Carterton-Witney-Oxford Line SOC 'Lite'

Oxfordshire County Council

Engineering feasibility report

V2-0 FINAL

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Glossary of terms

Acronym or Term	Meaning
AFC	Anticipated Final Cost
BEMU	Battery Electric Multiple Units
Cadenza	Cadenza Transport Consulting Ltd
CBP	Common Boundary Point
Crossover	A crossover is a pair of turnouts pointing towards each other on adjacent tracks, connected by a short straight section of track in the middle, to allow a train to cross over from one of the tracks to the other
CSM	Common Safety Method
DCO	Development Consent Order
DfT	Department for Transport
Double junction	A double junction connects one pair of tracks to another pair of tracks. It is an efficient way to connect two dual track routes where a flyover junction is not justified
EEH	England's Economic Heartland
EWR	East West Rail
GTE	Guided Transit Express
HIF2	Housing Infrastructure Fund
LEP	Local Economic Partnership
LTCP	Local Transport and Connectivity Plan
LVC	Land Value Capture
MOD	Ministry of Defence
NCLTF	North Cotswold Line Task Force
OBC	Outline Business Case
OCC	Oxfordshire County Council
OPEX	Operational Expenditure
ORCS	Oxfordshire Rail Corridor Study
OSR	Options Selection Report
PROW	Public Right of Ways
RAF	Royal Air Force
RMM	Rail Method of Measurement
RNEP	Rail Network Enhancements Pipeline
Single lead	A single lead junction connects a single track to the nearest track of a dual track 'main line'
SOBC	Strategic Outline Business Case [the predecessor to the SOC]
SOC	Strategic Outline Case
SOC-L	Strategic Outline Case – 'Lite'
Turnout	A turnout is a piece of track equipment (also sometimes referred to as a switch, or set of points, or junction) that allows a train to turn off one track onto another
TWAO	Transport and Works act Order
WODC	West Oxfordshire District Council
WOTG	Witney Oxford Transport Group

Executive Summary

An emerging need

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 are frequent but slow, especially at peak times, and there is no realistic alternative. The population in Carterton, Witney and Eynsham will have increased by between 14% and 55% from 2018 to 2028, and there is further pressure on the West Oxfordshire District to meet more of the county's housing provision in future. The forthcoming A40 widening project providing bus lanes and a new Park and Ride site will make public transport journeys more competitive and provide some short-term mitigation, but this is only buying time before capacity is reached again, circa 2031.

An exploratory study

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 Restoring Your Railway funding.

Oxfordshire County Council (OCC) set the brief of this study as 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' (SOC-L) format "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 for different routes. The SOC-L study has considered non-heavy rail modes at high level and concluded that heavy rail is the most suitable mode for investigation within this engineering report.

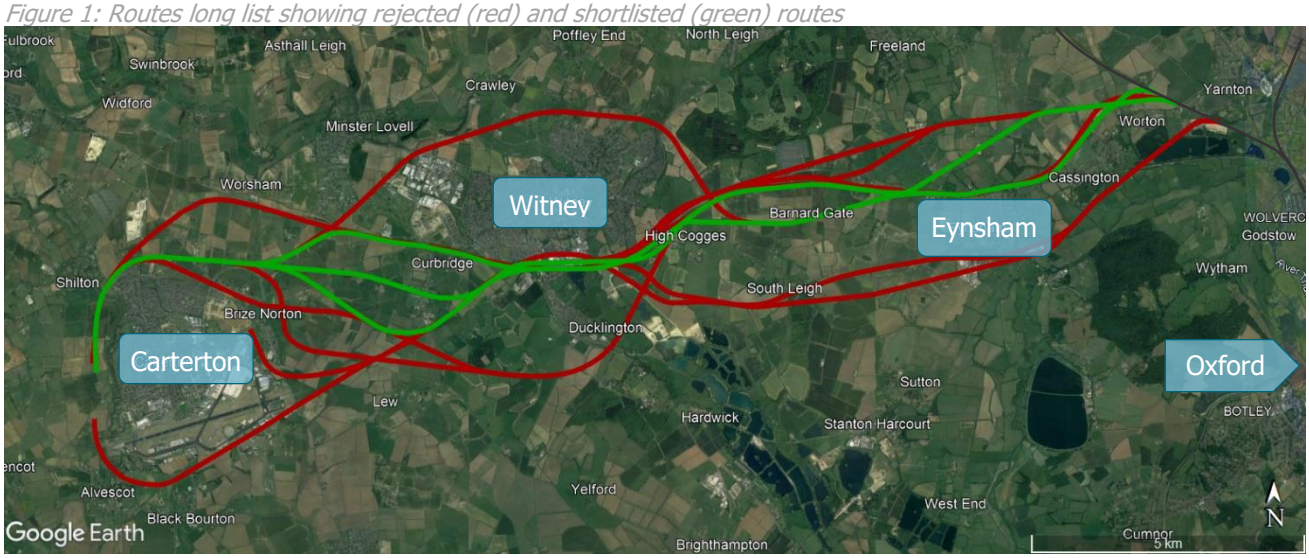
This engineering report is a component part of the SOC-L, primarily through the Financial Dimension aspect of the business case workstream. The wider aspects of demand, revenue, operations, journey time, and economic value are discussed as part of the five-dimension business case analysis in the SOC-L report. It is not the role of this study to develop or select a preferred route, but rather to assess whether there are viable railway options and if so to understand the likely range of costs of delivery.

A structured and objective approach

The project team began by reviewing relevant recent engineering studies for the A40 corridor and eliciting initial views from a wide range of stakeholders. The team worked with OCC to define the project mission statement as to "Provide a frequent and reliable rail service between Carterton and Oxford via Witney and Eynsham". This has set the overall goal of the project from which supporting requirements are derived.

The development of route options began with identifying potential station locations in and around the three towns, and then a long list of route strategies to target these locations. From this long list, some were rejected where they were unlikely to adequately meet the project requirements (Figure 1).

Figure 1: Routes long list showing rejected (red) and shortlisted (green) routes



The shortlisted options were divided into route sections for assessment of the likely linear form of construction (viaduct, embankment, at grade, cutting, tunnel) and other discrete costs such as stations, accommodation bridges, etc. for each section option. The different Route Section options could then be assembled in different combinations to evaluate the longest / shortest whole route combination for a rough check on journey time compatibility, and least / greatest cost whole route combinations to understand the likely cost range.

Figure 2: Whole route costs to Carterton West with Low, Mid, Upper Risk (@ 2023Q1 price base)

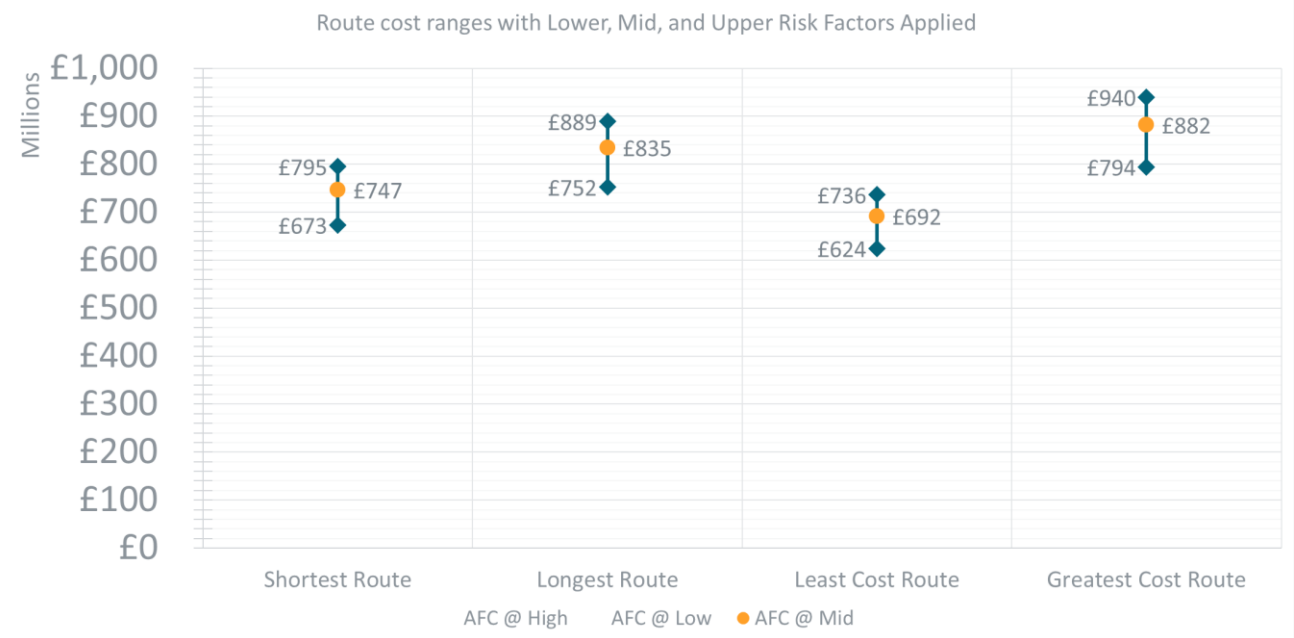


Figure 2 illustrates the whole route costs from the connection to the Cotswold Line at Yarnton through to a new station at Carterton West with interim stations at Eynsham, Witney, and Carterton North. These costs are at a 2023Q1 price base and exclude most land costs other than an allowance for the actual railway footprint. Any future construction cost estimation would therefore need to adjust these figures by actual or projected inflation to the point of delivery. The overall costs were compared at high level with two other new route projects in the UK to validate them and were shown to be in an appropriate range.

A pragmatic delivery plan

These are significant sums, and so the project team has considered phasing options along with a nominal delivery programme, summarised in Figure 3 and Table 1. The three-phased approach would encourage different funding solutions and enable the project to be delivered in more manageable packages.

Figure 3: Potential route phases

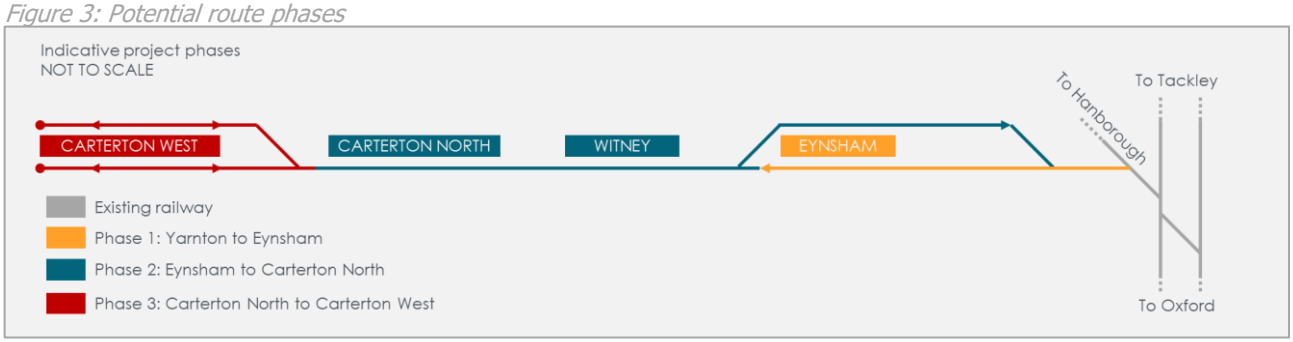


Table 1: Phased route costs at Medium risk level (@ 2023Q1 price base)

Potential phases	Least cost route	Greatest cost route	Delivery
Phase 1: Yarnton to Eynsham	£180M	£250M	2033H1
Phase 2: Eynsham to Carterton North	£420M	£540M	2036H2
Phase 3: Carterton North to Carterton West	£100M	£100M	2036H2

A positive output

The approach taken in this engineering study 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

An urgency to delivery

Nevertheless, for the timely delivery of this scheme it will be important to identify suitable funds to ensure progress is made while funding for the bulk of the scheme can be found. Such funding is often contingent on having the greater robustness of analysis from an Option Selection Report and Outline Business Case.

The 2021 AECOM report[1] for OCC (see SOC-L report for further discussion) indicated that the A40 enhancement schemes would reach practical and operational capacity by 2031 – just eight years away at time of writing. By that time, car journeys from Carterton and Witney will be taking 30 minutes longer and more than doubling car journey time from Eynsham. Bus journeys from Carterton will be nearly 1.5 hrs, and nearly 1 hr from Witney. These travel times could well have progressively damaging effects on the economies of Oxford and the towns along the A40 as people relocate, or do not take up jobs that require travel, or do not visit shops etc.. They could also increase pressure for housing closer to Oxford in order to reduce commuting time, and make it ever harder for the RAF to encourage their Service Personnel's families to live in or near Brize Norton. In short, failure to accommodate growth may precipitate decline.

Fortunately, it would be possible to deliver the first part of this railway by 2033H1 to relieve some of the pressure, and within a few years following, to deliver the rest of the railway for a more sustainable, productive and valuable local economy. But only if the scheme is developed at pace. Railways and other major infrastructure are long-lead projects taking up to a decade and crossing several political cycles.

It is therefore worth encouraging cross-party support wherever possible, along with local businesses and communities through a planned cycle of communications and engagement to build a sense of enthusiasm and ownership over several years. To achieve this, it will be necessary to accelerate the project through the next development stages because doing so will maximise the ability of the railway to deliver the capacity, journey time and economic benefits needed before the A40 corridor is simply unable to meet the travel needs of the people it serves.

[1] AECOM (2021) "A40 Smart Corridor Scheme, Transport Assessment", report for Oxfordshire CC, November

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 so 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 imminent upgrade of the 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 capacity again in 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.

Oxford 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.

Version 1-0 of this report was issued 30 March 2023 to accompany the 'Strategic Outline Case-Lite' (SOC-L) report[2] and two-page summary both issued on the same date prior to receipt of some operational cost and other data with the agreement of OCC. The follow-up SOC-L report captures the data received and addresses review comments kindly provided by the Network Rail 'Restore Your Railway' team and the WOTG.

By agreement with OCC the engineering costs in this report version 2-0 have not been recalculated for inflation over the last few months, though the delivery programme has been amended to reflect the extension of the SOC-L work and some other minor refinements have been made to the main text to aid clarity.

1.2 History of the route

Historically, there was a railway connecting the four residential centres, but it was closed to passenger services in 1962 (just prior to the Beeching cuts) and to freight in 1970.

Since then, the railway has been built over in several places, most notably at Witney, where the original spur and some of the through route has been cut off by the A40. At Eynsham, the historic railway ran to the south of the town where the B4449 has been built along the railway alignment, and some industrial development has taken place. Remaining land near where a station might be located is either in a flood zone or an ancient monument. At Carterton, the railway ran to the south of the Brize Norton air base, on the far side of the runway from the towns of Brize Norton and Carterton, and the airfield has been extended across the alignment. All of these changes have led to the historic route becoming impractical to rebuild a railway on to suit the modern need.

Population growth in the three towns is set to grow by between 14% and 55% from 2018 to 2028, and there is further pressure on West Oxfordshire District (WOD) – within which these towns are located – to meet more of the county's housing provision in future.

A previous study commissioned by OCC in 2014 to look at potential transport options between Witney and Oxford considered a variety of rail, bus and other transport solutions, concluding that in the longer term a guided busway might be a practical solution, with greater flexibility in accessing the towns within the corridor, but that a heavy rail solution could also be beneficial if demand warranted it.

[2] 2213-410-001 CWORC SOC-Lite report v1-0

The work by WOTG suggested that a scheme might be developed with relatively little direct property take, and provide a useful future alternative to the A40, providing a step-change in the corridor transport capacity and resilience. WOTG's work did not assess costs in any detail but it did explore the possibility of unlocking funding through a Land Value Capture (LVC) approach, designed to agree contributions with landowners who would stand to gain increased land value from the delivery of a railway.

1.3 Brief

OCC set the brief of this study as 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 (SOC) – 'Lite' format "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 was to be informed by the previous work, but not bound to it, so as to enable freedom in the development of ideas and solutions for different routes. The SOC-L study considered non-heavy rail modes at high level, but concluded that heavy rail was the preferred mode for investigation within this engineering report.

1.4 Purpose and structure of this document

OCC has asked Cadenza Transport Consulting Limited ("Cadenza") to prepare the SOC-L study. This engineering report is a component part feeding into the SOC-L, primarily through the Financial Dimension aspect of the business case workstream.

The structure of this report broadly follows the sequence of engineering activities undertaken over the four months of the study by the project team in responding to the brief.

In chapter 2 we summarise our review of the previous relevant engineering studies, noting that although the concept of reopening the former rail route has been discussed for many years, there have been no detailed studies of a rail scheme. Multi-modal studies of the A40 corridor have previously rejected a rail scheme on the grounds of cost and anticipated low traffic volumes. Since those studies, however, housing has increased and demand has risen to a point where the previous demand data is no longer valid and hence the conclusions may not be either.

In chapter 3 we describe the methodology taken to develop the engineering work and cost estimations. We describe the process of gathering relevant contextual information including the site visit, and the development of a mission statement with associated supporting requirements. This chapter also includes an explanation of the development of options from station locations, to a long list of routes, to a short list, and the breakdown into Route Sections for closer analysis and pricing before recompiling Route Sections into whole route options for overall assessment.

In chapter 4 we describe the options within each Route Section before setting out the reference whole route option costs in chapter 5. In chapter 6 we propose a phased approach to delivery with an indicative programme.

In chapter 7 we 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

The wider aspects of demand, revenue, operations, journey time, and economic value are discussed as part of the five-dimension business case analysis in the SOC-L report.

In the final chapter, chapter 8, we set out at high level the next steps that would be necessary to take this project forward.

1.5 Image credits

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

2 Review of relevant engineering studies

2.1 Outline Pre-Feasibility Study, Mott MacDonald (2001)

In 2001, Mott MacDonald was appointed to carry out an Outline Pre-Feasibility Study for Oxfordshire County Council and West Oxfordshire District Council of a new rail link between Oxford, Witney and Carterton/Brize Norton with the objective of identifying major physical barriers along the former rail route, options for overcoming these, and to assess options for restoration of heavy rail services, a new light rail operation or a guided bus system (to be integrated with the then-proposed city-wide Oxford Guided Transit Express (GTE) GTE guided bus system).

It was noted that light rail and guided bus options would need to use the same route alongside the rail lines into Oxford as the GTE, and thus an integrated design approach would be required.

The study concluded that restoration of the heavy rail service presented unacceptably high impacts against questionable benefits and high construction costs, and this option was therefore discounted. It should be noted that the study assumed use of the former rail route with minimal diversion around obstructions, and that alternative route options on new alignments were not considered.

Light rail options suggested included partial use of the former rail alignment, new on-street routes in Witney and Carterton, together with shared running with heavy rail services from Yarnton Junction to Oxford (i.e. tram train, although that term is not used in the report). Potential light rail extensions within Oxford, as an alternative to GTE routes were also suggested, together with a possible extension to Abingdon.

