribution also needs to be set aside for part of trainset set aside for a maintenance spare, but spread across several Thames Valley branches[5]. This project should therefore probably bear the leasing costs of 5 vehicles, which equates to around £600,000 p.a. An update from GWR in April 23 gave £176,000 per vehicle per year (i.e. £880,000 p.a.), but this is being queried, to see if it includes Intercity Express Project (IEP) trains, known to be more expensive.

6.4.5 Train cleaning & minor maintenance costs

From work with other TOCs, we understand that these typically cost around £0.70 per vehicle mile, so had allowed £250,000 p.a. However, April 23 figures from GWR quoted only £0.16 per vehicle mile, plus a further fixed £10k p.a.. That would give about another £60k p.a. for the fleet which, spread across 356,000 vehicle-miles, is another £0.17 per vehicle mile, totalling £0.33/vm, or £117,500 in this category.

6.4.6 Traincrew costs

As the intermediate stations are not expected to be staffed, we have assumed that trains on the Carterton and Cowley branches would, in addition to the driver, have a second person on board, at least to deal with revenue and passenger service issues.

FGW advised that a team of driver and conductor now cost around £125,000 p.a. to employ. It is difficult to see how, given the requirement for meal-breaks etc., it could take fewer than six sets of crew to operate the 30 round trips on any particular weekday. Adding to that the 7-day/week nature of operation, we expect that 9 teams of staff would need to be allocated to the full Oxford – Carterton service, for which we have set aside £1,125,000.

6.4.7 Train fuel/power costs

Emerging evidence and academic consensus suggests that battery traction should be of a similar, or perhaps lower, cost to diesel operation. FGW advised that fuel costs of a Class 165 would be expected to be £0.62 per vehicle mile, on the assumptions of 0.73 litres/vehicle mile and fuel at £0.84 per litre. That leads to an annual total of £220,720 p.a.

6.4.8 Summary of operating costs

In total, the operating costs of the Carterton service are expected to be as in the Table below. Operating costs for a truncated service to Eynsham have been proportioned down from the figures shown above for the full service, but taking into account some indivisibilities e.g. in the provision of spare trains.

Because the data was eventually supplied in April 2023, but our other calculations (e.g. engineering costs) are based on q4 2022 prices, we modified the values in Table 12 to £1.6 and £2.7m p.a. (reductions of 2.5% and 1.5% respectively) to reflect a comparable price reference date.

[5] One advantage of using a 2-car train of a type used elsewhere in the Thames Valley is that the cost of maintenance spare trains can be spread across several other branches (e.g. Henley, Marlow, Windsor), so the Carterton branch does not need to bear the entire cost of a trainset.

Table 12: Estimated operating costs of half-hourly Oxford – Carterton Service (in £'000 p.a.)

Cost Category	Eynsham	Carterton
Track Access	25	50
Track Access	25	50
Traction	110	220
Train Leasing	600	880
Train Cleaning/Minor Maintenance	58	117
Traincrew	750	1,125
Station Maintenance & Overheads	100	300
TOTAL	**1,643**	**2,742**

7 Appraisal

7.1 Overview

Government requirements for railway appraisals are that they are based on underlying economic parameters contained in the Treasury 'Green Book' and WebTAG website, and follow a 5-dimension business case, considering in turn:

- Strategic Dimension: does the scheme fit with other strategies and policies? (section 3)
- Economic Dimension: does the scheme have economic benefits substantially in excess of its costs?
- Financial Dimension: what is the impact on public finances?
- Commercial Dimension: can commercial arrangements be put in place to fund the scheme?
- Management Dimension: is the scheme physically implementable?

The earlier sections of this report have provided the background to each of these business case elements, enabling this section to undertake appraisal against them.

However, what has become clear in examining this proposal is that it is not solely a rail, or even a transport, scheme. Improvements in the A40 corridor are an *economic enabler* in the Oxford area, in the same way as the Docklands Light Railway (DLR) has been for London's Docklands, and Metrolink has for the Trafford and Salford Quays parts of Manchester.

7.2 Strategic dimension

Transport schemes might reasonably be considered in the Oxford – Carterton corridor to address the significant travel needs of a population forecast to expand. Oxfordshire CC's climate emergency policy requires decarbonisation to be a key element of that, so a public transport solution is to be preferred.

The existing A40 busway scheme is a vital first step in maintaining the competitiveness of bus services, in the light of road traffic conditions which are expected to deteriorate significantly (a.m. peak car journey times are forecast to be lengthened by 30 minutes within the next 10 years).

However, by around 2031, the bus service will be operating at economic and practical capacity (18 buses per hour) but more capacity will still be needed; such greater capacity would be provided by a rail mode.

If Oxford already had a light rail system, it could have been considered for extension towards Witney, but the overhead (e.g. new depot) costs associated with that indicate that this would not be cost-effective, and even if it were in place, the journey times are unlikely to be as good as the heavy rail proposition.

A ('heavy') rail solution, sharing existing track as far as the Yarnton area, and sharing trainsets as part of a wider Thames Valley branch line fleet, therefore seems to satisfy all the major strategic objectives and would be in line with the OCC Rail Strategic Statement (see Appendix B). Further, a rail solution is likely to have the backing of a wide range of commercial, political and other organisations in the region, as evidenced by the list of supporting letters to the WOTG (see Appendix D) following their original study.

7.3 Economic dimension

7.3.1 The WebTAG economic appraisal methodology

Conventional transport economics are dominated by a comparison of capital and operating costs against the time saving benefits provided by system enhancements. For public transport schemes, the extra revenues gained are also important, not only in providing another category of benefit, but also in their ability to cover future operating costs. Wider socio-economic benefits includes: generating new businesses and associated jobs; improving access to current jobs to sustain existing businesses; enabling economic development (either of new sites or through regeneration of old ones); reductions in social exclusion (by providing access to jobs within a commutable time and without need of access to car use); reduction in road accidents; and, addressing climate change. The DfT (2020, p.14) estimates that replacing each pass-km by petrol car with an equivalent by train saves ≈150g of CO_2. All of these effects are of increasing policy interest, even if many of these are more difficult to quantify.

Whilst noting these extra factors may be important benefits and even purposes of a new railway, the quantification and apparent independence of the Benefit:Cost Ratio (BCR) mean that BCR is nevertheless a dominant factor in determining whether a project should proceed or not – *but only if the relevant factors can be included*.

As noted above, the A40 transport corridor is an economic enabler, and the standard WebTAG appraisal method only considers marginal Wider Economic Benefits; this is inadequate and inappropriate here. Moreover, doing nothing is not a practical option. Oxford's economy (together with the economic ability of residents of West Oxfordshire) is already being constrained by travel difficulties, problems which will only be exacerbated as traffic on the A40 gets worse. The gross cost of constructing a railway is therefore not the appropriate cost to put in an appraisal – one needs to net off the costs of not doing a railway, as opposed to "doing nothing", as well as taking into account the expected contribution from Land Value Capture resulting from the increase in accessibility.

The DfT's WebTAG method is a formalised process designed for transport appraisals, and provides output tables relating to Public Accounts, Transport Economic Efficiency and Analysis of Monetised Costs and Benefits for the 'base case' (2031 Oxford – Carterton service, operated as a shuttle). Importantly, however, it only includes the very marginal WEBs included within conventional transport appraisal, and so is only one of the scenarios we present in the section about sensitivity tests.

7.3.2 The real 'Do-Nothing' comparator

The traditional approach described in the preceding section, however, is flawed, because it assumes the entire cost of the rail scheme to be an optional investment. In this case, doing nothing seems likely to lead to an increase in unemployment rates, and/or a reduction in the vitality of businesses within Oxford, as the city is unable to get people where they need to be efficiently.

A rail scheme such as this should therefore be compared against other reasonable transport alternatives designed to address the same issue. From the commentary expressed earlier in this report (e.g. see section 3) and summarised in the table in section 7.7 below, few if any of these alternatives are either physically-realistic, consistent with the other policy objectives set, or actually appear to achieve the desired outcomes. However, what is clear is that any such other alternatives are also not cheap. It is difficult to see how any such schemes could cost much less than £500m in capital and £1m p.a. in operating costs. Notional figures such as these are therefore a more realistic base against which to compare the rail scheme discussed here. Nevertheless, given the uncertainty around those figures, we present only some scenarios in the sensitivity testing section below.

Any of the transport alternatives, however, are likely to be justified (or not) on the land-use/ employment/ business benefits. To gain an understanding of the scale of these, we have calculated the value of each job created/saved. This has been achieved by taking the average GVA per head of Oxford and West Oxfordshire (source: ONS) and scaling it up to provide an NPV[6], in an analogous fashion to the other wider benefits in WebTAG. This is a specialist activity beyond the scope of this study, so at this stage, we have simply examined scenarios with notional numbers of those jobs saved/created.

Nevertheless, if one were to hypothesise that the rail scheme might unlock (say) 6,000 residential homes that could not otherwise be provided for lack of reasonable transport infrastructure, and only 10% of these contained a single individual undertaking a job that they could not otherwise have accessed, this might be considered as evidence of the scheme directly generating 600 new jobs, for which the GVA would be in the order of £660M. Although it requires further specialist assessment, if these assumptions were at all realistic, it would have a very significant impact on the overall economic case, almost completely balancing the railway least cost case.

7.3.3 Land Value Capture

A significant improvement in the quality of transport in the A40 corridor is expected to impact both on Oxford city (city centre shops, the business park etc.) in terms of enabling the sustainability and growth of employment centres, and upon West Oxfordshire (primarily residents) in terms of improving their accessibility to jobs and other facilities. One way of capturing this economically is through the increases in value of properties. Taxing the occupants of existing properties is relatively difficult, but there are already mechanisms in place to enable

[6] At £37k/job/year for 30 years, each job generated or sustained by the scheme would broadly add about £1.1M in GVA.

local authorities to recoup from developers some of the appreciation in the values of new properties (e.g. in the Carterton area). Recent work by E-Rail (2023) has demonstrated how significant that could be, in the A40 corridor, that value typically being worth about ¼ of the expected scheme cost. This significantly changes the economics of this scheme as well as the financial measures, as described in 7.4.

7.4 Financial dimension

Importantly, the annual revenues of a rail-based option are forecast to exceed the operating costs, so that continuing subsidy would not be expected to be required. However, there are clearly significant capital costs to be sourced.

Presentation of the financial dimension is provided to make explicit the impact on the taxpayer (within which, Central Government, Network Rail, Oxfordshire CC and West Oxfordshire DC have different impacts) and other participants. This is clearly a project which will need significant funding from Government (either central or local) but (especially for the more Westerly phases) might also attract contributions from Land Value Capture, which could reduce the burden on the public purse.

A recent study by E-Rail (2023) indicates that around £200M might be expected to be forthcoming in LVC contributions from around the stations assumed in our analysis. This is necessarily concentrated in the Carterton area, since developments at Saltcross are already under construction and therefore past the point of being able to provide such contributions. A key factor in the effectiveness of capturing land value is where other funding is unlikely to be sufficient, or permission to develop is unlikely to be awarded without the scheme in place.

7.5 Commercial dimension

Given the financial shortfall identified in the previous section, one needs to consider how a funding package might be put together. Expenditure on several years' worth of planning and subsequent construction will obviously need to precede any income from new rail revenues, and those will clearly only pay back the capital over many years with difficulty (if at all). Whilst Network Rail is expected to incorporate the newly-created assets in its portfolio when the project is completed, only then will it be (partly) repaid for its increased ongoing maintenance. Working with ORR, adjustments to its Regulated Asset Database will then need to be made, to ensure robust future infrastructure funding.