A guided bus option, with a route broadly similar to the light rail option was also identified.

The study concluded that the then combined population of Carterton and Witney was too small to furnish the minimum patronage required for any form of fixed link to be financially viable.

2.2 Engineering Feasibility Study, URS (2015)

This is an engineering study of the A40 corridor between Witney and Oxford which identifies a number of strategies to address transport conditions along the route. Options considered include:

- Highway improvements
- Bus lanes and new bus routes
- Guided busway, tram train and heavy rail operations along the former rail alignment with diversions at Witney – on-street in Witney for tram train, new route south of the A40 for heavy rail – with possible extensions to Carterton

The previous 2001 pre-feasibility study for reopening the rail link was reviewed. In relation to the conclusions of the 2001 study URS did not accept that the heavy rail option should be discounted, viewing its impacts as broadly similar to light rail, but potentially more attractive to the West Oxfordshire demographic. They did however question whether the demand from Carterton and Witney could support a heavy rail operation, while noting that there is significant projected population growth for the area.

The report notes various rail industry aspirations for improved rail services in the Oxford area. These have been further developed in later studies, so are not reviewed here.

The report proposes providing a heavy rail route mainly using the former rail alignment, but noting that some diversions would be required, in particular at Eynsham and Witney (where the conflict with the A40 slip roads is noted), and recommended a new terminus between Brize Norton village and Carterton. New buildings on the rail alignment, and former railway buildings now used for other purposes may need to be acquired. It would probably not be acceptable to reinstate former level crossings, so road closures or new bridges are likely to be required. The potential alternative route following the A40 corridor, and passing to the north of Eynsham is noted.

Light rail/tram and guided bus options are also briefly reviewed.

URS advise that in their professional judgement a heavy rail reinstatement scheme would cost of the order of £6.2m/km excluding land/property and mitigation measures. Together with improvements on the existing route into Oxford and minor roadworks associated with the project they estimate the overall cost for a Witney to Oxford heavy rail reinstatement to be £150m. Corresponding costs for light rail and guided bus options were estimated to be £129-207m and £90-140m respectively. It is suggested that heavy rail and guided bus are the preferred modes, with light rail only being preferred if part of a wider Oxford area light rail network.

2.3 North Cotswold Line Transformation (December 2019)

https://researchbriefings.files.parliament.uk/documents/CDP-2020-0004/NORTH-COTSWOLD-LINE-TASK-FORCE-STRATEGIC-BUSINESS-CASE-DEC-2019_ISSUE_110120-(002).pdf

https://researchbriefings.files.parliament.uk/documents/CDP-2020-0004/NORTH-COTSWOLD-LINE-TRANSFORMATION_MPs-Briefing-Note.pdf

In December 2019 a Strategic Outline Business Case (SOBC) was submitted for the upgrading of the North Cotswold Line by the North Cotswold Line Taskforce, a body comprised of five county local authorities (including OCC), five Local Enterprise Partnerships, the Great Western Railway, Network Rail and the Cotswold Line Promotion Group, with support from DfT and the West Midlands Rail Executive. The scheme includes track doubling between Wolvercote and Hanborough (4 miles) and between Evesham and Pershore (5 miles), together with second platforms at Hanborough and Pershore Stations. This will allow faster train journeys, a two train per hour service from Great Malvern / Kidderminster to London via Worcester and Oxford, together with an up to 4 tph local service from Hanborough to Oxford/Didcot Parkway. The capital cost is estimated to be £199m including optimism bias, with a Benefit Cost ratio of 4.46.

The SOBC envisaged that a Decision to Develop would be taken by March 2020, but it appears that this his has not yet occurred.

2.4 Oxfordshire Rail Corridor Study (ORCS) (March 2021)

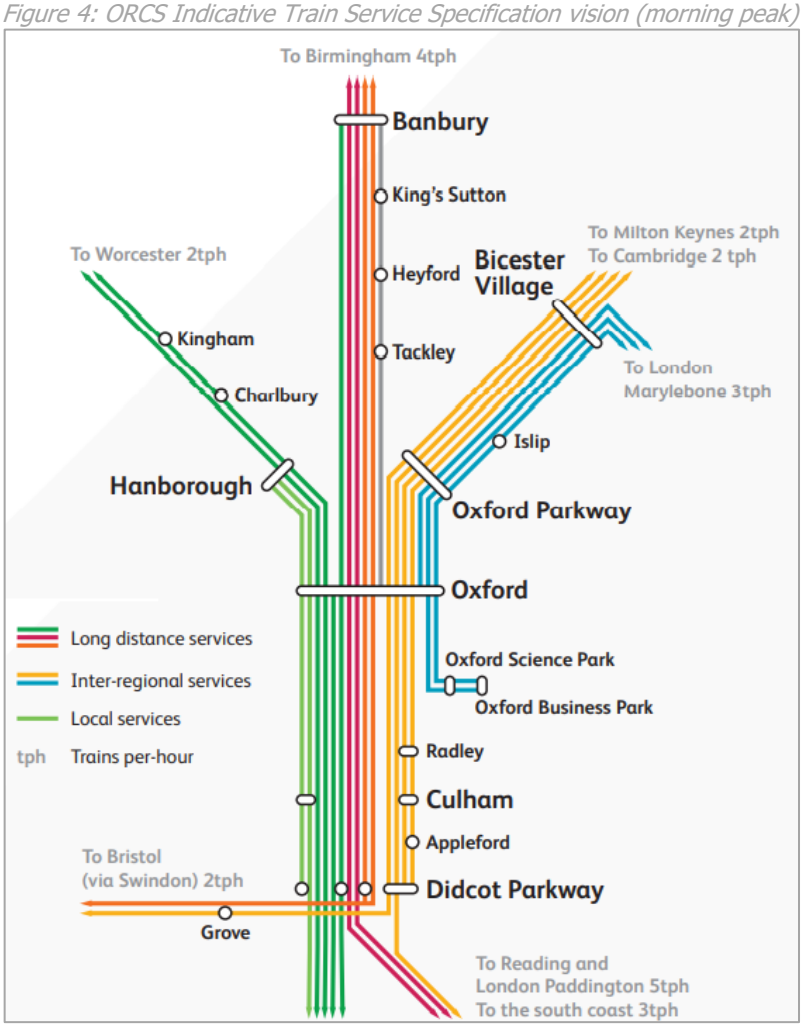
https://www.networkrail.co.uk/running-the-railway/our-routes/western/oxfordshire

https://www.networkrailmediacentre.co.uk/news/future-of-oxfordshire-rail-network-mapped-out-in-new-study

Oxfordshire Rail Corridor Study: Completion and Next Steps. Report of John Disley (OCC) and Andrew Down (Oxfordshire Growth Board Executive Officer Group) to Oxfordshire Growth Board, 22 March 2021

The Oxfordshire Rail Corridor Study (ORCS) looks in detail at the county's predicted growth in jobs and housing to present an industry vision for how the rail network can best support it looking at the potential requirements for Oxfordshire's future trains services in the medium (2028) and long-term (2033). Key requirements identified include improving connections across Oxford, especially linking Didcot Parkway to Bicester Village and Hanborough. The proposed 2033 indicative train service specification is shown in Figure 4. The study identifies increasing capacity at Oxford station as a vital first step to opening up the network for further growth.

Figure 4: ORCS Indicative Train Service Specification vision (morning peak)



The study's recommendations have been drawn together to form an overarching industry strategy for the county known as 'Oxfordshire Connect', which will be used to promote future investment priorities and help seek future funding through the Government's Rail Network Enhancements Pipeline (RNEP) and third parties. Subject to future funding and viable business cases, these could include additional services at Hanborough.

Doubling the tracks between Wolvercote Junction and Hanborough is seen as necessary to deliver the full train service specification, but is not identified as necessary to be implemented in the earlier stages.

In May 2021, the Department for Transport confirmed £69m of funding for Phase 2 of the Oxford Corridor Capacity Improvement Scheme, which is a package of rail enhancement schemes which provide extra capacity for the rail network as a base for further growth, plus additional facilities at the station and surrounding area.

2.5 Witney Oxford Transport Group Presentation

https://earth.google.com/web/data=MkEKPwo9CiExeEYzaTkyTWczRVYtOXNkaG9JRGcwcjlvcnVya2wzbzMSFgoUMDk0QzY3MDlENTE5QjNENDc0OUQgAQ

This presentation was developed by the Witney Oxford Transport Group (WOTG)[3], a voluntary, cross-party, community group set up by West Oxfordshire residents seeking practical solutions to the local transport situation. The Group notes that the district is extremely reliant on the already severely congested A40 with up to 32,000 vehicles per day using the route, a situation which will be further exacerbated by the more than

[3] Website at https://witneyoxfordtransport.org.uk

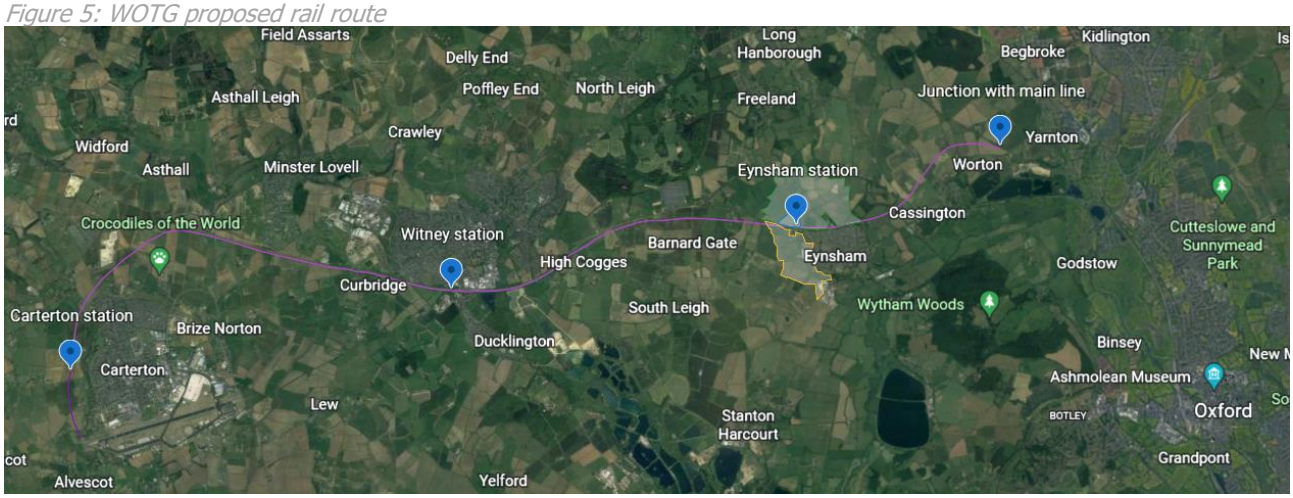
10,000 new houses to be built along the A40 corridor over the next ten years. The Group's key campaign is focused on restoring a rail link between Oxford, Eynsham, Witney and Carterton.

The presentation shows the Group's proposed approximately 24km (15 mile) route for a railway from a new junction on the North Cotswold Line north of Warton to stations at Eynsham, Witney and Carterton. The route stays as close as is practical to the A40 for almost its entire length. The route does not use any of the former rail alignment from Yarnton Junction to Eynsham and Witney, which passed to the south of Carterton.

The proposed route runs from a junction with the North Cotswold Line north of Worton, then passes to the north of Worton and Cassington villages to then run along the north side of the A40, and south of the proposed Salt Garden Village to a new station at Eynsham, integrated with the proposed A40 bus based 850 space Park and Ride site. The station would serve the existing Eynsham settlement, the proposed Salt Garden Village, and the West Eynsham Strategic Development area where 1000 homes are proposed.

West of the station the route would cross over the A40 on a heavily skewed bridge/viaduct crossing.

Figure 5: WOTG proposed rail route



The route then follows the south side of the A40, passing to the south of Witney, with a new station with Park and Ride proposed south of the A40 and west of the A415. The proposal here doesn't acknowledge the conflicts with the slip roads to/from the A40 westbound and the presence of hotels and other development close to the junction. As drawn, the route would need to be high enough to pass over the slip roads, which would result in an intrusive and costly viaduct over the junction area.

The presentation acknowledges that there are a range of options for the route and station location at Carterton. However no detail of options other than the Group's preferred route are presented, and there is no discussion of the relative merits of alternatives. In particular, a route running directly from the proposed Witney Station to a terminus on the east side of Carterton would be significantly shorter than the proposed route.

The route shown continues along the south side of the A40 from Witney to a point almost due north of Carterton, then turns to the south to a station located on the west side of the town. The report notes the potential benefit of extending the route to provide rail access into RAF Brize Norton, and indicates that the Station Commander is supportive. It is also suggested that if a light rail solution for passenger services was to be proposed, then the MoD should pay for upgrading the full route to heavy rail standards, to enable rail access to the airbase.

The presentation notes the environmental benefits of transferring traffic to rail, with the potential for operation of the line by battery powered electric trains.

The presentation notes that the proposed route passes close to only a very small number of residential properties. It is stated that the route is comparatively flat with modest undulation. A total of 17 new or altered bridges would be required, and the route crosses 14 footpaths and 5 bridleways.

The presentation notes the scale of planned housebuilding up to 2031, and the likely further building beyond, and suggests this amounts to an extra 10,000 homes in the area. Land Value Capture is proposed to part fund the new railway.

2.6 Restoring Your Railway Ideas Fund Application (March 2021): Witney Oxford Transport Group

This document was a submission, prepared by the Witney Oxford Transport Group, to the Department for Transport and Network Rail for funding to develop the case for a rail link from Oxford to Eynsham, Witney and Carterton. The submission related to the WOTG proposed scheme outlined in section 2.5 above.

The submission was sponsored by Layla Moran, MP for Oxford West and Abingdon, and it was stated that Robert Courts, MP for Witney, also supported the scheme, but as the then transport minister (2021) he was not able to formally sponsor the bid. The bid was also supported by local councils, Great Western Railway, RAF Brize Norton Station Commander, Oxfordshire LEP, England's Economic Heartland, Oxford University, the Lord Mayor of Oxford, Grosvenor Developments (Salt Cross Garden Village) and former Prime Minister David Cameron.

The bid document summarises the transport and economic case for developing a rail link, approximately 15 miles long (plus 4.5 miles of existing railway into Oxford Station) with a peak service of two trains per hour, serving new stations at Carterton, Witney and Eynsham, with Eynsham station to be integrated with the proposed A40 Park and Ride site. A potential freight link into RAF Brize Norton is also suggested.

The number of obstructions on the former rail route is noted, hence the proposed new alignment which follows the A40 corridor for most of its length.

WOTG claims firm commitments for a significant proportion of the funding required to develop a SOBC, which together with the DfT Ideas Fund funding would enable the SOBC to proceed. WOTG also believes that a significant Third Party funding contribution towards the scheme implementation cost could be available through the use of Land Value Capture in connection with the additional development opportunities around the station sites which the scheme would enable.

Indicative capital costs are provided, based on average per km capital costs from 2012 data. These include land acquisition, fees and a 40% estimating risk allowance, but do not include rolling stock. The total estimated cost is £348 million.

There is no estimate of operating costs or of benefits.

2.7 Technical Opinion by SLC Rail (October 2021)

This Carterton to Oxford Rail Corridor Technical Opinion report was commissioned by the Witney Oxford Transport Group.

This report assumes the general route for the rail alignment from Carterton to Eynsham as set out in the WOTG presentation described above.

The report examines three specific issues:

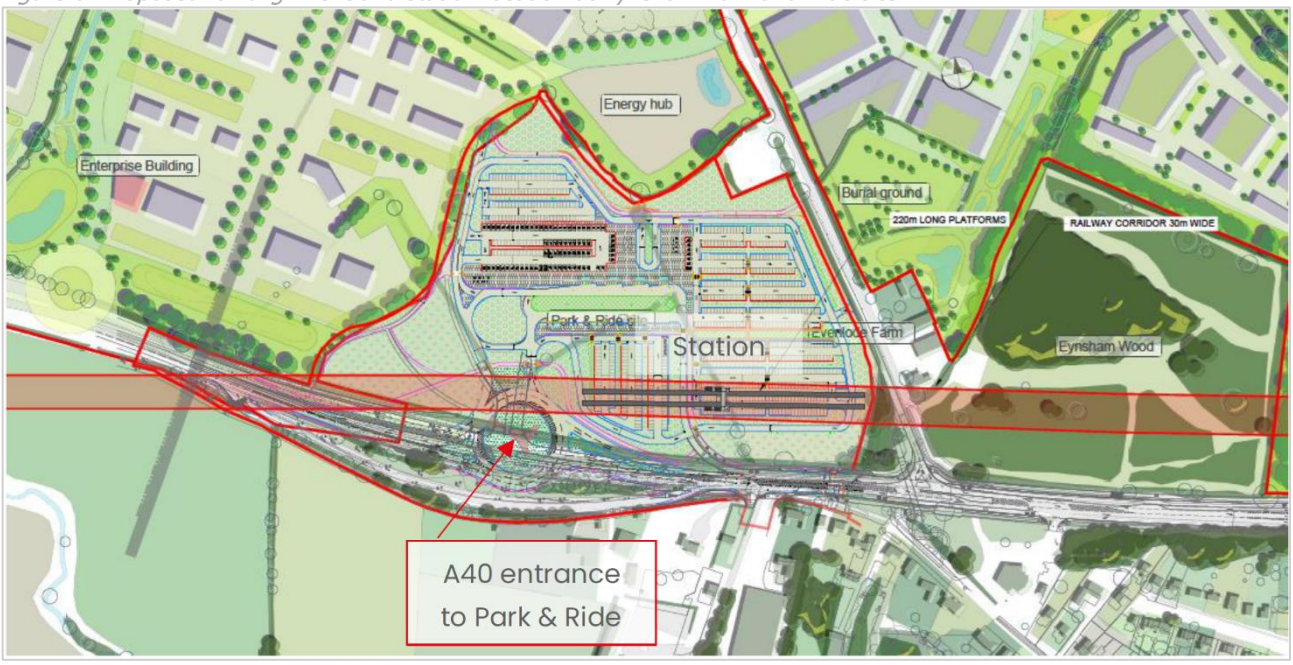
- Options for a new Eynsham station, located to the north of the existing settlement and integrated with the proposed A40 Park and Ride Site, and with good accessibility to Eynsham itself, the proposed Salt Cross Garden Village Development and the wider A40 corridor. The report also discusses a viaduct crossing over the A40 west of the station.
- Alignment options alongside the A40 east of Eynsham station, noting the interfaces with the proposed A40 upgrading and the Salt Cross Garden Village proposals
- Options for a connection with the National Rail network between Worton and Wolvercote.