At present, various parties are already involved in the scheme, and initial planning works will need to be paid for (probably by Oxfordshire CC) before a full application for funding of the main scheme is put to Central Government. We understand that a separate study is already underway to investigate the potential for Land Value Capture for sites yet to start development, and that has the potential significantly to reduce the total sum being sought from government.

7.6 Management dimension

Although there are many parties involved, discussions with stakeholders were unanimous in the view that the only appropriate organisation for taking this project forward was Oxfordshire County Council. The District Council is too small/does not have the resources, and current train operator FGW cannot be confident of continuing to be the operator throughout the life of the project. The scheme is not part of the funded national rail network, so this is not an obvious Network Rail project.

We should recognise that there are some practical difficulties with this scheme, the risks of which will need to be managed. These include:

- Detailed negotiations with land-owners and neighbours;
- Disruption during construction;
- Maintaining political support through various election cycles;
- Ensuring that the appropriate organisations have access to, and budget for, the required funds from now until project completion (an indicative project plan is available separately), making due allowances to keep track with inflation;
- Seeking contributory funding, and particularly investigating the potential for Land Value Capture in relation to developments which have not started yet;

- Understanding the best balance between construction before all the expected developments are in place, and the need to provide funding in the interim;
- Coordination with the programme of development of a new type of 'not diesel' train for the Thames Valley rail branch lines;
- A need to work with Network Rail on issues such as timetabling, the physical infrastructure connection, and inter-actions between this scheme and other rail projects in the area (most obviously any upgrade to the North Cotswold Line)

7.7 Overall appraisal

At this early stage of appraisal, it is not necessary to have fully enumerated all costs and benefits, in order to be able to make some preliminary conclusions as to the relative performance of different modal options. A summary of these options, subjectively assessed against the measures of success set out in section 3.6, is shown below.

Table 13: Summary appraisal table

Criterion to be addressed	Do-nothing	Highway ('Do minimum')	Bus	Light Rail	Heavy Rail
Demand from increasing population					
Provides sufficient long-term capacity					
Climate emergency					
Provides time savings					
Convenience (frequency, quality, accessibility, connectivity)					
Enables economic development					
Ability to extract Land Value Capture					
Reduces social exclusion					
Improves transport safety					
Improves transport corridor resilience					
Construction cost					
Ability to implement given existing road & rail infrastructure and built environment					
Covers operating costs					

Colour coding: Black: fails to address the issue at all, contravenes one of the key objectives, or is unrealistically difficult; Red: poor outcome; Yellow: satisfactory outcome; Green: good outcome

It is clear from Table 13 that the 'Do Nothing' option leads to strongly negative outcomes against all criterion other than capital expenditure and ability to implement. However, despite the lack of 'up front' capital costs, the real costs of decline through economic and social stagnation will become more and more apparent over time.

The 'Do minimum' highway option provides limited improvement over the Do Nothing option, but generally performs poorly against most criteria. The one highlight in favour of a new highway (or expanded A40) is that users would find it very convenient – at least until it, too, becomes congested.

The bus option performs satisfactorily against most criteria but poorly in the critical areas of time savings, long term capacity, and transport corridor resilience. In other words, it might meet some short term need, but is not sustainable as a long term solution.

The light rail (tram/tram-train) option performs better than the bus in most respects, and if a light rail system already existed in Oxford then it would be worth considering an extension, but this is not the case nor is likely to be so and therefore it rates very poorly for implementation into the built environment. Another significant negative is its inability to deliver sufficient time savings to make the journeys from Witney and Carterton attractive enough to unlock sufficient benefits to make it worthwhile investing in the enabling infrastructure of a depot (with operational and maintenance staff) or the risk of introducing rails into central Oxford roads.

Finally, the heavy rail option scores generally well against most criteria, delivering journey time savings and capacity to provide accessibility, resilience, and speed. It comes at a significant price, requiring major interactions with other local infrastructure in specific locations, and will in part be reliant on first/last mile connectivity for its success. However, as a public transport scheme to complement existing transport facilities, the heavy rail option offers a wide range of benefits for a long-term solution supporting the sustainability of these three towns in West Oxfordshire.

7.8 Scheme scenarios and results

Although we have undertaken considerable work on rail options, transport options for the A40 corridor have significant elements of uncertainty. These include wider changes in land-use, employment and population (which are outside the scope of a traditional transport appraisal), what level of contribution from Land Value Capture might be appropriate, as well as what might be a realistic do-minimum situation. 'Do-nothing' by contrast in this context implies a significant and likely unacceptable reduction in economic activity, if local residents either cannot access employment, or have to disrupt family life in order to take advantage of acceptable car journey speeds only available at anti-social times of day.

It therefore seems appropriate to present a range of scenarios, since if this project is to proceed, it will do so on the basis of these wider considerations. In the table below, the capital cost of £692M represents the mid-point estimate of the least cost route. The mid-point of the high-cost route is £180M more, but this is slightly less than the potential LVC: this means that the BCR of the greatest cost options with this LVC contribution is the same as of the least cost options without it. The 'Do-minimum' cost is assumed to be a highway scheme at only £500M as derived in 3.4 and value of jobs created is derived in 7.3.2.

The demand figures which underlie this table are based round the central case of 570,000 trips p.a. leading to £3.9m rail revenue, which exceeds the estimated rail operating costs of £2.7m p.a. Travel time savings are valued at £1.2m p.a., whilst 1.4m car miles p.a. are expected to be saved with associated environmental and health benefits.

Table 14: Results table of scenarios, Carterton North - Oxford, 2033 at a 2023Q1 price base

Scenario	Rail option capital cost £m	Do-minimum capital cost £m	Land Value Capture £m	Jobs created/ safeguarded	Benefit:Cost Ratio
'Do nothing' with least cost railway	692	0	0	0	0.21
'Do minimum' offset with least cost railway	692	500	0	0	1.23

Scenario	Rail option capital cost £m	Do-minimum capital cost £m	Land Value Capture £m	Jobs created/ safeguarded	Benefit:Cost Ratio
'Do minimum' offset with least cost railway plus 10 new jobs	692	500	0	10	1.47
'Do minimum' offset with least cost railway plus 100 new jobs	692	500	0	100	3.71
'Do minimum' offset with least cost railway plus 100 new jobs and LVC	692	500	192	100	Financially positive
'Do minimum' offset with greatest cost railway plus 10 new jobs and LVC	882	500	190	10	1.47
'Do minimum' offset with greatest cost railway plus 100 new jobs and LVC	882	500	190	100	3.71
Greatest cost railway with 600 new jobs and LVC but no offset of Do-minimum	882	0	190	600	2.83

Table 14 demonstrates the limitations of the basic WebTAG appraisal method to capture the contextual benefits of this scheme. Whereas most transport schemes gain their benefits from marginal journey time improvements, the real benefit of this scheme is that of an *economic enabler*, unlocking sustainable development and jobs that are unlikely to exist without it. More than that, a failure to begin the process of enabling transport capacity and resilience in the A40 corridor is likely to steadily starve both Oxford and the West Oxfordshire towns of affordable homes and accessible jobs (neither of which is captures in the basic WebTAG approach as a benefit).

If the rail scheme is compared, not with an unrealistic 'do nothing' scheme, but a 'Do Minimum' scheme – which itself may not be a long term solution – the traditional BCR measure becomes more positive. If LVC is added to the mix, the BCR improves further. But it is the addition of jobs created or safeguarded by the scheme that makes the biggest economic difference. Even comparing against a hypothetical 'Do nothing' scenario, just 600 jobs plus LVC could potentially deliver the highest cost railway scheme with a BCR of 2.8. However, it is beyond the scope of this commission to define how many jobs might actually be created through the delivery of the railway, and our recommendation is that this forms the subject of the next stage of the project.

7.9 Route sensitivity tests

This section examines the more-detailed issue of variations in the project plan for, and operation of, the railway scheme only.

7.9.1 Staged approach to Saltcross only

Only running as far as Eynsham probably costs around 1/2 of the total operating costs, and only requires around 1/6 of the construction costs. Our modelling suggests that it provides for over 1/3 of the demand, the shorter-distance nature of the traffic means that those passengers only provide perhaps ¼ of the time savings and 1/8 of the revenue. However, that is likely to be an under-estimate, since some people from Witney might also be expected to drive to it, and such traffic could be encouraged by promoting Park and Ride at Saltcross.

Overall, though, the service would be expected only just to cover the marginal costs of operating it. Moreover, the low number of car miles saved provides few road congestion or environmental benefits, the latter exacerbated by the fact that trains only really provide significant environmental benefits when they are wellloaded. This makes an Eynsham-only option only valuable as a 'pump-primer' for a bigger scheme, or as a temporary terminus, enabling train services to start before the more complicated construction works in the Witney area are completed.

7.9.2 Through-working to Cowley

Whilst the change in benefits has been noted above, this option also provides a more-resilient service, since there is more time available at Cowley for train services to wait before their booked return journey. Note also that the use of shorter local trains for the Cowley service is more cost-efficient than of 4-car trains running to/from London Marylebone.

7.9.3 Increased demand

With formal forecasts for the longer term (2041) not available, all we have been able to do is to calculate the impact of a notional 10% increase in local population. From that, we estimate that the BCR of the main option would rise only slightly.

7.9.4 Route sensitivity results

A summary of the restricted transport-only results for the 2031 Base and sensitivity tests as described above is shown in Table 15. This is designed to show the marginal impact on the BCR of the different operational options. Extension to Cowley clearly improves matters, whilst only operating to Eynsham (although clearly a possible staging strategy) provides a poorer economic case than running further West.

Table 15: Base Model results, 2031

Test	Passenger Trips	Car miles saved	Travel Time Savings	Passenger Revenue	Operating costs	Operating Profit	BCR
units	'000 p.a.	m p.a	£m p.a.	£m p.a.	£m p.a.	£m p.a.	
2031 base	570	1.4	1.2	3.9	2.4	1.5	0.16
(i) Eynsham only	200	0.9	0.6	1.2	1.6	-0.4	0.10
(ii) Eynsham-Cowley	210	0.9	0.8	1.3	1.6	-0.3	0.15
(iii) Carterton-Cowley	620	1.45	1.8	4.2	2.7	1.5	0.19
(iv) 2031 base + 10%	630	1.55	1.35	4.3	2.7	1.6	0.18

8 Conclusions

8.1 Strategic

The strategic case for providing a rail link from Oxford to Eynsham/Saltcross, Witney and Carterton is founded on a range of fundamental principles:

- existing transport in the corridor is already under capacity pressure, but considerable further housing is planned
- road conditions are expected to deteriorate very significantly in the next decade (see Figure 12 below)
- only a public transport solution will meet OCC's environmental and climate emergency objectives
- the A40 bus priority scheme provides valuable short- and medium-term relief for public transport users but will soon reach the economic/practical limit of bus operation
- only a heavy rail solution can provide sufficient proportional and absolute journey time reductions
- these enable the wider social benefits (e.g. reduction in social exclusion, access to jobs, inward investment) to be realised
- a heavy rail solution will also appeal to a wider range of market segments, including as access to longer-distance travel
- there is no 'do-nothing' option: failure to act will lead to negative economic outcomes, and alternative means of avoiding these (e.g. road improvements) are of a similar order of magnitude of cost

Figure 12: Journey time comparisons 2021/2031 (sources: AECOM; Cadenza)

8.2 Demand & revenue

A station needs to be constructed relatively near into the centre of Witney if the railway is to attract its full complement of Witney residents *and* incoming passengers. The attractiveness of access to the railway will play a key part in its success, and thus care will need to be taken over the quality of likely walking and cycling routes from key origins within Witney.