2.7.1 Eynsham Station

The report proposes an alignment immediately to the north of the A40 and across the southern side of the proposed Park and Ride site, with a station located in the southeast corner, close to Cuckoo Lane. Two

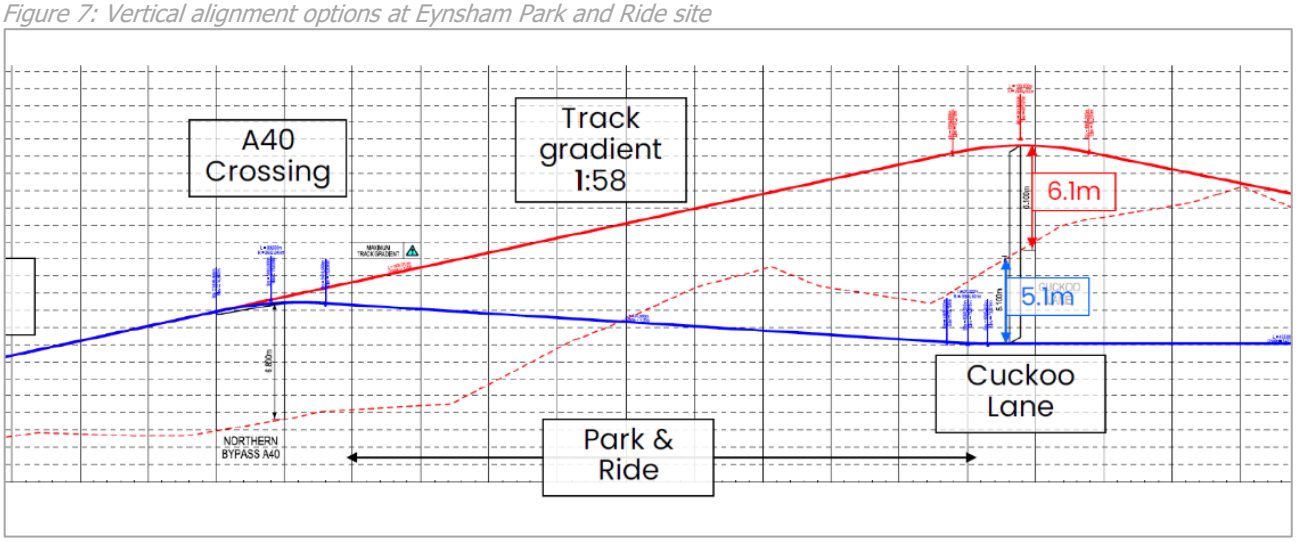
vertical alignment options are proposed, one passing over Cuckoo Lane, the other passing beneath it. Both options assume the railway would pass over the A40 to the west of the site.

Figure 6: Proposed rail alignment and station location at Eynsham Park and Ride site



Both vertical alignment options would locate the station on a gradient (1 in 58 for the over Cuckoo Lane option, 1 in 200 for the under Cuckoo Lane option), and this is unlikely to be acceptable. However, the vertical alignments were later modified in a subsequent study described in section 2.9.

Figure 7: Vertical alignment options at Eynsham Park and Ride site



In this 2021 study, it is noted that the presence of the rail alignment might require the vehicular access arrangements to the site to be amended.

No account appears to have been taken of the loss of space within the Park and Ride site, and the consequent reduction in parking capacity that would result.

Appendices A and B are more detailed plan and profile drawings of the proposed alignment from west of Eynsham to the junction with the North Cotswold Line.

2.7.2 Rail Route East of Park and Ride Site

The proposed route runs along the north side of the A40 south of the proposed Salt Cross Garden Village.

The report notes conflicts with other existing/proposed land uses:

- Crossing the Hanborough-A40 Lower Road
- Aligning with proposed layouts of Salt Cross Garden Village
- Potential land-use conflict between the route and the existing Tesco Express supermarket/filling station and two adjacent motor traders
- Eynsham Wood (Woodland Trust)

The report notes that the original rail alignment to the south of Eynsham is now partly used by the B4449, is located in the Thames/Evenlode flood plain, and does not provide the same opportunity for a modern widely accessible multi-modal transport interchange at the Park and Ride site. The WOT Group's proposed Witney-Eynsham-Oxford route would also require significant amendment to facilitate a station south of Eynsham. This option has therefore not been considered further.

2.7.3 Connection to National Rail

Four connection options are considered. The two southern options are rejected due to alignment issues at Wolvercote junction and environmental impacts.

Two northern connections are discussed, at Yarnton, on the site of the original railway junction, and north of Worton. For the Yarnton junction two route alignments are considered, one broadly following the former rail alignment and passing through the waste management site, the other diverting to the north of the waste management site, but then sharing the former rail route with the waste management plant access road along the alignment between two lakes. The former route has better geometry and higher line speeds, but impacts the waste management site. Both of these options would then run along the north side of the A40 through Cassington village, affecting up to 10 residential properties.

The preferred route passes to the north of Cassington and Worton, with minimal property impacts, and is clearly the best option for a route which runs north of the A40 at Eynsham.

The report also notes that Network Rail's Oxfordshire Rail Corridor Study proposes redoubling the Cotswold Line between Wolvercote North Junction and Hanborough, together with an increase in the frequency of Oxford-Worcester trains and a new 2 tph local service from Oxford to Hanborough. The report questions whether the local rail network could handle an additional Carterton – Oxford service in addition to these proposals.

2.8 RYR 368: Witney to Oxford (October 2021)

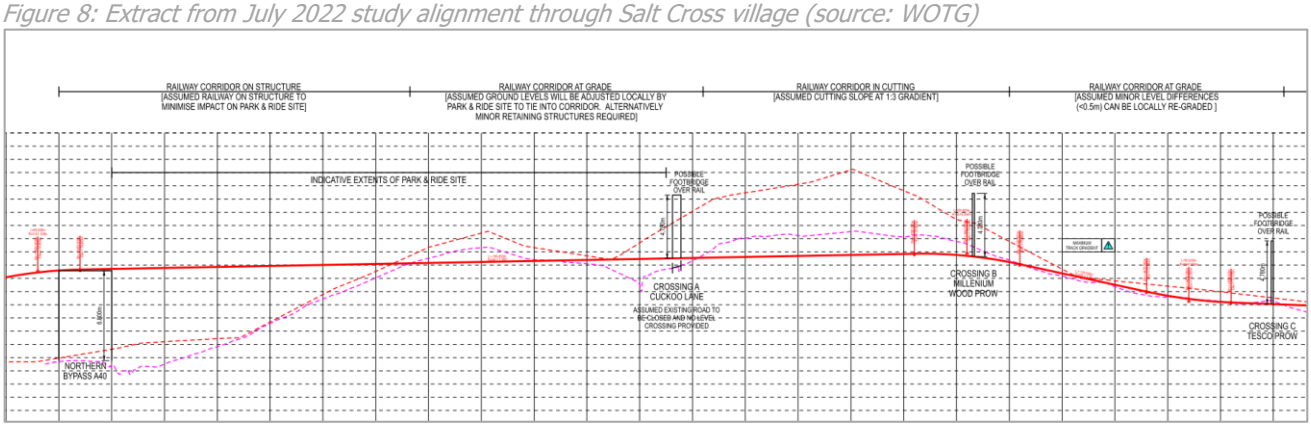
This document is a one page review, received in October 2021, by Atkins to DfT of the Restoring Your Railway Ideas Fund Application Third Round described in the previous section.

The overall comment was that the proposal sets out clear transport issues that the scheme would solve as well as supporting a number of large housing developments in the area (although these are not confirmed). Further consideration must be given to wider transport intervention in the area and the scheme's compatibility with these. The promoter has an understanding of issues still to be resolved, primarily timetabling and linking with the main line network and cost benefit analysis. There is good local support for the scheme and most authorities are on board, with some minor concerns raised by Oxfordshire County Council (OCC).

2.9 Carterton to Oxford Railway Corridor (July 2022)

SLC Rail provided WOTG with a brief study evaluating the route through Salt Cross Garden Village, refining their work from 2021, in particular the vertical alignment as shown in Figure 8.

Figure 8: Extract from July 2022 study alignment through Salt Cross village (source: WOTG)



In this update, the vertical alignment assumes that Cuckoo Lane will be closed, enabling an 'at grade' solution immediately north of the A40 which able to cross over the A40 to the west at the same level because the highway falls away with the natural topography. To the east, the railway continues at a similar level, crossing over Mill Lane and Lower Crossing road before returning to ground level.

2.10 A40 Improvements (July 2021-ongoing)

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

https://news.oxfordshire.gov.uk/plans-to-improve-journeys-between-witney-and-oxford-take-a-step-forward/

The A40 Improvements project comprises six major schemes with a combined cost of £180M, 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 currently under construction in Eynsham will provide easier access to improved and more reliable bus services into Oxford.
- 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.

In July 2023, the county cabinet approved a new plan to build the programme in phases, starting with dedicated bus lanes in each direction connecting with the Eynsham Park and Ride and Active Travel improvements.

2.11 Summary of previous studies

While the concept of reopening the former rail route from Oxford to Witney or Carterton has been discussed for some years, there have been no detailed studies of a rail scheme, and in multi-modal studies of the A40 corridor, rail options have generally been filtered out early on, mainly on grounds of cost and the perception that likely traffic volumes are insufficient to justify a heavy rail solution. Consequently, there has previously

been virtually no policy support for the scheme, and the public transport policies of local transport and planning policy documents are focussed on bus-based options on the A40, together with upgrading of existing rail infrastructure and improved train services.

Recent rail improvements in the Oxford area have been focussed on the East-West Rail scheme and capacity improvements at Oxford Station, which in turn will facilitate increases in services on all routes through the city. Proposals for substantial improvements to the North Cotswold Line (to which a Carterton-Witney-Oxford line would connect) have been developed with a strong business case, but it appears that there is at present no commitment to implement those proposals.

The construction of a new rail link is advocated by the Witney Oxford Transport Group, a voluntary community group, which has set out its proposal for an entirely new alignment from a junction with the North Cotswold Line near Yarnton, then following the A40 corridor to north of Carterton, then turning south to a terminus on the west side of Carterton. The group has commissioned limited professional studies of route options and submitted a Restoring Your Railway bid for funding for further scheme development, but the reasons for its choice of route alignment and the alternatives which may have been considered are not fully set out.

This current study seeks to build on this previous body of work, but not be bound by it. It is intended to fill in the remaining gaps at a feasibility level of investigation looking specifically at heavy rail solutions in order to understand what may be possible, and what it might cost.

3 Methodology

3.1 Information gathering

3.1.1 Overview

The bulk of this study has been completed over a period of four months, beginning with a period of information gathering. The purpose of this was to develop a clear understanding of the work that had been previously carried out, and the context of the scheme, along with agreeing the primary objectives and requirements for a new railway in this area. Initial views were sought from a range of stakeholders, with subsequent discussions and a site visit to gain familiarity with the study area.

3.1.2 Requirements

The review of previous studies is summarised in section 2 and sets the scene for the work in this study. Following this, the project team worked with OCC to develop a 'Mission statement' intended to succinctly capture the overall purpose of the project. This was agreed with senior leadership at OCC on 06 Dec 2022 as:

> "Provide a frequent and reliable rail service between Carterton and Oxford via Witney and Eynsham"

This was then developed by the project team along with OCC Officers into a longer list of requirements as shown in Appendix A. These requirements set the goals and framework for design development.

3.1.3 Stakeholder views

At the same time, the project team contacted a range of known and likely stakeholders through emails, telephone calls and meetings to understand their initial views about the prospect of a new railway between Carterton, Witney, Eynsham and Oxford. The project team contacted representatives of:

- OCC Councillors
- OCC officers
- West Oxford District Council Planning Team
- Witney-Oxford Transport Group (WOTG)
- Railfuture
- Train Operating Company (FGW)
- Network Rail
- Department of Transport (DfT)
- Ministry of Defence (MOD) / RAF Brize Norton
- North Cotswold Line Task Force (NCLTF)
- England's Economic Heartland (EEH)
- Carterton Town Council
- Eynsham Parish Council
- Witney Town Council
- Housing Infrastructure Fund (HIF2)
- Oxford City Council
- Witney North & East
- Witney South & Central
- Witney West & Bampton
- Burford & Carterton North
- Eynsham

- Carterton South & West
- Hanborough & Minster Lovell
- Wolvercote & Summertown
- Grosvenor (Salt Cross Village)

We are grateful for all the feedback we received and note the following themes and particular points of interest from responses:

- Local Councillors generally supportive in principle, but:
  - Concerned about cost and perceived implications of needing to accept additional housing to pay for it
  - A view that buses may be a cheaper and better solution
- NCLTF: Concern that the two projects might compete for market share and funding
- Network Rail: Supportive
- RAF Brize Norton: Sees an opportunity to reduce commuting to/from Brize Norton by car, and to assist service family members being able to access jobs / learning / leisure opportunities

It is perhaps not surprising that local Councillors are supportive but nervous about housing impacts 'to pay for it'. Significant railway projects are typically the most expensive infrastructure project that a local authority will have undertaken for a long time, and it is understandable that there should be a reluctance to see mass housing as the means of affording it. However, this view perhaps does not incorporate the context of economic benefits to the region as discussed in the SOC-L, or recognise the housing pressures that exist anyway, with the consequential impact that new housing (or the lack of it in the right places) puts on existing transport infrastructure. Similarly, it does not appreciate that failure to accommodate growth could result in precipitating decline.

The assumption that adding more buses to the A40 will meet the transport need in its entirety does not recognise that there is an economic and practical capacity to buses as a transport service – not least because there will come a point where it is not viable to turn the number of buses around in central Oxford, and because the buses are still using the A40 and hence do not provide resilience in the transport corridor.

We followed up the conversation with NCLTF with a technical discussion between the two study's demand analysts, who agreed that the concern about competing market share is not significant because the two schemes serve largely different markets.

The meeting with RAF Brize Norton revealed the extent of travel movements every day by car to and from Brize Norton, and similarly the practical difficulties of service families trying to balance the travel needs of service members accessing Brize Norton, while also enabling their family members to take up jobs in the area. The comment "Being in Carterton is quite limiting [for service families] because transport links are so bad" reflected the view that the buses are primarily for local connections and are not direct to anywhere, meaning that travel times to Oxford are too long to be practical. This can lead to journeys being taken by car, which is bad for pollution and congestion, or not being taken at all, which is bad for the individual and for the local economy.

The overall message from the initial engagement with Stakeholders is one of support for the opportunity and the benefits on congestion and travel opportunities for the local community, balanced with nervousness about the impacts it might have on the local environment through consequential housing development.

3.1.4 Site visit

Figure 9: View across fields close to a possible alignment option (source: Cadenza)

As the early station locations and potential route options were developed, we undertook a two-day site visit by car and on foot at publicly-accessible locations over the whole study area. This did not reveal any 'show-stopper' issues, but was valuable in appreciating the local topography and potential constraints for different routes.

Figure 10: View west along the A40 at the western edge of Eynsham (source: Cadenza)

3.2 Development of section options (pre-cost)

3.2.1 Station locations

The development of route sections began with the project team considering strategic locations where a station might be attractive for local residents and/or future residents if development were to take place nearby. Not every theoretically possible location was identified and assessed, but only representative station locations testing different strategies (see Figure 11).

Figure 11: Initial list of approximate potential station locations (blue circles)

These were assessed at high level without regard for whether a route to/from the station were possible. The purpose of this exercise was simply to identify potential target locations for the alignment to reach or come as close as reasonably practicable, rather than define a specific point to which a route must pass through.

3.2.2 Assumptions

Prior to preparing the alignments, various technical working assumptions were developed to support option development without being distracted by unnecessary detail to develop definitive answers at this early stage. Particularly important assumptions included:

- Two-car train units to run initially, with passive provision for four-car units in future. This leads to approximately 50m platform installed, with straight alignment for at least a further 50m in due course
- Trains will be Battery Electric Multiple Units (BEMUs)
- Single track railway, with strategic passing loops as necessary
- A journey time between Oxford and Carterton of 22/23 mins, allowing for some resilience in turnaround times at each end and a one hour round trip service.
- A battery charging point at Oxford via the anticipated overhead line electrification within the station
- A general line speed of 70mph (110kph), recognising that train speeds will be lower when approaching or departing a station. This helps define the minimum horizontal curvature of the track.
- A maximum gradient of 1%, so as not to preclude potential freight operations to Brize Norton at this stage
- No works required south of Yarnton Junction to Oxford, or are already committed by others (e.g. at Oxford Station)
- Trains can be stabled and maintained at an existing depot. i.e. no depot modification costs are included

3.2.3 Preliminary consolidation of section options

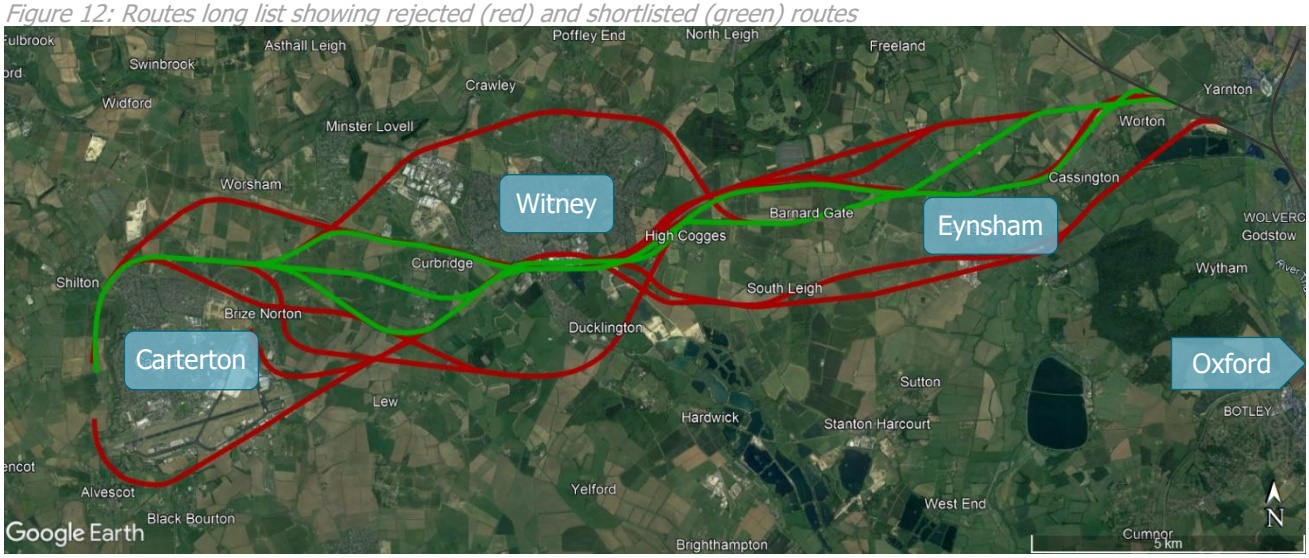
An initial 'long list' of alignment options was developed in plan only, to link the various potential station locations via reasonable routes.

From this long list it was possible to discard some routes fairly quickly on the grounds that they did not really serve the project objectives effectively.

- A route over the north of Witney was discarded on the grounds that it didn't really serve most of Witney, and being so long would result in an unacceptable journey time.
- A route to the south of Eynsham was rejected on the grounds that much of the available route would be on or near flood plain or an ancient monument, and the station would fail to serve the majority of Eynsham (including the planned Salt Cross and west Eynsham developments.

- A similar route to the north of the proposed Salt Cross development was abandoned as being largely inaccessible by existing residents of Eynsham.
- A route south of Ducklington was not pursued because it didn't serve Witney other than as a potential Park and Ride station located near the A40 to the east of Witney, and was relatively long. Since OCC made it clear they did not wish to encourage more car use, this route was considered unlikely to be a viable option.
- Variations on routes into the heart of Carterton were considered likely to be unviable because of evident development on the approaches, and the difficulty of crossing roads where bridges would be impractical given that the railway regulator, the Office of Rail and Road, will generally not permit new level crossings.

Figure 12: Routes long list showing rejected (red) and shortlisted (green) routes



This exercise resulted in a series of route options that each could be said to serve the project objectives and be likely to be practically viable. Nevertheless, following the site visit, the opportunity was taken to refine the short list alignment in response to risks and opportunities observed on site for the initial short list options.

3.2.4 Section boundaries

The short listed routes were then subjected to an internal peer review exercise leading to further refinement before settling on agreed alignments for assessment of costs. The process for cost development is described in section 3.5, but an interim measure was to break the routes up into five sections at Common Boundary Points (CBPs) where they intersected. This allows comparison of different options within a section, such that different permutations could be derived and easily calculated to form a range of end-to-end route combinations and associated costs in a manageable way.

3.3 Operations

3.3.1 Project phasing

The interface between operations and engineering is also influenced by the potential for phasing the project. For a project of this scale, it can be more palatable to funders to begin with a small affordable section as 'Proof of concept' but to anticipate future stages as subsequent opportunities.

The project team therefore considered that there could conceivably be three, or possibly four, phases as follows:

- Phase 1: Yarnton junction to Eynsham
- Phase 2a: Eynsham to Witney
- Phase 2b: Witney to Carterton North
- Phase 3: Carterton North to Carterton West

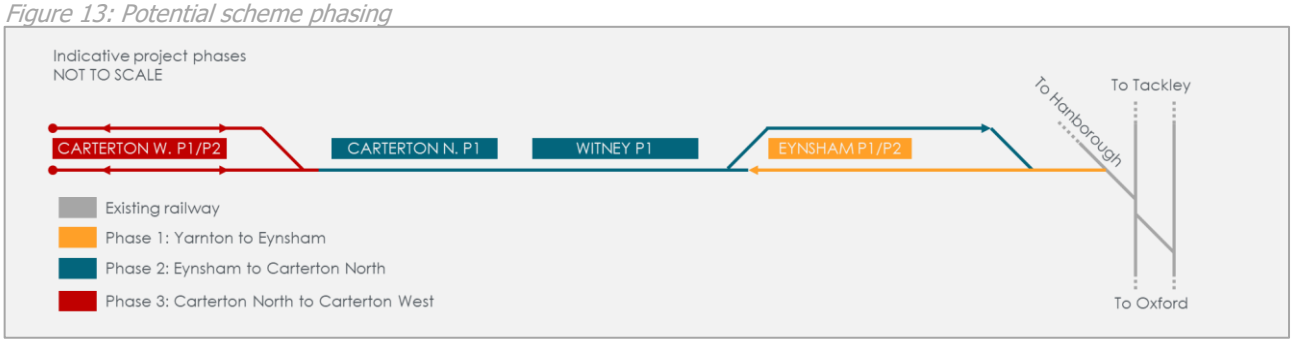
It is likely that Phases 2a and 2b would be combined into a single Phase 2, because stopping at Witney part way along a viaduct (whichever option is selected) would lose the economies of scale that would be incurred

by returning some time later to complete the viaduct and extend the impact of local disruption during construction. Once past Witney, the vertical alignment would return to ground level quickly, and the relatively short distance to Carterton North would unlock significant benefits.

The final phase, to Carterton West would likely be dependent on committed development around the proposed station. Although proportionally low cost of construction, it could not exist in isolation from the main route and if timing and budget permitted, could be bundled in as part of Phase 2 (a and b combined) or Phase 2b.

For a two trains per hour service (i.e. a train every 30 minutes) Phase 1 to Eynsham would require one train in service, Phase 2a to Witney and Phase 2b to Carterton North would require two trains, and Phase 3 to Carterton West would require three trains.

Figure 13: Potential scheme phasing



3.3.2 Single / dual track

The operational strategy is described in more detail in the SOC-L but the key outputs relevant to the engineering development are the length and location of single and dual track sections. Single track sections are less expensive to construct, but constrain operations because only one train may be in that section at any one time, unless both are heading in the same direction and separated by signal sections. Dual track sections allow two trains to travel in opposite directions at the same point at the same time as long as they are on different tracks, but are more expensive to build.

The early operational analysis concluded the following working operational assumptions that impact on the infrastructure:

- It is not necessary to dual track the main line section from Wolvercote junction to the Yarnton turnout[4], and a single track connection is sufficient
  - If, however, the North Cotswold Line project is implemented first, it will create a dual track railway on this section, and the alignment would need to be designed to enable a future junction at Yarnton. Whether this junction is a double junction[5] or a single lead junction[6] with a crossover[7] would depend on the position of the dual track curve near Yarnton Road bridge and the operational service pattern expected. There could be some benefit to including passive (or even active) provision of signals, depending on the confidence levels for the connection to Eynsham in the first instance.
- If the railway only goes as far as Eynsham, in a 'first phase', it can be a single track to Eynsham
- If the railway is extended beyond Eynsham, a double track section will be necessary from immediately after Yarnton junction, to immediately west of the station at Eynsham
  - This would allow trains to pass, and provide resilience to the service if either train line has delayed operations

[4] A turnout is a piece of track equipment (also sometimes referred to as a switch, or set of points, or junction) that allows a train to turn off one track onto another
[5] A double junction connects one pair of tracks to another pair of tracks. It is an efficient way to connect two dual track routes where a flyover junction is not justified (as in this case)
[6] A single lead junction connects a single track to the nearest track of a dual track 'main line'
[7] A crossover is a pair of turnouts pointing towards each other on adjacent tracks, connected by a short straight section of track in the middle, to allow a train to cross over from one of the tracks to the other

- If the railway is extended to Carterton West, a dual track section will be needed between Carterton North and Carterton West
  - This allows sufficient time for an inbound train to turn back at Carterton West, and potentially to charge up batteries if necessary
- Battery trains will be used, and will be able to be charged within the turnaround time at Oxford, via the electrification that will exist in the station by the time this project needs it
- The trains will achieve an average speed of 100 kph (60 mph), allowing for stops at each station along the route.

It is expected that when it comes to seeking legal powers for the railway, that at-grade single-track sections will make allowance for potential dualling in future. However, the more expensive viaduct sections are likely to remain as single track to avoid undue costs. Future operations would need to accommodate this potential constraint.

3.4 Development of route options

3.4.1 Combining section options into reference routes

In order to develop an end-to-end route, the Common Boundary Points enabled the design team to stitch together several combinations of sections to give different route options. In particular, the least cost and greatest cost options which gives a useful cost envelope, but other combinations are possible such as the shortest or longest route (useful for journey times and operational considerations), and least or greatest catchment (useful for demand considerations).

For this stage of the project, it is not necessary to select any one of these, or even to report on all of them, but rather the benefit is to develop an understanding of the range of opportunities and impacts available for consideration. In turn, these can inform the strategic approach in the subsequent study stage with an understanding of the range of possible outcomes and hence shape the adoption of route options for evaluation.

3.4.2 Route cost build up

At this project stage the purpose of cost build up is to establish an indicative cost range. This can be achieved by combining together the least cost sections and greatest cost sections to give an upper and lower bound envelope. Although the least cost option might seem the obvious combination to pursue, it may be that one or more of the more expensive route sections also accesses proportionally greater demand, leading to greater value for money. In this event, the least cost route may not yield the greatest value.

3.5 Cost estimation

3.5.1 Overall approach

For this concept design stage, it is appropriate to capture the costs for each section option and then combine section options to form overall end-to-end route costs for a range of options.

For efficiency, the approach taken was to define a 'menu' of unit cost rates for linear forms of construction, and then to define how much of each form of construction was relevant for each route, to the nearest 0.1km. Thus, a section option might have 1.5km of tunnel, 0.0km in cutting, 3.3km at grade, 2.3km on embankment and 0.4km on viaduct making a total length of 7.5km. When each construction type's length is multiplied by its relevant rate, the total direct cost for the linear infrastructure is obtained.

In addition, there was also a menu for discrete items, such as overbridges or underbridges[8], stations, or other specific costs that are not included in the linear costs.

The means by which the direct cost (i.e. the construction value of the asset delivered) unit rates were developed is described in 3.5.2.

[8] For railways, an overbridge is one that carries a road or something else over the railway. Similarly an underbridge allows the road, river, or something else to pass under the railway.

The direct costs for linear and discrete items were totalled and then uplifted by an allowance for overheads applied on a percentage basis. These overheads capture the costs associated with the delivery of the direct cost items, and include such aspects as design, site construction management, project management, consents, property, risk etc. The means by which the overhead costs were developed is described in 3.5.3.

Once the direct costs and overhead costs were calculated, the total Anticipated Final Cost (AFC) could be calculated for the section option. The route cost is then the sum of the relevant section costs.

Although this approach lacks the nuance of individual route end-to end build up of pricing, it is commensurate with the level of design understanding available and the level of accuracy expected for the SOC. The intent at the SOC-L stage is not to select a preferred option, or to commit to a project budget, but rather develop an understanding of the anticipated range of costs a developed solution might be expected to lie within.

Further details on cost assumptions and exclusions and a full summary of the section option direct costs calculated are contained in Appendix B.

3.5.2 Direct cost unit rates

The process of developing the direct cost unit rates began with the engineering team identifying the likely 'menu' of items they would need to use to piece together each option.

Costs for menu items were developed either by reference to several similar recent costs and an average taken, or by building up a price for a representative km or discrete asset based on assumptions developed with the engineering team.

For example, overbridge unit costs were based on an average cost of several other recent railway schemes, whereas the unit rate for embankments was based on a series of assumptions on a typical height, and side slope gradient, to determine likely fill volume per km run. The linear unit rates were derived for single track km and double track km for use as required.

Where costs were developed from a build-up, these were developed using typical details and element unit rates used on other early stage railway projects to form an 'all-in' cost for a discrete item or a nominal 1km. Clearly, these cannot take account of location-specific details such as access roads or specific constraints or unusual ground conditions, so nominal allowances have been made in the build-up, recognising that there will be some situations where this is an overestimate and others where it is an underestimate.

This is commensurate with the current stage of design when a great deal is ordinarily not known, and therefore there is a significant allowance for risk in the later part of the build-up that is expected to recognise these unknowns.

3.5.3 Overheads

Overhead allowances have been developed in line with Network Rail's guidance for SOC schemes[9], tailoring each overhead cost percentage allowance to individual asset groups / disciplines rather than a blanket allowance across the whole project.

Percentages are multiplied in line with the Rail Method of Measurement (RMM) with the direct construction costs. "Indirect construction works" allow for contractor preliminaries, overheads, and profit. "Project Design / Team Fees and other project costs" allow for design and project management fees, fees to public bodies and sponsors agents, and individual items such as land costs and disruptive railway access. Once "indirect construction works" and "Project Design / Team Fees and other project costs" have been applied to the direct construction cost, this gives the Base Cost.

Risk has then been applied to the Base Cost as a two-step process. The first applies a complexity factor to individual assess groups / disciplines direct costs and sums them up to get a weighted complexity risk value for the section. The second then multiplies this risk value by a Low, Medium, or High percentage to give three risk levels.

[9] Cost Planning Procedure, Feb 2020, Issue 3.4, Network Rail

The price base- for the costs is 2023Q1. Inflation would normally be applied to the mid-point of construction, but as the current global and national economic climate is highly uncertain, as is the likely construction mid-point, we have not inflated costs further.

Therefore, the sum of the Base Cost (direct, indirect, and design costs), plus Risk, gives the AFC at the stated price date and does not allow for inflation or land and property costs. AFCs are produced for Low, Medium, and High risk levels.

The above process to calculate overhead costs is in line with Network Rail Cost Planning Procedures, to support business planning from the SOC stage.

3.5.4 Evaluation of section option quantities

3.5.4.1 Linear section option quantities

The section options were developed within Google Earth Pro software which also gives an indication of the ground profile along the route identified. From this, the engineering team was able to identify where there were significant hills, valleys, or steep gradients to be negotiated.

Taking each section option in turn, the engineer identified lengths of the option likely to fall into each of the construction type menu items. These were recorded and totalled up to provide the quantities that would then be multiplied by the relevant rate.

3.5.4.2 Discrete item quantities

Discrete items such as overbridges or underbridges were identified by the engineer who provided a simple count of each discrete item.

Where the route crossed farm access tracks, a judgement was taken that some of these might become accommodation overbridges, other tracks might be diverted to the nearest overbridge, and some would simply be closed.

Occasionally there were some unforeseen items that would be likely to trigger unique costs, and where these were encountered, the estimator agreed assumptions with the engineer and developed a representative cost.

3.5.5 Risk

The overall risk allowance is based on a two-stage process. The first assesses the complexity of the scheme at a discipline level and the second creates the risk spread.

The complexity of the scheme is based on the definitions summarised in Table 2 and allocated as shown in Table 3.

Table 2: Complexity factor definitions

Category	Weighting	Example Descriptions
Standard engineering	0.20	Construction of buildings that do not require any special design considerations
		Construction of standard infrastructure or facilities
Non-standard engineering	0.50	Construction of buildings with special design considerations e.g. site / access / space constraints,
		Integration with utilities
		Construction of specialist infrastructure such as innovative rail solutions
		Upgrade to or extension of existing infrastructure e.g. Heritage considerations,
Highly complex engineering	1.00	New major station development in a constrained environment
		Major track / S&C upgrade involving multiple stages and/or interfaces with other projects
Novel technical development	1.20	Development of new technology / software
		Integration of new systems (infrastructure and rolling stock interfaces or control systems)

In general, the lowest factor (0.2) was used in Table 3 for works that would not necessarily require the skills of a specialist railway contractor to deliver or were standard railway engineering activities. The next factor (0.5) was used for railway works where these were expected to be complex or difficult. A factor of 1 was used for the Train Power Systems discipline on the grounds that this was predominantly for the battery charging costs, which are relatively new to the industry.

Table 3: Discipline complexity factors

Discipline / Category	Complexity factor
Railway Control Systems	0.2
Train Power Systems	N/A
Electric Power and Plant	0.2
Permanent Way	0.2
Operational Telecommunications Systems	0.2
Buildings and Property	0.5
Civil Engineering	0.5
Enabling Works	0.5
Preliminaries Overheads and Profit	0.2
Project / Design Team Fees and Other	0.2

The discipline direct costs, multiplied by the relevant complexity factors, plus the overheads costs, were then multiplied by the risk factors set out in Table 4 to provide a risk range in recognition of the uncertainty involved in the design and estimation of the project at this stage i.e. the mid risk point for Civil Engineering would be 0.5 x 105% = 52.5% and the same process applied to each discipline.

Table 4: Risk factors

Risk level	Risk factor
4.01 Risk @ Low	64%
4.02 Risk @ Mid	105%
4.03 Risk @ Upper	132%

The impact of this risk assessment process results in an average route level risk allowance of approximately 33% which is lower than might be normally adopted by Network Rail at this stage of a project, but reflects

the construction of a fairly simple railway in largely greenfield conditions in contrast to Network Rail's normal projects that are delivered within an operational railway environment. There is an interface at Yarnton junction, but this is considered sufficiently small in overall project terms as to not warrant additional uplift to the standard rates.

4 Sections commentary

4.1 Overview

The shortlisted section routes together form a corridor for which a price range can be developed, and also provide a broad corridor within which future route refinement work should be based.

The sections below discuss the makeup of this corridor in order from Yarnton where the route will leave the existing line, to Carterton West. Corridors are being presented here rather than the proposed routes to avoid any blight that could arise, particularly when the development of the routes should be refined during any future work.

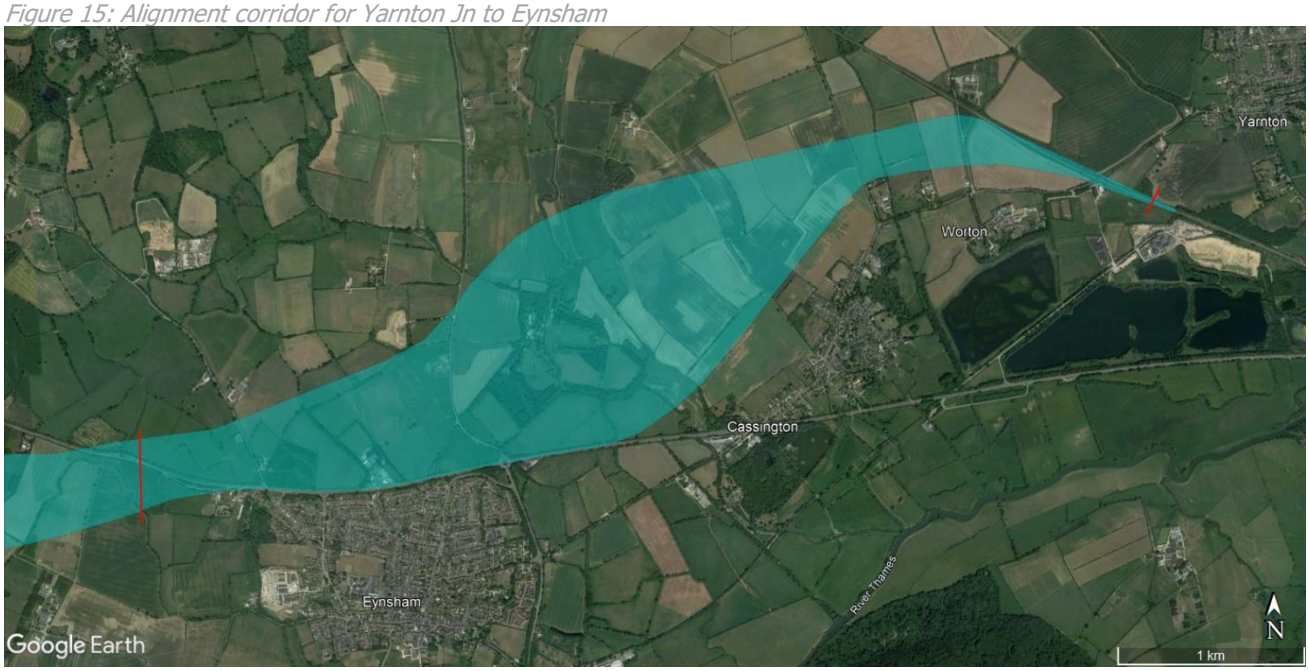
Figure 14: Alignment corridor for the full scheme

4.2 Section 1: Yarnton Junction to Eynsham

4.2.1 Section 1 overview

Route Section 1 runs from the existing Cotswold Line to a Common Boundary Point just west of Eynsham. The two representative options within the corridor shown in Figure 15 run broadly to the north and to the south of the corridor, but have different characteristics as described below. There is some capacity to blend the two representative options such that either connection from the main line can connect with either route towards Eynsham.