The distance of the proposed station(s) at Carterton North from the existing town centre affects the ability of the scheme to attract traffic to the proposed rail service. This represents something of a trade-off between accessibility and impacts including cost. It is anticipated that care would be taken to ensuring the integration with local bus routes to enable efficient public transport first/last mile, and in particular the connectivity with RAF Brize Norton.

Nevertheless, the position of Carterton North station would support the provision of electronic signage strategically positioned alongside the route that drivers would take towards Oxford to indicate the current drive time to Oxford in comparison to the journey time by train. A similar strategy might be employed at Eynsham to encourage drivers to give up their planned journey and take the car instead.

8.3 Engineering feasibility

The approach taken in the engineering feasibility report has been appropriate for a high-level study of this nature and has been able to conclude that:

- There are viable route options for a resilient half-hourly service using battery trains
- The whole route costs are substantial but in line with comparator projects
- The whole route may be delivered in useful phases with Phase 1 in operation by 2033H1

8.4 Operability

Running through to Cowley has very significant advantages for the Carterton scheme. As well as increasing demand by providing more journey opportunities that do not require an interchange:

- it creates greater slack in the timetable, increasing expected service reliability;
- it increases the amount of time spent under the overhead wires, improving the case for battery operation;
- it reduces the amount of time required in the platform at Oxford, where platform space is limited;
- use of a 2-car train from Carterton to Cowley is also more cost-effective than a 4-car train from London Marylebone.

8.5 Business case

The business case has been evaluated in line with the DfT's standard WebTAG approach for this stage of the project. On this basis alone, which balances capital and operating costs with revenue and journey time savings, and compares the scheme with a 'Do Nothing' alternative, the overall BCR of the least cost scheme is relatively low at circa 0.2, though importantly the operating revenue is greater than the operational costs.

In practice, the forecast congestion along the A40, as the only significant transport infrastructure in West Oxfordshire, is set to increase to levels that mean there is no reasonable 'Do Nothing' scenario. Therefore, the scheme should be considered against the 'Do Minimum' scenario, which for the purposes of this analysis is assumed to be a highway widening or new road project costing. When considered against that more realistic alternative, the BCR improves dramatically to about 1.2.

However, what has become clear through the development of this work is that the primary purpose of this scheme is that of an economic enabler, in the same way as the Docklands Light Railway (DLR) has been for London's Docklands, and Metrolink has for the Trafford and Salford Quays parts of Manchester.

The factors that make it an economic enabler are:

- Constrained housing within central Oxford
- Constrained and deteriorating transport capacity on the A40
- Limited ability to provide additional housing at Carterton, Witney and Eynsham because of transport constraints
- Projected journey times from Witney and Carterton within the next ten years that are unsustainable for accessing jobs in Oxford

A railway would provide the capacity and journey times that would make living in Carterton / Witney / Eynsham and working (or studying, etc.) in Oxford a viable and sustainable way of life. Businesses could then invest in Oxford or the three towns knowing that employees could reliably and quickly get to work. In turn, that would unlock land for sustainable development to meet the needs for affordable housing, adding land value which could be used in part to support the delivery of the railway and economic value to Oxfordshire which is widely considered an unaffordable place to live for many.

If LVC is added to the mix, the BCR improves further. But it is the addition of jobs created or safeguarded by the scheme that makes the biggest economic difference. Even comparing against a hypothetical 'Do nothing' scenario, just 600 jobs plus LVC could potentially deliver the highest cost railway scheme with a BCR of 2.8. However, it is beyond the scope of this commission to define how many jobs might actually be created through the delivery of the railway, and our recommendation is that this forms the subject of the next stage of the project.

Although it would be more cost-effective and yield greater benefits to construct the whole railway in one project, delivery of the railway could be achieved in phases contingent on funding and suitable legal powers to build the railway, phases 2a and 2b likely being possible to do in separate phases but likely to be delivered together.

- Phase 1: Oxford – Eynsham
- Phase 2a: Eynsham – Witney
- Phase 2b: Witney – Carterton North
- Phase 3: Carterton North – Carterton West

8.6 Review against the project brief

The project brief was to: "to establish if there is a strategic need for the proposed railway line and any resulting investment required. It should clearly explain the drivers for the railway line and how it satisfies OCC long term policy objectives such as to consider how any route/stations fit with interchange opportunities, active travel and accessibility (in particular the Local Transport and Connectivity Plan (LTCP)".

8.6.1 Is there a strategic need for the proposed railway line?

Yes. The combination of rising demand within the highly constrained transport corridor of the A40 is set to reach practical capacity by about 2031, by which time journey time and reliability will be so poor that it is likely to have a significantly detrimental impact on the economies of Carterton, Witney, Eynsham and Oxford.

8.6.2 What is the investment required?

The infrastructure costs for the whole scheme are estimated to be in the order of £800 Million at a 2023Q1 price base. The engineering feasibility report describes how this may be broken into three phases of approximately £220 Million for Phase 1 to Eynsham, £480 Million for Phase 2 to Carterton North, with Phase 3 to Carterton West at £100 Million.

If progressed at pace through the next design and planning stages, Phase 1 could potentially be delivered by 2033, in time to relieve the capacity constraints, with the subsequent phases delivered by 2035, all depending on the planning strategy and suitable funding.

8.6.3 What are the drivers for the railway line?

The value of the railway as a solution is that it provides:

- A step change in the capacity of the transport corridor, with the ability to further increase capacity through longer trains for marginal additional cost
- Reduced journey times to as little as 23 minutes from Carterton, compared to approximately 90 minutes by bus
- A reliable journey time, unaffected by congestion or road traffic accidents
- A more sustainable transport solution in comparison to a highway alternative that would simply import more cars and buses into Oxford
- An enabler to position new development further from Oxford, while facilitating access to Oxford for jobs, leisure, health etc., contributing to social mobility
- A catalyst to support the economic development of Carterton, Witney, and Eynsham through local investment in jobs more easily accessible from up and down the line
    - A facility to enable MOD service personnel to access Brize Norton without needing a car, and their families to access local jobs
    - Potential opportunity to re-imagine the industrial estate in south Witney for higher density of jobs, and create a regional attractor bringing visitors by sustainable transport

    - Greater access to the businesses and research area envisaged adjacent to the Salt Cross development in Eynsham
- An opportunity to provide a practical and expandable solution to the detrimental economic impacts that A40 congestion is likely to incur within the next ten years.