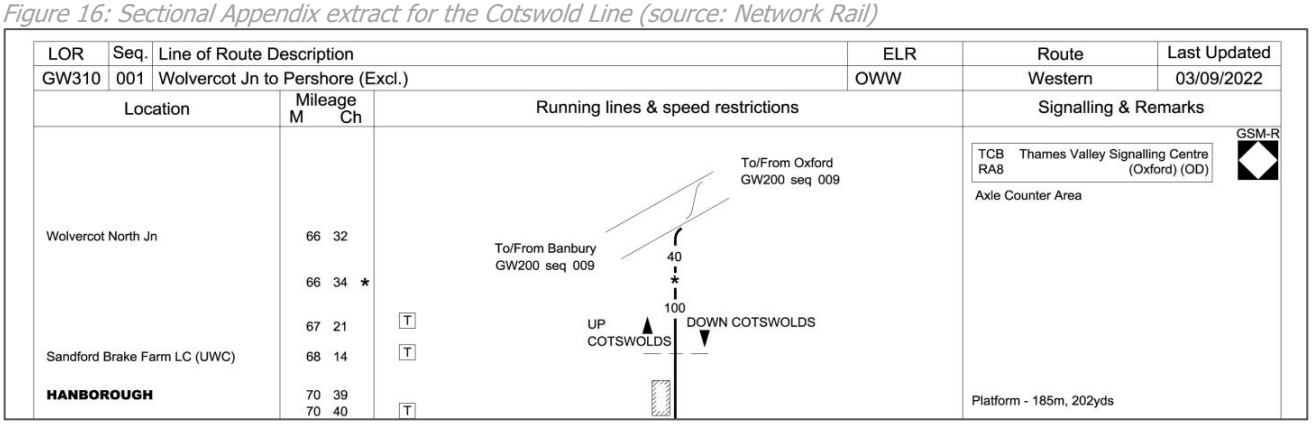
Figure 15: Alignment corridor for Yarnton Jn to Eynsham



4.2.2 Cotswold Line connection

The Cotswold Line currently exists as a single track heading north-west from Wolvercote North Junction with a 100mph line speed (see Figure 16). For the purposes of this study, we have assumed this remains the case (see 3.3.2). It is then necessary to access the Carterton branch using a turnout protected by signals on both lines.

Figure 16: Sectional Appendix extract for the Cotswold Line (source: Network Rail)



The options for locating the turnouts are constrained by the curve in the track under the Yarnton Road overbridge as turnouts on curves are generally avoided where practicable. Thus, the north and south connection options are either north or south of the curve.

Figure 17: Views north and south from Yarnton overbridge (source: Cadenza)

The northern connection option is on the straight track before the water treatment works and would cut across the works access road, requiring a new overbridge in this location.

The southern connection option is on the straight track south of the Yarnton Road overbridge and runs alongside the existing alignment until after the overbridge. Although the track bed was formerly designed for two tracks, the current alignment is central on the formation. One option may be to realign the existing track to allow the new branch to pass under the existing bridge, but this would require significant relaying and would not future-proof for future track dualling as proposed by the NCLTF. We have therefore assumed that a new Yarnton Road overbridge would be necessary capable of crossing three tracks. This would also improve the highway bridge which has poor sight lines and widths.

4.2.3 Section 1 northern option

After departing the Cotswold line, the northern option leaves the Yarnton connection and passes westwards through a steeply-rising gradient on the approach to the Evenlode river valley, where the ground profile

sharply falls away. This combination requires tunnel followed by viaduct as the route leaves the hill and crosses the river.

Thereafter the route drops to grade when practicable, and passes through the Salt Cross development in cutting, so as to reduce impact through the site. Through discussions with the developer, we have identified an alignment that minimises the impact of this strategy for a centrally-located station, but would give access off the A40 corridor via the site currently used for a petrol station.

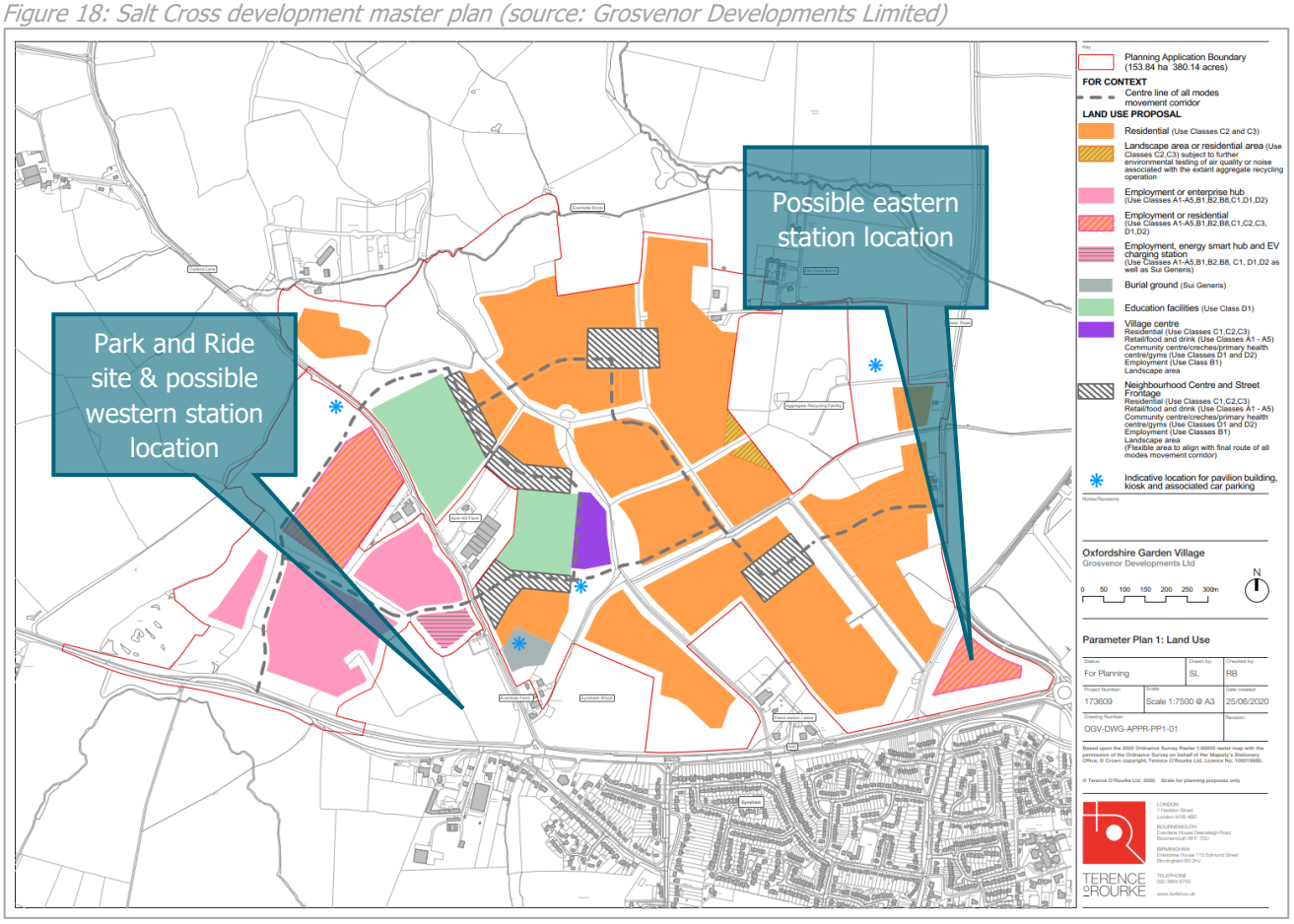
West of the presumed station location, the ground level falls away to the west of Eynsham, and the railway emerges on viaduct to cross over the A40 which descends on a steep gradient beneath the railway.

4.2.4 Section 1 southern option

After the Yarnton connection, the southern option runs along a more southerly trajectory so that it follows the relatively flat topography and joins the A40 corridor between Lower Road and Cassington. At this point, it rises up on embankment to cross over Lower Road and then runs along the southern boundary of the Salt Cross development. This option has also been discussed with the developer to understand how best to minimise impacts and facilitate their ambitions to provide north-south connectivity across the A40/railway transport corridor and enable access for existing Eynsham residents. It should be noted that there may be Roman remains in one field that would be crossed by the route, though the significance of this is not known at this stage.

The southern route continues westward, and adjacent to the A40 on embankment or possibly a retained earth wall before leaving the development to cross over the A40 on a viaduct.

Figure 18: Salt Cross development master plan (source: Grosvenor Developments Limited)



This route has two potential station locations as shown in Figure 18. One to the west over the Park and Ride, as proposed by WOTG, the other to the east, in the south-east quadrant of the Salt Cross development. For all car drivers approaching either station / Park and Ride from any direction, encouragement to reconsider their public transport options could be further enhanced by real-time

data on electronic screens showing the comparative journey times of car, bus and train to central Oxford.

4.2.4.1 Western Salt Cross location

The western location would link with the bus Park and Ride that will exist by the time the railway is developed. It would also capture traffic approaching from the west of Eynsham – though this would hopefully reduce significantly by the time the railway runs to Carterton because those likely to use the train will have already got on, unless car drivers have a change of heart when they encounter congestion.

However, during construction of the station, there would be significant disruption to the Park and Ride for more than a year at a period when it is likely to be well-used.

It would also increase the cost of the project (all other things being equal) because the dual track from Yarnton Junction would extend further west to create a dual platform station (for operational reasons).

Furthermore, it would probably result in the viaduct over the A40 needing to be built as dual track as far as the embankment west of the A40 because the reduction to single track section would ideally not be on the viaduct itself. This is because there can be complications with the track junction that can occur if located on a flexible bridge structure.

Much of the viaduct at the station and over the A40 would need to be built in the first Phase (see Figure 13) because of the difficulty of coming back later to complete a half-built viaduct.

Passengers would be expected to come from the Salt Cross development, but probably not from the existing Eynsham because they would have to travel in the opposite direction to that which they want to eventually go, and they already have a good bus service from within Eynsham to Oxford via Swinford. Car access could well be difficult because it would mean driving west along the A40 then turning right into the Park and Ride, across busy oncoming eastbound A40 traffic.

4.2.4.2 Eastern Salt Cross location

A station in the eastern location (at the south-east corner of the Salt Cross development) would adopt a triangular parcel of land currently allocated to employment or residential use. Bus interchange, kiss-and-ride, taxi and disabled car parking would be in this triangle with general parking the other side of Lower Road, to the north-east of the roundabout.

In this event, it would be beneficial to make this space the new bus Park and Ride as well, for an integrated transport solution – each mode playing to its strengths. The Park and Ride currently under construction would be re-purposed to strengthen and expand the adjacent employment / enterprise hub as an centre for investment. It is noted that the closure of the Park and Ride relatively soon after opening might incur criticism but would limit the disruption to the Park and Ride during construction and allow better integrated transport solution in the longer term.

One of the purposes of a station location at the eastern edge of Eynsham is to give best access to the existing Eynsham residents from the south via the roundabout. It would still mean travelling in the wrong direction (north), but for car users from Eynsham planning on driving to Oxford, it gives them an alternative if they encounter congestion.

Car users from the Salt Cross development would likely migrate towards the A40 via Lower Road or the A40, and in either case, they would have a last opportunity before leaving Eynsham to re-assess their journey and park, catching the train or bus as meets their specific needs.

4.2.5 Section 1 options summary

The Cotswolds line connection northern option is likely the most attractive as a shorter length of railway is required to be built and it does not require the replacement of Yarnton Road overbridge unlike the southern connection option.

Of the two route options, the northern option requires a tunnel and would have greatest impact on the plans for the Salt Cross Garden Village. The southern option keeps the transport corridor to the A40 but in doing so requires the removal of part of the Millennium wood. The southern option is considered most practical from a railway alignment perspective and would likely be able to serve more people in the existing Eynsham village site as well as the proposed Salt Cross Garden Village.

4.3 Section 2: Eynsham to High Cogges

4.3.1 Section 2 overview

Route Section 2 runs from a Common Boundary Point just west of Eynsham to a Common Boundary Point at High Cogges. The two representative options within the corridor shown in Figure 19 run broadly to the north and to the south of the corridor, but have different characteristics as described below. There is some capacity to blend the two representative options such that either of the Route Section options in Section 1 can connect with either route towards High Cogges.

There is no proposed station location in this section.

Figure 19: Alignment corridor for Eynsham to High Cogges

4.3.2 Section 2 northern option

The northern option progresses west off the viaduct across the A40 onto an embankment where the railway descends back to existing ground level. This option continues west at grade across agricultural land until it reaches the A40. In this area, the topography is gradually increasing in elevation up to High Cogges. Once this alignment reaches the A40, it turns in a southwest direction staying south of the A40 to High Cogges between the village and the A40 junction.

This route crosses several Public Right of Ways (PROWs) and two public roads (South Leigh Road, and an unnamed single track road to Barnard Gate). An accommodation bridge is likely required where the route crosses through a farm property.

4.3.3 Section 2 southern option

The southern option progresses southwest off the A40 viaduct onto an embankment to descend to ground level similar to the northern option. This alignment continues at ground level ascending the natural topography up to High Cogges. The alignment continues southwest until it crosses the unnamed road to Barnard Gate where it turns due west all the way to High Cogges between the village and the A40 junction.

This route crosses several Public Right of Ways (PROWs) and two public roads (South Leigh Road, and an unnamed single track road to Barnard Gate). An accommodation bridge is likely required where the route crosses through a farm property.

A variation of this option passing to the south of High Cogges village could be favourable depending on the alignment choice in Section 3.

4.3.4 Section 2 options summary

The two options in this route section are relatively similar. Once over the A40 both are likely to run at existing ground level up to High Cogges over agricultural land. The route through High Cogges will require further consideration of residential property boundaries, though will likely depend on the onward route through Section 3.

4.4 Section 3: High Cogges to Witney

4.4.1 Section 3 overview

Route Section 3 runs from the Common Boundary Point at High Cogges to a Common Boundary Point to the west of Ducklington and south of Witney. The two representative options within the corridor shown in Figure 20 run to the north and to the south of the A40 between Witney and Ducklington. There is some capacity to blend the two representative options such that either of the Route Section options in Section 2 can connect with either route towards Witney.

The topography in this area drops from High Cogges to Witney significantly before levelling off at the River Windrush and Ducklington Lake. The A40 bridge over Ducklington Lane and the associated slip roads are also a significant obstacle to navigate.

Figure 20: Alignment corridor for High Cogges to Witney

This section of the route is anticipated to be permanently single track to limit the cost of the viaduct necessary for both options. This could become a significant operational constraint if in future there was a desire to run a more frequent train service than has been assumed in this study though given the costs of this section for a single track, it has been considered that dualling this section would be likely to be more expensive than the operational penalty of adjusting service patterns to suit.

4.4.2 Section 3 northern option

The northern option progresses southwest from High Cogges in a deep cutting before transitioning onto a viaduct to the east of Stanton Harcourt Road. The alignment continues west on the viaduct over the A40 and the River Windrush into the existing Station Lane industrial estate. This crossing on a skew would be a very significant span and may require localised realignment of one side of the A40.

Figure 21: View west from Stanton Harcourt Road at the approximate crossing site (source: Cadenza)

This route continues west on a viaduct through the existing industrial estate where a station location is proposed at high level (5-10m above ground level). Once passing through the station the route continues on viaduct over Ducklington Lane and the A40 eastbound off ramp and into the Thorney Leys industrial estate.

The viaduct continues west through the Thorney Leys industrial estate before turning southwest back over the A40 at a location where the A40 elevation has dropped by almost 5m in relation to its level when crossing Ducklington Lane.

In both the industrial estates several units will need to be acquired to accommodate this route. An approximately 2.4km long viaduct is required for this route option and its height means that it is likely that two sections of overhead power line may need to be diverted or placed underground.

There are broadly two different strategies that could be employed where the viaduct interfaces with the industrial estate. One is to minimise impact with the least amount of buildings impacted, leaving the estate to function as close as possible to how it is today. It would put the station within easy walking distance of the Witney town centre and make rail travel to and from Witney an attractive proposition.

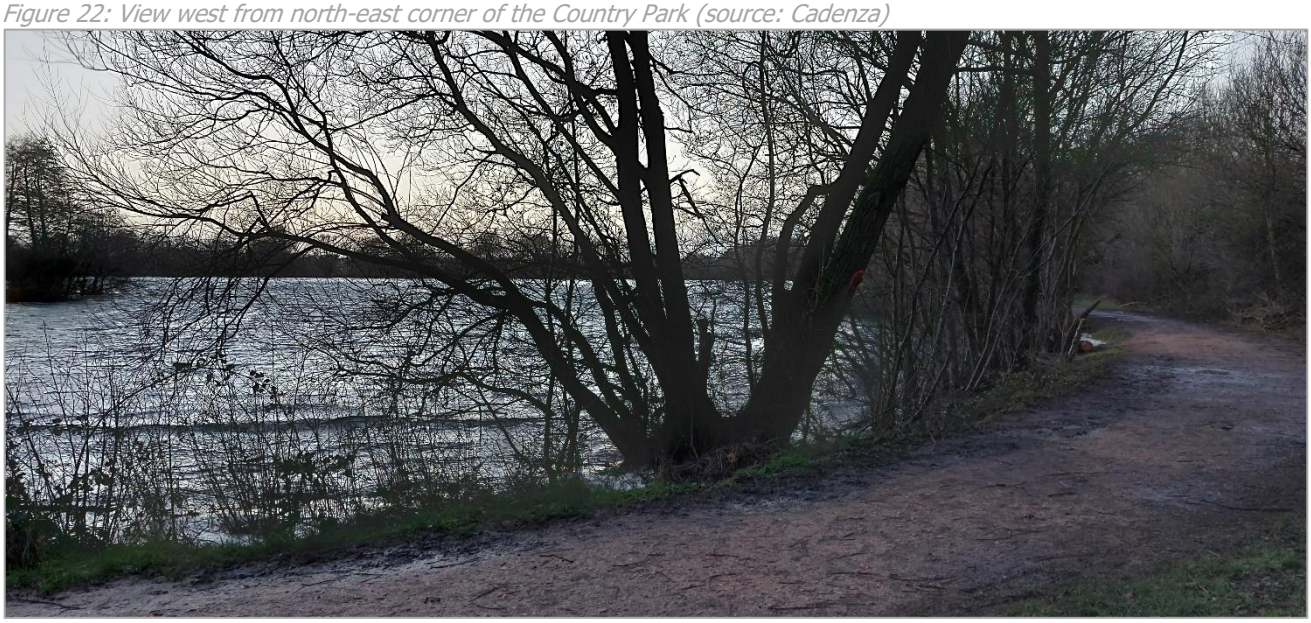
The other is to view this impact as a catalyst to re-think the whole industrial estate area with a new masterplan focussed on local (and possibly regional) economic growth. Depending on the extent of the ambition, the developable area could be in the order of 20-50 Acres. For comparison, the Westfield shopping centre at Stratford (London) is about 50 Acres; the Merry Hill Shopping centre in Birmingham is about 65 Acres. This is not to say that a major shopping complex is the most appropriate use of this space, but rather to give an idea of scale. Other potential uses include leisure, learning, health, business and research.