8.6.4 How does the proposed railway line satisfy OCC long term policy objectives?

Oxfordshire's strategic policies for low-carbon accessibility around the county will be very difficult to achieve with further road development. However, the recognised need to deal with the anticipated increase in population and employment clearly requires some form of transport intervention.

The railway concept has been developed with integrated transport principles in mind, particularly considering how station locations may encourage active travel through safe and clear walking/cycling routes, but also providing integration with local feeder bus services at the stations so that those too far away to walk can still be connected to the railway.

An alternative highways-based strategy to meet capacity would require significant further A40 widening, or an additional major road, which would cost a similar amount to the railway, but be more disruptive to construct, increase parking problems in Oxford, conflict with OCC policy to reduce car travel, and be unable to provide the capacity or journey time benefits a railway would bring.

In summary, only a rail-based solution appears capable of delivering the benefits described while supporting more detailed policies about place-shaping and reductions in road traffic accidents, social exclusion etc..

8.7 Next steps

This document only reflects early work on the project. We have highlighted its innate value, but a good business case is dependent upon a true comparison with alternative expenditure which will be needed to avoid the economic deterioration of the area. Moreover, considerable areas of uncertainty remain, with objectives in the next stages to:

- Quantify the value of the wider economic benefits, such as new jobs and housing, and comparing the negative impact of a 'do-nothing' option;
- Carry out a land, environment and planning assessment of the potential route area to establish any high risk interfaces;
- Optimise the route alignment options and explore the potential for linkages with the ongoing Cowley re-opening project, since it appears that operation of the latter with a smaller local train would be more cost-effective than extending the journey of a larger, higher-specification train from London.
- Carry out a public consultation exercise on the route options;
- Continue to explore the potential contribution of Land Value Capture;
- Complete an Outline Business Case
- Take the scheme through a Transport and Works Act Order or similar planning instrument
- Prepare for delivery of the scheme, noting that this project is of a scale and type that could be delivered by a Special Purpose Vehicle organisation or other commercial consortium rather than Network Rail.
    - Procurement of delivery could take several different forms, with Design, Build, Operations and Maintenance grouped in different configurations
    - Procurement of construction would need to be preceded by a Final Business Case

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Appendices

A Introduction to the Generalised Cost Model (GCOST™) tool

This section includes a summary of the Generalised Cost Model (GCOST™) tool.

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The GCOST™ Model:
A Technique for Estimating Rail Passenger Demand

There are a several techniques for estimating the demand for railway services, ranging in scope, complexity and accuracy. There are two basic approaches – top-down methods using market data and bottom-up methods using data taken from individual passengers and residents.

Trip Rates

Perhaps the simplest way of estimating the demand for a service is through the application of trip rates. For a given size of population, the number of trips may be relatively constant. One might therefore estimate the number of trips at a completely new site from its population. The main problem with this approach is that it does not take into account the distribution of trips. For a railway network, with a limited number of stations and lines, this is a critical issue. If demand is not to the places that the railway serves, the size of the population is virtually irrelevant. Local pressure for stations may need to be resisted if the railway is in an inappropriate direction. For instance, residents of Soham in Cambridgeshire have long campaigned for a station, but trains would run between Ely and Bury St Edmunds. As the favoured destination is Cambridge, which would require a change of trains, the station is unlikely to be successful, and demand estimates based on its population will be misleading.

Gravity Model

The distributional element of trip-making is taken care of in a gravity model. This recognises that trip rates vary by distance as well as the size of population. The formula normally used for it is:

$$T_{ij} = k \cdot \frac{P_i \cdot P_j}{D_{ij}^2}$$

where T_{ij} is the number of trips between places i and j
P_i and P_j are the populations of the two places
D_{ij}^2 is the distance between the two places
and k is a constant.

This method enables rail planners to discern between alternative destinations. If these are not located on the rail network, then rail trips to and from them will not be assumed. However, the primary weakness of this approach is that it takes no account of service quality. In reality, the level of rail trips will also depend upon road speeds on parallel roads. Where roads are substantially improved, rail demand falls off; if the railway is subsequently upgraded, or the road gets congested, rail demand may build up again.

Network Models

In areas where there is a great deal of planning activity, it may make sense for a local authority or transport provider to set up a network model. This will contain information about the current number of trip ends, the networks of the different modes, and the service patterns of different public transport alternatives. As this data collection exercise is substantial, its costs make it too expensive for most applications outside metropolitan areas.

However, once collected, demand can be assigned across the network very easily, and estimates made of the potential use of new facilities and services. The demand may be assigned between modes using a **logit model**, which allocates traffic dependent upon the difficulty of using them. This latter is usually measured in 'generalised cost', which may be considered by the layman as an index of hassle. To the economist, it represents a measure of disutility. The mode with the least hassle (or least disutility of use) will be that which is favoured in an 'all-or-nothing' model. The logit model, however, is more realistic, in assigning demand across a range of modes, although of course that with the lowest generalised cost gets the largest share. The logit statistical function, however, also allocates significant amounts of traffic to alternatives which are close in generalised cost; conversely, as generalised costs increase, the proportion of traffic forecast to use them falls off steeply.