The existing industrial units could be relocated nearby, e.g. adjacent to the existing industrial estate at West Witney, or perhaps south west of the A40. A carefully-considered masterplan could generate significant economic activity and provide several hundred local jobs. It could become a major attractor to the area, increasing house price values, but also traffic – hence why the railway connection would be both the catalyst and a necessary feature of such a significant investment.

4.4.3 Section 3 southern option

The southern option progresses along the southside of the A40 in deep cutting before transitioning onto embankment continuing to Ducklington Country Park. The route runs along the northern edge of the park and may require the northern edge or the Lake to be redefined to retain the walking route.

Figure 22: View west from north-east corner of the Country Park (source: Cadenza)



At the park's western boundary, the route transitions onto a viaduct approximately 1km long travelling between Ducklington Lake and the A40, over the westbound off-ramp slip road, Ducklingon Lane and a relocated westbound on-ramp before landing back onto an embankment to the west of Ducklington Lane. As for the northern option, the height of the viaduct means that it is likely to require the limited diversion or undergrounding of two sections of overhead power line.

Figure 23: View east over the Travelodge hotel car park and A40 westbound on-ramp (source: Cadenza)

To accommodate this option the westbound on ramp to the A40 would need to be replaced with a new access to the west of Ducklington Lane. The Travelodge hotel and Shell petrol station may also be required to be purchased with the proposed station site likely on the land of the Travelodge hotel car park.

A station in this location would have less impact on local businesses, but would be south of the A40 which could form a psychological barrier to some Witney residents and adds walking/cycling distance that may reduce its attractiveness to users, particularly at night.

The viaduct for this option would be required to be approximately 1km long. Stanton Harcourt bridge over the A40 would likely need replacing with a structure that crosses over both the A40 and the railway line.

4.4.4 Section 3 options summary

Both of these options require a viaduct to pass through the Witney area and cross Ducklington Lane. Both options have consequential impacts on overhead power lines. This means that the cost per km in this section is significant when compared to other sections.

The northern option requires a greater length of viaduct as well as significant property acquisition, however the benefit to this would be a station closer to the large existing population of Witney, as well as an opportunity for economic development in the industrial estate area.

The southern option still requires a long viaduct, though it is shorter (and therefore cheaper) than the northern option. Properties would still be required, and a significant piece of enabling works would be needed to replace the existing westbound on-ramp to the A40.

Both station options in this section would be required to be at high level on single track viaduct adjacent to the A40.

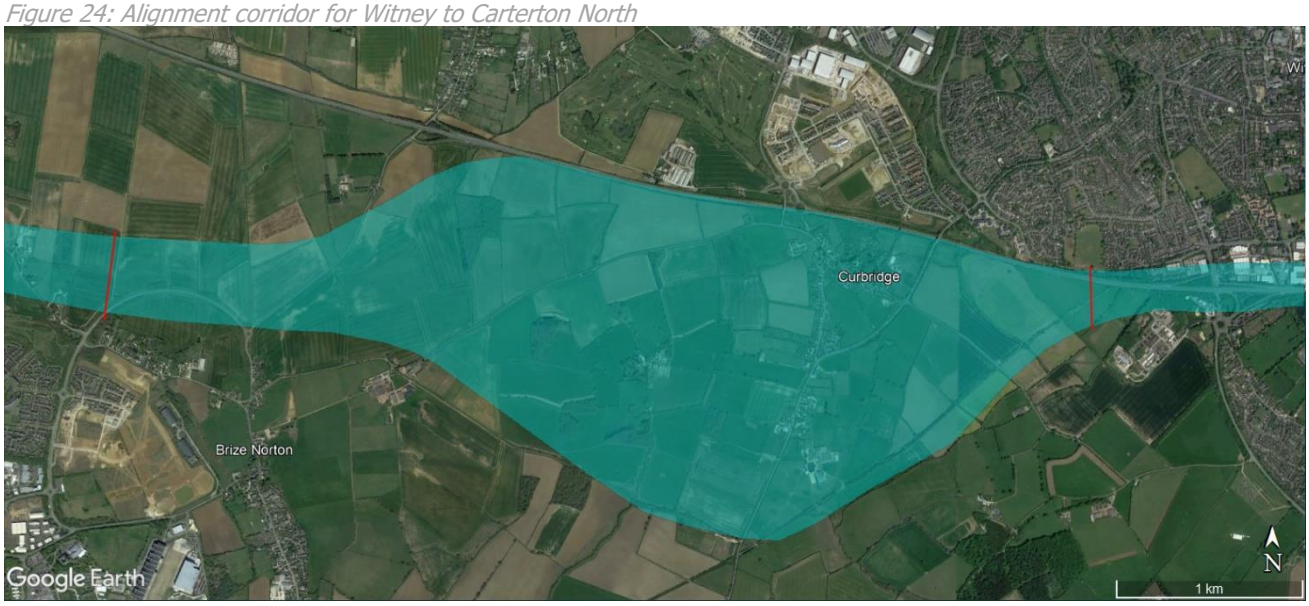
4.5 Section 4: Witney to Carterton North

4.5.1 Overview

Route Section 4 runs from the Common Boundary Point southwest of Witney to the Common Boundary Point northeast of Carterton. The three representative options within the corridor shown in Figure 24 run to the north, south, and through the centre of the corridor. There is some capacity to blend the three representative options such that either of the Route Section options in Section 3 can connect with either route towards Carterton.

The topography in this area gradually rises from east to west flattening out on the approach to Carterton North which is assumed to be located just to the north of the B4477.

Figure 24: Alignment corridor for Witney to Carterton North



4.5.2 Section 4 northern option

The northern option runs alongside the south side of the A40 from Witney, gradually increasing in elevation with the natural topography. East of Brize Norton Road this alignment turns southwest crossing Brize Norton Road and then west to the north of the B4477 at the proposed station location.

An overbridge will be required for Brize Norton Road as well as modifications to the existing A40 overbridges at Curbridge to also cross over the railway line. The topography immediately adjacent to the southern edge

of the A40 is difficult, and there may be consequential local highway alterations for bridges affected by the railway.

4.5.3 Section 4 central option

The central option leaves Section 3 on the former railway alignment in a southwest direction before turning west through Curbridge then turning northwest passing Caswell House. This route then turns west to arrive at the same station location as the northern option beyond Brize Norton Road.

Overbridges will be required for Witney Road, Brize Norton Road, the A4095, and Curbridge Road – for which a short section of railway cutting may be required. The local impact on Curbridge village and the neighbouring Caswell House is likely to raise significant objection.

4.5.4 Section 4 southern option

The southern option leaves on the same alignment as the central option but continues further along the former rail alignment, passing the southern end of Curbridge before turning northwest. This route continues, gradually increasing in elevation with the natural topography before joining the central and southern options beyond Brize Norton Road at the proposed station location.

Overbridges will be required for Witney Road, Brize Norton Road, the A4095, and Curbridge Road.

4.5.5 Brize Norton freight connection

In discussions with the MOD at Brize Norton, the prospect of a freight connection was considered. On balance it seemed likely that a dedicated freight connection close to or within the site was unlikely to have a strong business case. However, further consideration could be made for a dedicate freight spur near Carterton within the corridor outlined to allow for occasional freight deliveries such that road handling would be limited to the 'last mile' only. All options in Section 4 and 5 could accommodate such a spur.

4.5.6 Section 4 options summary

Of the three options, the southern option has fewer constraints though will be the most expensive due to being the longest route. The northern option has the challenge of modifying or replacing two road bridges that currently cross the A40 with consequential highway impacts. The central option cuts through the centre of Curbridge and would almost certainly see some challenge.

4.6 Section 5: Carterton North to Carterton West

4.6.1 Overview

This section of the overall route would have a symbiotic relationship with the development it would serve; it is likely that a significant development west of Carterton would be dependent on the railway, while the railway would be dependent on the development. However, it would also provide much better connectivity through to the west of Carterton and is far enough away from Carterton North to attract different users.

Route Section 5 runs from the Common Boundary Point northeast of Carterton to the west side of Carterton, just north of Alvescot Road. A single option has been developed in this section due to the limited options available. All of the Route Section options in Section 4 options end west of Carterton.

The topography of this area is typically level with the exception of Shill Brook between Shilton and Carterton when levels drop down to brook level and then back up to a similar height as before. A short section of embankment with an underbridge or viaduct would be necessary here. The vertical alignment falls towards Alvescot Road along the northern edge of Carterton.

Figure 25: Alignment corridor for Carterton North to Carterton West

This route travels west along Carterton's northern edge along to Carterton Football Club. Here it turns south, crossing Shilton Road and Shill Brook continuing on the level ground to the east of Carterton ending north of Alvescot Road where the Carterton West station is proposed (see Figure 26).

The additional route length and turnaround time means that some of this track would need to be dualled, and an extra train required, to allow a regular half-hourly service to function. The current expectation is that the station would consist of an island platform so that passengers can arrive at the station and not worry they are on the wrong platform.

Figure 26: View north along approximate alignment west of Carterton (source: Cadenza)

5 Whole route options development and costs

5.1 Introduction

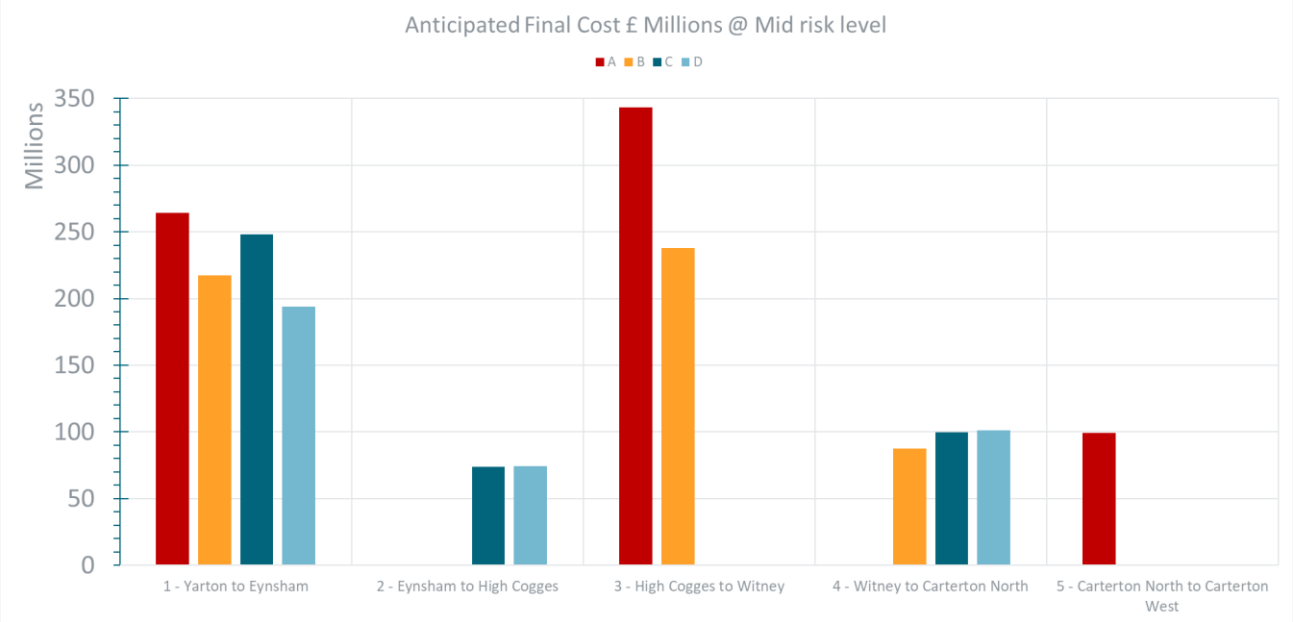
The Route Sections developed in chapter 4 have been costed based on the methodology presented in 3.5 and described further in Appendix B with key assumptions and exclusions. Route Section options may be stitched together at Common Boundary Points in almost any theoretical combination. Since it is beyond the scope of this study to select a preferred option, it is not necessary to evaluate each option and score against weighted or unweighted criteria. It is assumed that each combination will have its advantages and disadvantages, but the trade-offs between advantages, disadvantages and cost will take place at the next stage.

At this stage of the project, it is of most value to understand the range of costs to understand the potential scale of the budget, and to understand the range of distances as a proxy for journey time, which in turn links to operational viability. In all cases, infrastructure and systems costs have been included for running 2 tph from Oxford to Carterton West with new stations at Eynsham, Witney, Carterton North, and Carterton West.

As the construction dates are highly uncertain, being dependent on grouping, phasing, and planning strategy, and there is high uncertainty around inflation, inflation has not been applied above the cost base at the submission of this document (2023Q1). A Medium Risk level assessment has been applied to the Base Cost (Direct costs plus Design and project team fees, plus other development costs) as it will give the most suitable risk estimation for consideration. It does mean, however, that any budgets developed on this basis would need to be index-linked to a suitable railway construction index to avoid budget erosion through inflation.

5.2 Route Section costs

Figure 27: Cost of route section options for AFC @ Medium Risk



Route Sections 2, 4 and 5 are broadly similar and relatively low because the topography in each is broadly flat for similar section lengths, with localised cuttings or embankments and occasional accommodation bridges.

Route Section 1 includes a connection with the Cotswold Line, and a dual track loop section requiring turnouts and signalling, all of which increase the infrastructure needed in this Route Section. For reasons of topography, options towards the north are more expensive because of the hill to the east of the River Evenlode requiring deep cuttings or tunnel followed by viaduct across the valley floor. More southerly options are affected by needing to cross Lower Road at height on the approach into the Salt Cross development.

Route Section 3 is significantly more expensive because of the need for significant lengths of viaduct and high embankment, whether running to the north or south of the A40. The option to the north has 1.4km more

viaduct, but the option to the south requires relocation of the A40 westbound on-ramp. Consequently the cost per km is about four times that of Route Section 4.

Table 5: Cost variance of route sections

Route Section	Minimum section cost	Maximum section cost	Cost range of Routes Sections
Section 1: Yarnton to Eynsham	£194M	£264M	£70M
Section 2: Eynsham to High Cogges	£74M	£74M	£0M
Section 3: High Cogges to Witney	£238M	£343M	£106M
Section 4: Witney to Carterton North	£87M	£101M	£14M
Section 5: Carterton North to Carterton West	£99M	£99M	N/A Single route only

The cost range of all the route sections is shown in Table 5 and Figure 27. Within the Sections, the most variance between the options is in Route Sections 1 and 3. Route Section 1 cost variance is a result of route topography, whereas Route Section 3 cost variance is a result of the quantum of different types of infrastructure. The choice of route through this section will also have the greatest impact on the whole route costs as the two different options have a variance of approximately £106m (North vs South option).

It would be simple to conclude here that the cheaper (Southern) option is the obvious choice, but the northern option places a station closer to the existing population and could act as a catalyst for high quality redevelopment of the industrial estates (see 4.4.2). The southern route still requires a viaduct and would need to navigate past Ducklington Lake with modifications to the path through the country park.

However, it may also be noted that for the cost of Route Section 3 Option A, it may be possible to have both Route Section 3 Option B and Route Section 4 Option B which, if funds are limited, might enable the railway to go further for the same money and serve Carterton as well as Witney. These are decisions best made through consultation with budget holders and key stakeholders in the subsequent stages of this project.

5.3 Whole route options development

As explained in 5.1, the route section lengths and costs have been brought together to create whole route options. To develop whole route options to evaluate, we have created four theoretical whole routes from Yarnton to Carterton West as:

- Shortest route (22.1km new track)
- Longest route (23.6km new track)
- Least cost route (developed after the section options had been costed)
- Greatest cost route (developed after the section options had been costed)

Table 6 shows which section options presented in section 4 make up the routes.

Table 6: Whole route options

Route	Section 1 – Yarnton to Eynsham	Section 2 – Eynsham to High Cogges	Section 3 – High Cogges to Witney	Section 4 – Witney to Carterton North	Section 5 – Carterton North to Carterton West
Shortest route	North Jn & Northern Option	Southern Option	Southern Option	Northern Option	Single Option
Longest route	South Jn & Southern Option	Northern Option	Northern Option	Southern Option	Single Option
Least cost route	North Jn & Southern Option	Southern Option	Southern Option	Northern Option	Single Option
Greatest cost route	South Jn & Northern Option	Northern Option	Northern Option	Southern Option	Single Option

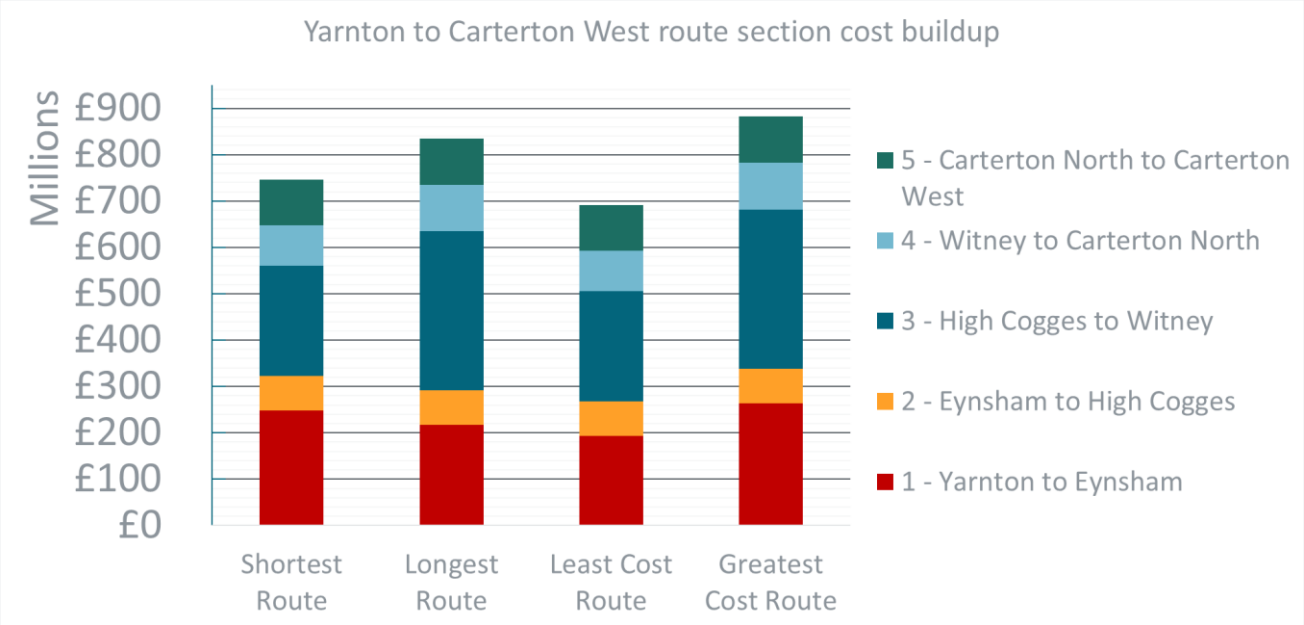
As may be expected, the greatest and least whole route cost section options correlate closely with the longest and shortest routes respectively. This is not surprising, as a railway is a mostly linear system and costs are generally proportional to length. The exception is in Section 1 where the northern route is shorter but has more expensive construction due to the topography, described previously.

The difference between longest and shortest whole routes is only 1.5km (about 1 mile). At an assumed average speed of 100kph (60mph), the time taken to traverse this distance is about 1 minute. On an assumed 22-23 minute end-to-end journey time, this is just under 5% of the journey time and represents about 1/3 of the assumed contingency allowance which would affect the reliability of railway operations. This suggests that the longer whole route should only be considered if it has significant cost or other advantages.

5.4 Comparison of whole route costs

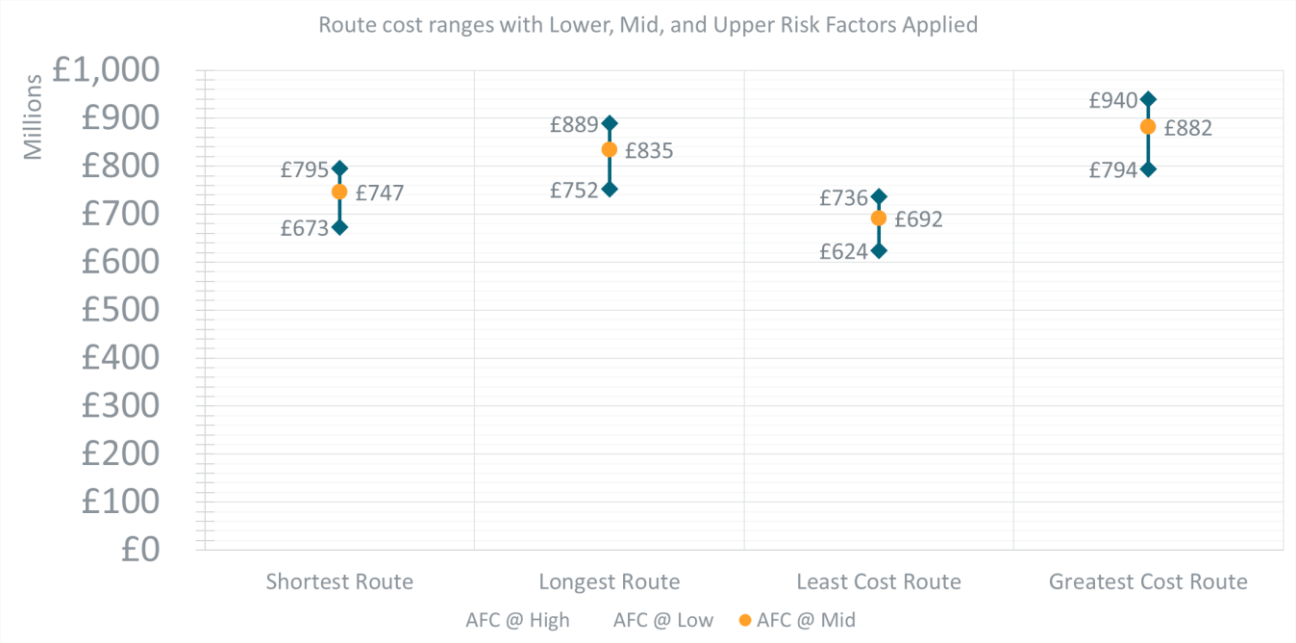
Drawing the costs of the different Route Sections together, we derive whole route costs from Yarnton to Carterton West for the four possible options as shown in Figure 28 with Upper or Lower risk bounds are presented in Figure 29. These are based on a medium level of risk overhead applied, as developed by Network Rail for early stage projects such as this.

Figure 28: Route cost build ups by section for AFC @ Medium Risk



Given the early stage of this work, it is likely that the eventual preferred option will be in the range between the Least Cost Route and Greatest Cost Route.

Figure 29: Whole route costs to Carterton West with Low, Mid, Upper Risk



When varying risk allowances are applied the range becomes slightly wider as shown in Figure 29. With the lowest risk factor applied to the Least Cost Route, and the highest risk factor applied to the Greatest Cost Route, the range extends between £624M and £940M. The range is about half of the value of the least cost which, though broad, is appropriate for this first stage study given the extensive unknowns inherent in the level of detail available at this point.

5.5 Costs validation

In this section we review whether the estimated capital costs are reasonable 'in the round', and a suitable indicator for the purposes of discussion and business case analysis.

Benchmarking is often an approach that is claimed to give an indication as to whether the 'bottom up'[10] estimate falls within a range that a 'top down'[11] estimate would support. Though attractive in theory, the practice is often more difficult because it is rare that enough relevant projects are available at an appropriate and consistent level of cost granularity to warrant suitable analysis. In reality, the tolerance accuracies of this approach are seldom better than the original methodology used to develop the costs in the first instance.

However, we propose five tests below as useful in assessing the validity of the cost estimates:

- Are the input cost rates derived appropriately?
- Is the cost estimating process reasonable?
- Is the process of developing the quantities reasonable?
- Does the balance of influential costs look reasonable?
- How do the all-in costs compare with similar projects?

The first four of these are addressed in earlier parts of this report (see 3.5, 5.2, and 5.3) that set out the basis of developing the cost build-ups. The fifth test requires comparison with other similar projects.

This is a difficult task to do because of the paucity of relevant projects in recent UK history. Although there have been recent 'Restore Your Railway' and similar projects, these have typically focussed on upgrading existing railways or reinstating old trackbeds. We are not aware of recent schemes that have delivered new greenfield heavy rail railways over any significant length in the UK.

[10] A 'bottom up' estimate is based on building up costs from the smallest items and adding them together to get the total
[11] A 'top down' estimate is based on looking at the all-in costs of other projects for analysis based on their component parts

The closest relevant projects we are able to refer to are the Borders Railway opened in 2015, and the emerging East West Rail (EWR) Central Section Route E which is still in planning. Selected route data is shown in Table 7.

Table 7: Project comparisons

Railway	Borders Railway[12] (opened in 2015)	Yarnton Junction to Carterton West	East West Rail Central Section[13] Route E selected (planned)
Route length	50km approx.	23km (approx. between Yarnton Jn and Carterton West)	54km
Track	Largely single track on old route	Largely single track on new route	Largely dual track on new route
All-in delivery cost at published date	£353M @ 2012Q1	£692M-£882M @ 2023Q1	£2,943 @ 2019Q4
All in delivery cost (£M) @ 2023Q1[14]	£620M	£692M-£882M	£3,491M
All-in cost £M/ route-km	£12.4M/km	£30.9/km - £37.8M/km	£65M/km

Comparing the route lengths of the three projects, the current study is slightly less than half of the length of the comparator projects.

The Borders Railway was single track largely on existing route, whereas EWR will largely be dual track on a new route (though there is a substantial section upgrading the Marston Vale Line) with a high-frequency service. Together, these factors indicate why EWR is anticipated to be more than five times the cost of the Borders Railway. Yarnton Junction to Carterton West is mostly single section of track on entirely new route, so by simple comparison, we would expect the rates per route-km to be greater than the Borders Railway, and less than EWR, with a balance slightly closer to the Borders Railway scheme.

This is borne out by the all-in route costs/km assessment with a mid-range cost per km of about £34.4M/km which is just below the mid-point between the other two project route costs/km.

Comparing the all-in costs in relation to the type of scheme we balance the route from Yarnton Junction to Carterton West with Borders Railway at twice the length but considerably less complexity. Apart from in isolated locations, Borders Railway did not need to create its own cuttings, embankments and structures, and these form the majority of costs for this project. It is not unreasonable therefore to reconcile half the length with three times the route complexity to arrive at an overall expectation of about 1.5 times the cost of Borders Railway as circa £930M which is slightly above the top end of our estimate at Medium Risk.

Comparing with EWR, we have a project with twice the length and dual track throughout its length, with several new stations, including Bedford station which will be significant. Some of that is on existing dual track, but will involve new signalling for a much higher frequency of service and longer trains than are anticipated for the route from Yarnton Junction to Carterton West. On balance, it seems reasonable to consider the EWR scheme at twice the length and 2-3 times the complexity should be about 4-6 times more expensive than from Yarnton Junction to Carterton West, or to reverse the equation, Yarnton Junction to Carterton West should be around 17%-25% of the overall cost of the EWR scheme. This would put it as about £593M-£872M, which is an extraordinarily close approximation to our anticipated Mid-risk cost range.

[12] https://www.railfuturescotland.org.uk/pages.php?name=bordersrailway
[13] https://eastwestrail.co.uk/library/nrreports
[14] Inflation is based on BCIS Online "All-in TPI" Forecasts and Records

The combined comparison suggests we may be a little on the low side with one assessment, and a little high with the other, but overall appear to be in the right range.

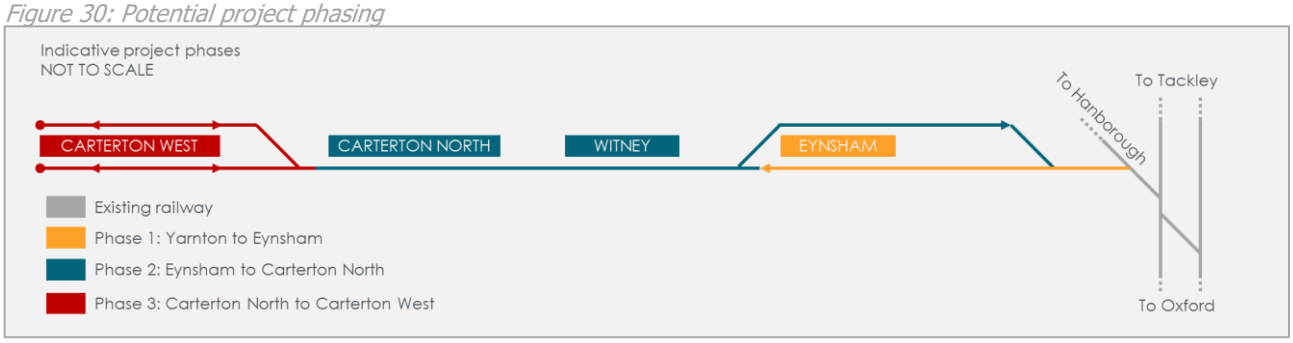
There is a risk in this 'top-down' approach, that the rough approximations described are inadvertently 'reverse-engineered' to give a result that aligns with expectations, but it is considered that the arguments above are not unreasonable and therefore the outcomes from this broad comparison give comfort that the estimates are acceptable.

6 Project phasing and funding

6.1 Project phasing

It is common for a project of this scale to be phased as described in 3.3.1 on page 17 and repeated in Figure 30.

Figure 30: Potential project phasing

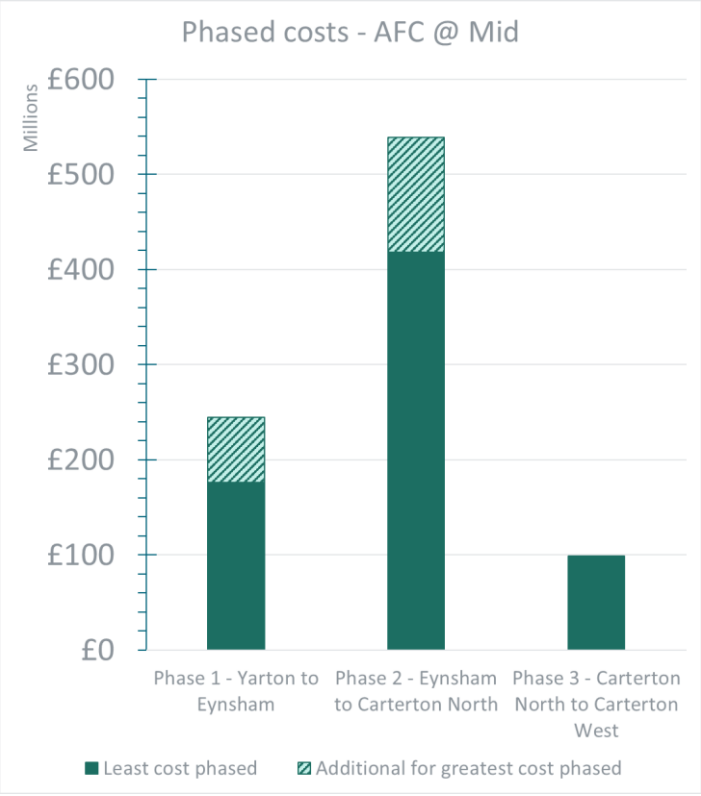


There are disadvantages to phased delivery, notably the loss of efficiencies in working through the planning process, and the consolidation of procurement and project management activities as well as economies of scale for the contractor to deliver. This can lead to delay in delivery and consequential delay in realising proposed benefits.

However, the advantages of phasing are that the whole project is simply not affordable and so it allows the project to be broken into manageable sections, with lessons learned from one phase brought into the next. It also allows potential investors to see how the earlier stages have been received, and (hopefully) give confidence that the forecast demand is realistic.

The potential phasing above is indicative and there are variations that could be considered as discussed further in 6.2, but based on the costs and phases developed above, the following charts indicate the potential costs of each phase with the Medium level risk applied.

Figure 31: Phased routes for AFC at Mid Risk level



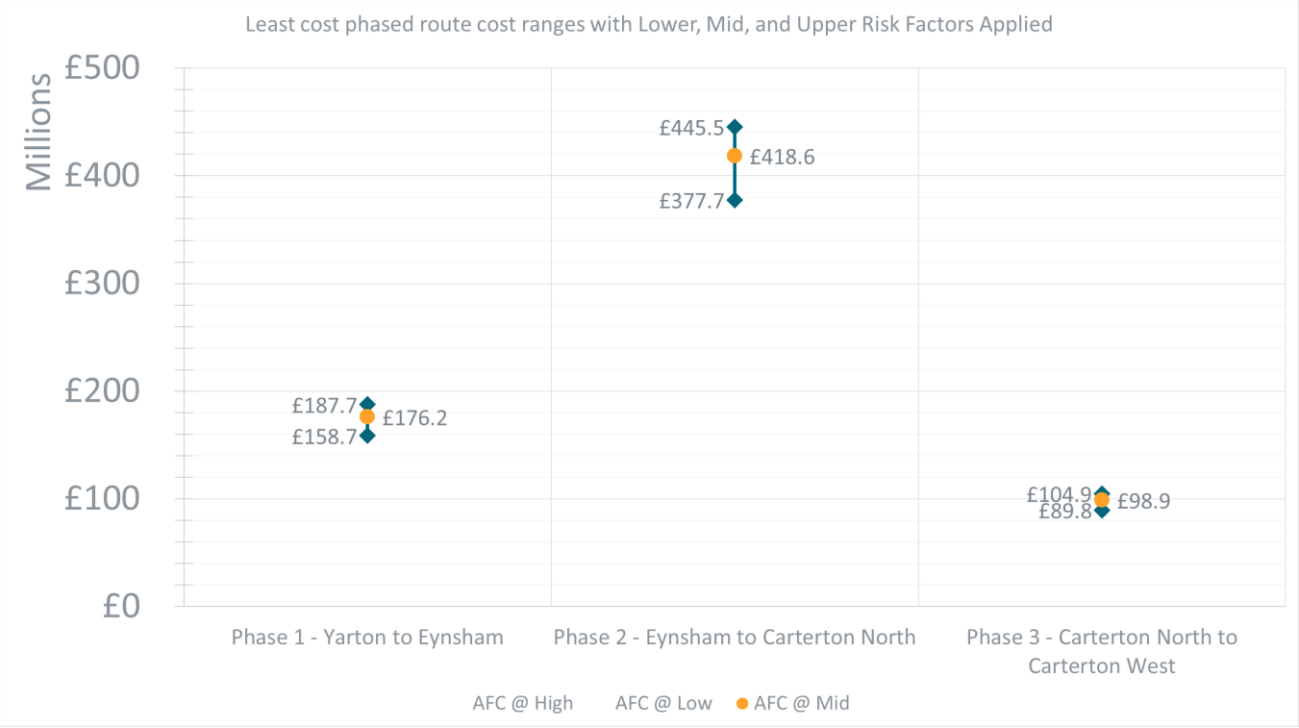
When the whole route is phased, the phase cost ranges based on different route options at Mid-Risk are as shown in Figure 31 and Table 8. These indicate that a new branch line to a new station at Eynsham would cost in the region of approximately £180M to £250M with the second phase cosing approximately £420M to £540M. The final phase would be lower cost at approximately £100M.

Table 8: Phased route costs at Medium risk level

Phase	Least cost route	Greatest cost route
Phase 1: Yarnton to Eynsham	£176M	£245M
Phase 2: Eynsham to Carterton North	£419M	£539M
Phase 3: Carterton North to Carterton West	£99M	£99M

When differing risk levels are taken into account for the Least Cost Phased Route, Figure 32 gives an indication of the potential spread of phased costs. These will be greater for any other combination of section options.