Stated Preference

The main weakness of a network model is its difficulty in representing qualitative elements e.g. seat comfort, the ability to listen to one's own music, lack of information etc. These issues, which are difficult to quantify, are collectively described as modal preferences. A second problem area associated with network models has been their deterministic nature e.g. if an alternative is better in generalised cost terms, then most traffic will be allocated to it. In reality, however, this may not occur, especially if the potential traveller has no experience of the new alternative. It may be, for instance, that it is intended to introduce a tram system, but most British residents have not travelled on a tram for generations. Its benefits may therefore not be understood.

By describing the constituents of tram travel, however (e.g. the quality of stops, the smoothness of the ride, the appearance of the vehicle), and trading these off against variables which are understood (e.g. fare), it is possible to ascertain valuations of qualitative elements of the journey. Stated Preference analysis is the recognised technique for doing this, but it does require considerable fieldwork and analysis if robust results are to be obtained. SP results fed into a network model whose mode choice is allocated using a logit function would, however, provide the best method available, if resources permitted.

The GCOST™ model

Many schemes and options, however, are only analysed at the feasibility stage. A full SP analysis at this level of detail would be prohibitively expensive. The Railway Consultancy Ltd has therefore developed the GCOST™ model, which is a time-efficient and cost-effective way of analysing options for new stations and services.

The GCOST™ model is a spreadsheet-based model constructed as a series of Excel worksheets (see below). Each of the first five comprises details of an element of the journey, for a range of pairs of key traffic origins (Os) and destinations (Ds). The data is collected separately for peak and offpeak conditions, and for the main modes involved e.g. car, bus, train, park & ride. Journey elements which may be appropriate include access (e.g. walking to the station), waiting, in-vehicle time, the number of interchanges, and public transport fares and car parking charges. The sixth sheet calculates the generalised cost for each O:D pair.

The seventh sheet contains some global information about trips, which can be adapted to the circumstances. It may be that Journey-to-Work data is available from the Census, or perhaps only settlement size data exists, in which case a gravity model would be used to estimate the likely volumes of traffic (by all modes) between Origins and Destinations. Critically, however, the main part of this sheet comprises a nested logit model, which allocates traffic between the various modes. It does this by 'nesting' similar modes, such as Car type and Public transport type modes, and using LogSum to find the probabilities of passengers choosing the different options.

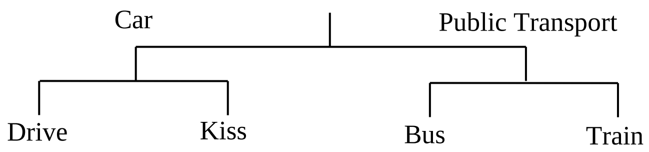


Figure 1. Nested Logit Model Structure

The model should be calibrated to reproduce existing data – a small-scale survey may be needed here, in order to ensure that the model is working correctly. Once calibrated, however, the model can be used to forecast new situations, by varying the input data to reflect options for the future – perhaps faster services, or a new station.

Subsequent pages of the workbook provide information on the base number of trips, the new number of trips and the difference between them – should one need it, for each Origin:Destination (O:D) pair examined, and separately for peak and off-peak conditions. However, caution needs to be expressed that forecasts at such levels of detail are less accurate than for the wider total. Similar sets of pages examine revenues (based on the differences in the number of trips multiplied by the known fares) and time savings (based on the differences in the number of trips multiplied by the differences in generalised costs). These are both key outputs for any appraisal, with private-sector clients more interested in the revenues, but wider economic appraisals required by Government often being dependent upon the time savings.

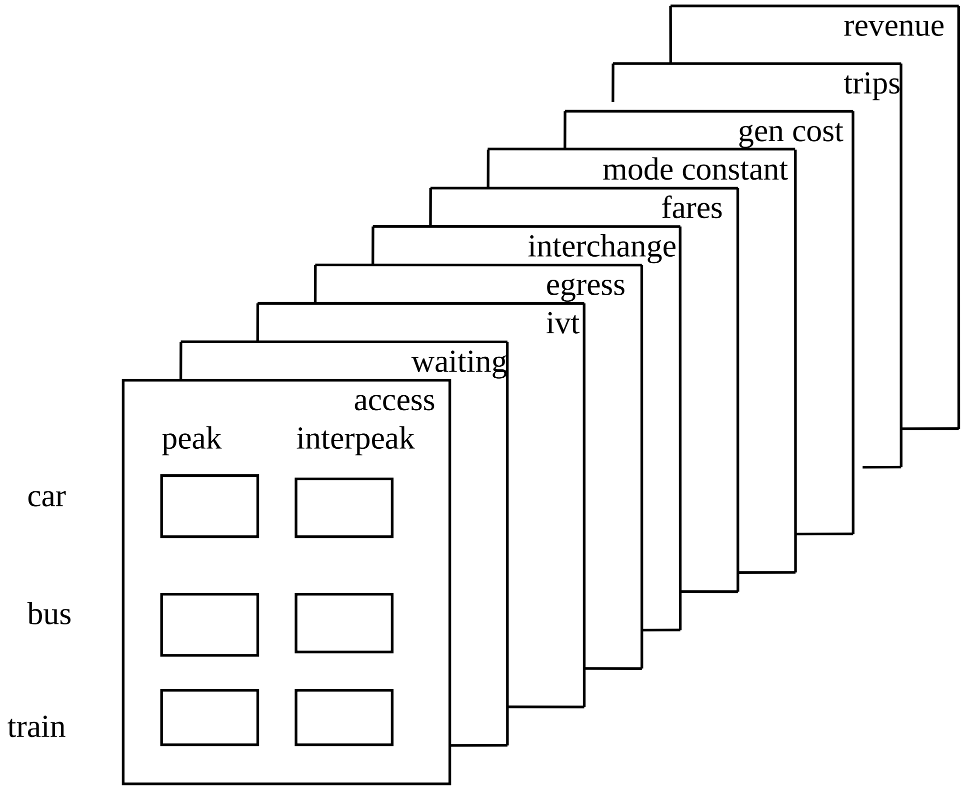


Figure 2. GCOST™ Model Structure

Two final pages examine the potential for newly-generated traffic. This occurs by scaling up the input fares elasticity (response rate) to estimate generalised cost elasticities for each O:D pair, and then applying those to the reductions in generalised cost caused by the new rail option.

Previous Experience

The general modelling approach used in the GCOST™ model is well-established, but has been adapted specifically for this purpose by The Railway Consultancy Ltd. It has been used on studies including:

- New park and ride station at Millhouses, Sheffield (South Yorkshire PTE)
- New platforms at High Meads, Stratford (London Borough of Hackney)
- New interchange station at Allerton (Merseyside PTE)
- Gospel Oak – Barking Line Development Study (Silverlink Trains)

- New station at Golborne (Greater Manchester PTE)
- Hyperloop route for Britain (UK Ultraspeed)
- Development of the St Albans Abbey line (Hertfordshire)
- New station at Pontrilas (Herefordshire)
- New suburban rail service in Mexico (private-sector promoter)

We believe that it is best suited for situations in which around 20 key traffic zones are required, although, up to 75 zones can be catered for. In larger applications, the data assembly exercise becomes quite onerous, but the required data can more easily be collated from appropriate network models, as occurred in the Allerton study.

B Oxfordshire County Council rail strategic statement

This section includes the rail strategic statement signed by the Leader of OCC and the Cabinet Member for Travel and Development Strategy for OCC.

Oxfordshire is committed to achieving a net-zero carbon future, with clear Council priorities including:

- *Put action to address the climate emergency at the heart of our work*
- *Invest in an inclusive, integrated and sustainable transport network*
- *Prioritise the health and wellbeing of residents*

To achieve this, enhanced connectivity will be needed for residents to access employment, education and services, enabling everyone to benefit from economic opportunities and a high quality of life. This will require a transformed, equitable and safe transport network based on provision of sustainable transport modes such public transport and active travel, rather than providing for private vehicles.

For West Oxfordshire, the key transport and connectivity corridor is that between Oxford, Eynsham, Witney and Carterton. The focus for planning improvements on this corridor over the last few years has been along the A40, with £180 million of investment planned for delivery over the next few years, including a new Park and Ride and bus lanes. These works support delivery of planned housing, particularly in Witney and Eynsham, and will significantly improve bus services on this corridor, reducing journey times and enabling bus companies to invest in higher quality and more frequent services.

However, these measures only deal with current pressures and the immediate future, and we now need to look longer-term, and understand whether rail could have a complementary role on this corridor by enabling further sustainable public transport choice and achieving the required behaviour change needed to deliver our policy goals. The Council is committed to exploring the potential for how rail can achieve these aims.

The Strategic Outline Business Case will be the first stage in understanding whether there is potential for a rail solution between Oxford and Witney and Carterton. It will show not only whether a rail link would be a deliverable proposition, but also whether it could complement delivery of sustainable development and access to high quality jobs. The County and District Councils will carefully review conclusions from the work to see whether to take rail proposals forward to the more detailed stage.

Liz Leffman

Cllr Liz Leffman
Leader, Oxfordshire County Council

Duncan Enright

Cllr Duncan Enright
Cabinet Member for Travel and Development Strategy, Oxfordshire County Council

OXFORDSHIRE COUNTY COUNCIL

C West Oxfordshire District Council statement of support

This section includes a statement of support from West Oxfordshire District Council to examine the railway opportunity further.

WODC statement of support for preparation of Strategic Outline Case 'Lite'

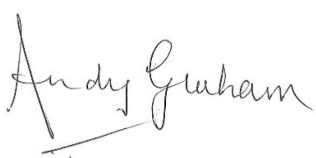
The District Council strongly supports the work which is being undertaken to further explore the potential for a new rail link between Carterton, Witney and Oxford.

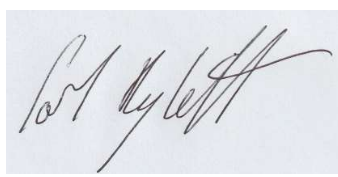
The Council declared a climate emergency in 2019 and reducing our carbon emissions from road-based transport is vital if we are to meaningfully tackle the emergency and help meet the 2050 national zero target.

Our current Local Plan recognises the traffic problems experienced daily along the A40 and the environmental and economic impacts this has. This is reflected in the plan's vision which aims to reduce reliance on the private car by providing improved opportunities for walking, cycling and public transport.

Whilst Oxfordshire County Council's A40 smart corridor project will clearly go a long way towards meeting this aim through bus priority measures and enhanced cycle and pedestrian routes, it is sensible to consider what more can potentially be done in the longer-term, including the part that a rail-based solution could possibly play.

The preparation of this study is very timely as the District Council is in the early stages of reviewing its Local Plan through to 2041. We look forward to further discussing the outputs with Oxfordshire County Council and other key stakeholders and whether or not a rail-based solution is a technically feasible and financially viable proposition that we should be looking to take into account through the preparation of our new Local Plan.





COUNCILLOR ANDY GRAHAM
Leader of the Council

COUNCILLOR CARL RYLETT
Executive Member for Planning & Sustainable Development

D List of other statements of support

Previous work by the Witney Oxford Transport Group attracted letters of support (available on request) from the following organisations (in alphabetical order):

- Carterton Town Council (Nov 2020)
- Englands Economic Heartland (Mar 2021)
- Eynsham Parish Council (Dec 2020)
- Great Western Railways (Mar 2021)
- Grosvenor Strategic Land (Feb 2021)
- Lord Mayor of Oxford (Nov 2020)
- Oxford University (Feb 2021)
- Oxfordshire County Council (Mar 2021)
- Oxfordshire Local Enterprise Partnership (Mar 2021)
- RAF Brize Norton (Oct 2023)
- Witney Town Council (Dec 2020)

The wide range of political, commercial and other organisations in support of this scheme is impressive, and points to a consistent view of the benefits a railway scheme could bring to the area.