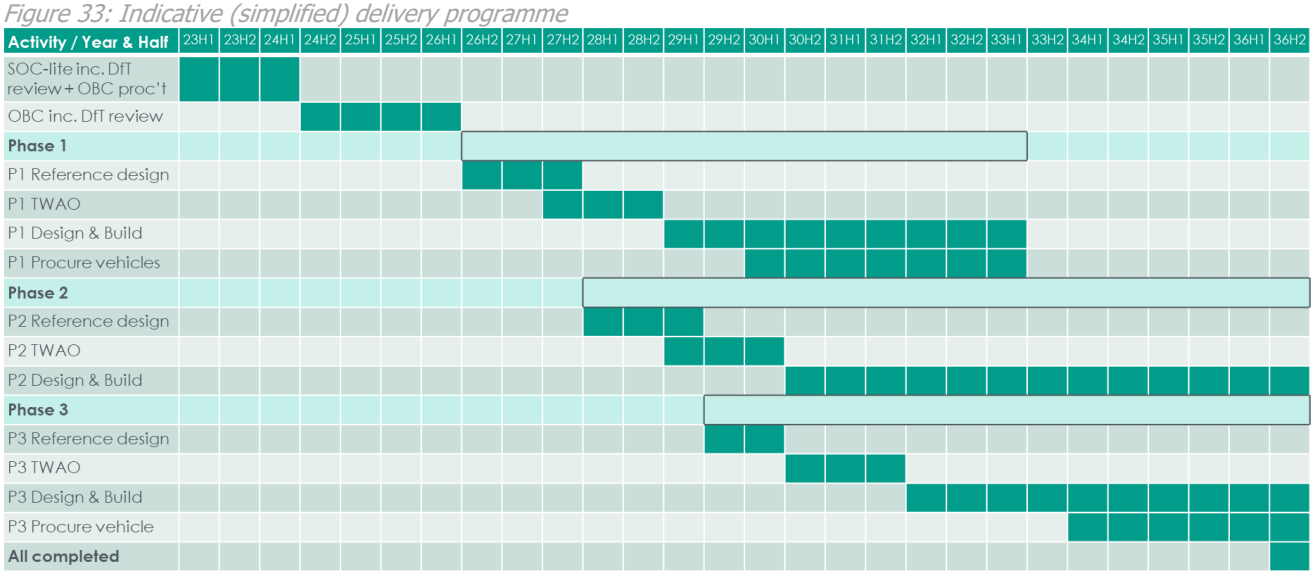
Figure 32: Least cost phased route costs with Low, Mid, Upper Risk



6.2 Delivery programme

A summary of the programme is shown below in Figure 33. A more detailed, but nonetheless still high level, indicative programme is contained in Appendix A.3.

Figure 33: Indicative (simplified) delivery programme



At this stage of the project, the indicative programme encapsulates various assumptions which would be suitable for further strategic discussion e.g.

- 6 month allowance for each DfT review of SOC-lite and OBC reports
- Each phase to be delivered through a Transport and Works act Order (TWAO) rather than Development Consent Order (DCO)
- Each phase to be delivered via its own TWAO, as opposed to combining two or all three
- Design development for each phase to be delivered in sequence, Phases 2/3 awaiting successful outcome of the Phase 1 TWAO before commencement
- Each phase to be delivered via a separate Design and Build contract, for which procurement and DfT signoff takes place during the TWAO process

The comparative complexity between Phase 2 and Phase 3 means that although Phase 3 starts later than Phase 2, it is significantly less complex, so can be completed more quickly and potentially delivered at the same time. This implies that Phases 2 and 3 might be delivered as part of the same contract, and there would be a good basis for doing so but it might be subject to funding dependent on different timing triggers – such as developer agreements or permissions, which is why they are currently shown as separate activities.

Inevitably, the question will be asked whether the programme could be delivered quicker, and the answer is that it can, but it will depend on key stakeholders' appetite for risk, and willingness to work efficiently. Some work shown as sequential might be developed in parallel, or at least overlapping to some extent. But this does introduce the risk of re-work or abortive work if there are late changes or a TWAO application is not granted. The procurement strategy can have a very significant impact on the ability to start work packages quickly and, as a critical path activity, will have a direct impact on the final delivery date.

6.3 Project funding

The question of project funding is considered in the SOC-L report, but it suffices here to note that different funding sources are likely to be necessary in order to deliver the scheme. Potential sources include: The Department for Transport; OCC; Landowners; Developers; and potentially private investors.

7 Conclusion

7.1 Approach taken

The approach taken to the development of this study reflects the outputs required. The outputs of this study are to ascertain physical viability and to understand the potential scale of costs of a viable scheme.

To that end it is not necessary to identify a 'preferred route' or evaluate between route options, but rather to consider at a high level the likely constraints and costs resulting from different route strategies and hence the range of costs that result.

The project team began by understanding what previous studies had considered and concluded. Further information gathering took place in the form of a site visit, and initial stakeholder feedback based on a series of standard questions and some meetings.

Discussions with the client team led to the agreement of a clear and simple mission statement to "Provide a frequent and reliable rail service between Carterton and Oxford via Witney and Eynsham". From this, a range of supporting requirements was developed to help shape the design assumptions and decisions.

The design work began with an assessment of potentially desirable station locations, then the creation of a 'long list' of routes that illustrated different strategies for accessing the stations. Where some of these routes were clearly not going to deliver the key requirements as well as other potential route strategies, they were set aside to leave a short list of routes that might reasonably be contenders for final selection.

To assist in the cost build-ups, the short-listed routes were subdivided into Route Sections that came close together at nodes or 'Common Boundary Points'. This enabled the project team to build up a whole route option length and cost from any combination of Route Section options.

The costs were built up from typical 'all-in' direct costs for different linear construction types, such as viaduct, embankment, at grade, and cutting, plus discrete item costs for other infrastructure at key points, such as stations, road bridges etc. The direct costs were factored up to incorporate allowances for typical overheads, such as project management costs, design, contractors' site setup, overheads and profit, risk allowance etc. to reveal a total cost per Route Section option. The costs for each Route Section were then combined to form a range of whole route costs and route lengths, to cross-check against assumptions made in the operational analysis for the Strategic Outline Case-Lite.

This approach has allowed the project team to focus its attention on developing a limited number of credible route strategies, and gain an understanding of the likely interfaces and costs resulting from each. This provides sufficient detail to feed into the Financial Dimension of the SOC-L. Subsequent project stages and the development of a single preferred route will reduce the cost uncertainty inherent at this stage.

7.2 Key findings

7.2.1 There are viable route options for a resilient half-hourly service using battery trains

The work has identified at least two routes in most route sections that would be viable if taken forward for construction. Each will have different impacts and opportunities but the combination and refinement of these is for a subsequent stage of work.

7.2.2 The whole route costs are substantial but in line with comparator projects

The mid-risk range of whole route costs is estimated to be between £690M and £890M, with key exclusions for land costs and inflation beyond 2023Q1. This is a significant project cost but this should be considered in the light of the value it generates and the cost of alternatives, as discussed in the SOC-L.

The all-in whole route costs have been compared to two other relevant new-build UK railway projects and although they are different to this project, indicate that the costs identified are within an expected range.

7.2.3 The whole route may be delivered in useful phases with Phase 1 in operation by 2033

It is feasible in operational and delivery terms to break the project down into three or more phases if funding for the whole scheme cannot be identified initially.

- Phase 1 would create a new spur off the Cotswold Line to Eynsham by 2033H1
- Phase 2 would extend the railway from Eynsham to Carterton North, and dual the track from just after the junction with the Cotswold Line to the western end of Eynsham station by 2036H2
- Phase 3 would extend the railway from Carterton North to Carterton West with a mix of dual and single track, potentially also by 2036H2

There is a possibility that an interim phase to Witney could be considered, but on balance the expectation is that the relative value for money for extending to Carterton North makes it appropriate to include the route to Carterton North and Witney in Phase 2.

8 Next steps

8.1 Business case

In the very short term, the work of this report feeds into the SOC-L report, primarily within the Financial Dimension section. In that report, the wider aspects of demand, revenue, operations, journey time, and economic value are discussed as part of the five-dimension business case analysis.

The next step for the Business case work would be to prepare an Outline Business Case (OBC) based on a technical Options Selection Report (OSR), described below.

8.2 Technical development

If OCC decides to take this scheme forward, the next technical step would be to identify a range of route options and select a preferred option for further development in an OSR. The purpose of these activities is to enable a robust response to the key questions:

- Which option should be taken forward for development?
- How much will that option cost?

Noting that other rail/bus options have been considered and discounted in the SOC-L, it may nevertheless be appropriate to develop a 'counterfactual' best credible highways-based alternative to provide a non-rail cost comparator for addressing the emerging A40 capacity constraints, though this may only be considered at high level since a highway solution would conflict with OCC's Climate Emergency policy.

The identification and selection of rail route options could require such activities as:

- Options generation and initial sifting
- Horizontal and vertical alignment track design of sifted options
- Desktop geological/geotechnical survey
- Concept design of key structures e.g. the Witney viaduct(s)
- Concept design of stations, including in-principle connections to local neighbourhoods, public transport links and car parking
- Concept design of key highway alterations (e.g. the relocated Witney westbound on-ramp)
- Indicative Masterplanning for Witney Station north option
- Imagery for consultation and engagement
- Workshops with key stakeholders
- Desktop or scoping environmental and archaeological survey
- Preliminary carbon calculations
- Refined cost estimation
- Indicative operational assessment / timetable analysis

The activities above should be focussed on what is required to answer these questions. The design needs to be developed sufficiently far as to enable reasonable and fair comparison between options, with input from relevant stakeholders. For this reason the work may require suitable drawings and graphics for consultation purposes, rather than as an end in themselves.

The selection of a preferred design could require such activities as:

- Public consultation activities
- Workshops with key stakeholders
- Multi-Criteria Analysis

Assessing the costs of each option is part of the selection process, but the improved design will reduce the inherent uncertainty in the cost estimates and justify a reduction in the risk allowances.

Although the indicative overall costs outlined in this study are clearly substantial, and it is unlikely that OCC will have set such sums aside for these works, the cumulative project fees will remain relatively small up to the point where the first package of design and build works is commissioned – anticipated to be early 2029 (see Figure 33).

For the timely delivery of this scheme it will be important to identify suitable funds to ensure progress is made while funding for the bulk of the scheme can be found. Such funding is often contingent on having the greater robustness of analysis from an Option Selection Report and Outline Business Case.

8.3 Gathering support

The 2021 AECOM report[15] for OCC (see SOC-L report for further discussion) indicated that the A40 enhancement schemes would reach practical and operational capacity by 2031 – just eight years away at time of writing. By that time, car journeys from Carterton and Witney will be taking 30 minutes longer and more than doubling car journey time from Eynsham. Bus journeys from Carterton will be nearly 1.5 hrs, and nearly 1 hr from Witney.

These travel times are very likely to have progressively damaging effects on the economies of Oxford and the towns along the A40 as people relocate elsewhere, or do not take up jobs that require travel, or do not visit shops etc.. They also increase pressure for housing closer to Oxford in order to reduce commuting time, and make it ever harder for the RAF to encourage their Service Personnel's families to live in or near Brize Norton.

For Carterton, Witney and Eynsham, a failure to progress the scheme is likely to steadily starve these communities of the ability to work and connect with Oxford. For Oxford, a failure to progress the scheme is likely to gradually undermine the ability of businesses to recruit staff as house prices rise still further beyond the affordability of newcomers, and without staff at reasonable rates, their ability to trade competitively will decline. In short, failure to accommodate growth may precipitate decline.

Fortunately, it would be possible to deliver the first part of this railway by 2033H1 to relieve some of the pressure, and within a few years following, to deliver the rest of the railway for a more sustainable, productive and valuable local economy. But only if the scheme is developed at pace. Railways and other major infrastructure are long-lead projects taking up to a decade and crossing several political cycles.

It is therefore worth encouraging cross-party support wherever possible, along with local businesses and communities through a planned cycle of communications and engagement to build a sense of enthusiasm and ownership over several years. To achieve this, it will be necessary to accelerate the project through the next design development stages because doing so will maximise the ability of the railway to deliver the capacity, journey time and economic benefits needed before the A40 corridor is simply unable to meet the travel needs of the people it serves.

[15] AECOM (2021) "A40 Smart Corridor Scheme, Transport Assessment", report for Oxfordshire CC, November

Appendices

A Project requirements and assumptions

A.1 Project requirements

[Data extracted 16 Feb 2023]

Project requirements are developed at different levels, and are categorised as types to indicate how constrained the requirement is.

At this stage of the project, requirements are typically at Level 0: Mission; Level 1: Principle; or Level 2: Strategic. In time, further disaggregation will illustrate the Level 4: Functional and Level 5: Detailed requirements.

The category types are set as:

- 1. Desirable: Something that *could* be provided, if it has marginal detrimental impact
- 2. Targeted: Something that *should* be provided, unless detrimental impacts are disproportional to the costs
- 3. Mandatory: Something that *must* be provided, or the scheme cannot continue as envisaged

Table 9: Table of requirements

Row ID	Requirement title	Requirement level	Requirement type	Status	Reasons/Explanations	Exceptions ("Unless")	Notes
REQ001	**Provide a frequent and reliable rail service between Carterton and Oxford via Witney and Eynsham**	0: Mission	**3. Mandatory - Must**	**3: Live**			
REQ005	**An existing population of Carterton must be served by a station**	1: Principle	**3. Mandatory - Must**	**3: Live**		**Unless planned as part of a subsequent phase**	
REQ006	**An existing population of Witney must be served by a station**	1: Principle	**3. Mandatory - Must**	**3: Live**		**Unless planned as part of a subsequent phase**	
REQ007	**An existing population of Eynsham must be served by a station**	1: Principle	**3. Mandatory - Must**	**3: Live**			
REQ002	**Frequency of service must be at least hourly in each direction at the busiest times**	1: Principle	**3. Mandatory - Must**	**3: Live**	**A more infrequent service is unlikely to be used**		
REQ003	Frequency of service should be at least half-hourly in each direction at the busiest times	1: Principle	2. Targeted - Should	3: Live	Typical target frequency for a commuter railway		

Row ID	Requirement title	Requirement level	Requirement type	Status	Reasons/Explanations	Exceptions ("Unless")	Notes
REQ004	Frequency of services could be up to quarterly in each direction at the busiest times	1: Principle	1. Desirable - Could	3: Live	If the scheme is a great success, having the capacity for 4tph would be desirable to meet increased demand	Unless significant additional infrastructure required to facilitate	Passive provision might be made in land acquisition and structures.
REQ008	**Service must be able to recover from a westbound train running 2 minutes late from Oxford by the time that same service reconnects with the main line**	1: Principle	**3. Mandatory - Must**	**3: Live**	**To minimise disruption re-imported to the main line**		**Specified timing is up for discussion**
REQ009	Service should be able to recover from a westbound train running 5 minutes late from Oxford by the time that same service reconnects with the main line	1: Principle	2. Targeted - Should	3: Live	To minimise disruption re-imported to the main line		Specified timing is up for discussion
REQ010	Service could be able to recover from a westbound train running 10 minutes late from Oxford by the time that same service reconnects with the main line	1: Principle	1. Desirable - Could	3: Live	To minimise disruption re-imported to the main line		Specified timing is up for discussion
REQ011	The time to travel to Oxford station from any given station should be faster than all other modes	1: Principle	2. Targeted - Should	3: Live	To encourage a modal shift to rail		Assuming practical travel times
REQ015	Failed trains should be able to be bypassed or pushed into a siding	1: Principle	2. Targeted - Should	3: Live	To allow for the storage of a failed train without significant disruption	Unless planned as part of a subsequent phased delivery	
REQ013	Station car parks could incorporate provision for Park and Ride functionality where located within 400m of the A40	1: Principle	1. Desirable - Could	3: Live			We won't have the detail to be able to develop car park sizings until a later design stage
REQ014	**Station car parks must build sufficient spaces for at least 50% of the ten-year demand estimate at first day of operation but have secured sufficient land space for the anticipated ten-year demand**	1: Principle	**3. Mandatory - Must**	**3: Live**	**To provide a minimum design life of ten years before other measures to be undertaken**		**We may not have the detail to be able to develop car park sizings until a later design stage**

Row ID	Requirement title	Requirement level	Requirement type	Status	Reasons/Explanations	Exceptions ("Unless")	Notes
REQ017	Station locations should make allowance for additional financially-sustainable community facilities within or adjacent to the station plot	1: Principle	2. Targeted - Should	3: Live	To pro-actively encourage integration between the community and its station.		Potential uses include: GP surgery; nursery; business start-up zone; community hall; convenience store; food court, etc.
REQ016	**Stations must provide facilities for secure cycle parking**	1: Principle	**3. Mandatory - Must**	**3: Live**	**To encourage active travel to the station**		
REQ019	**Platforms must provide for a minimum 2-car length service**	1: Principle	**3. Mandatory - Must**	**3: Live**	**Shortest train-set length likely to be used**		
REQ020	Platforms should provide for a minimum 4-car length service	1: Principle	2. Targeted - Should	3: Live	07. Station Infrastructure		To allow future lengthening of trains
REQ021	The alignment could provide passive provision for future extension up to 8-car length services	1: Principle	1. Desirable - Could	3: Live	To retain straight and level track where practicable as future provision for capacity enhancement		A ten-car IEP should be able to run with Selective Door Opening; an 8-car set from London to Didcot/ Oxford might be diverted to Carterton for operational reasons
REQ018	Dedicated cycling infrastructure could be provided between the station and the local cycling infrastructure and/or the centre of the population intended to be served	1: Principle	1. Desirable - Could	3: Live	To encourage active travel to the station		
REQ022	Land purchase should be made to accommodate future dual tracking of any single line sections (including construction access)	1: Principle	2. Targeted - Should	3: Live	To support future capacity enhancements / service frequency / resilience	Unless impact is high and probability of needing the second track in a given location is low.	This could be disruptive where close to residential accommodation

Row ID	Requirement title	Requirement level	Requirement type	Status	Reasons/Explanations	Exceptions ("Unless")	Notes
REQ023	The round trip time for a shuttle service from Oxford to Carterton should be no more than one hour, including turnaround times at each end	1: Principle	2. Targeted - Should	3: Live	To allow clock face timetable	Unless through services are envisaged from Cowley or similar or provision of additional train units is acceptable	
REQ024	Track could be suitable for freight services to run	1: Principle	1. Desirable - Could	3: Live		Unless no desire from MOD or other stakeholder	
REQ025	**Route must be designed for possible battery train operation**	1: Principle	**3. Mandatory - Must**	**3: Live**			
REQ026	Route should be designed with passive provision for Overhead Line electrification	1: Principle	2. Targeted - Should	3: Live			
REQ027	Route should be designed to enable phased delivery	1: Principle	2. Targeted - Should	3: Live	To support delivery as funding allows		Phase limits should be driven by step changes in operational cost and benefit, so that each phase can be supported by a positive business case
REQ028	Project should be developed to attract a range of possible funding options	1: Principle	2. Targeted - Should	3: Live	To maximise opportunity of blending funding to achieve sufficient investment		
REQ029	**Route must avoid land with statutory protective designations (e.g. SSSI)**	1: Principle	**3. Mandatory - Must**	**3: Live**	**To avoid risk of project failure due to veto from Environment Agency / Natural England etc. and/or major local objections.**	**Unless suitable mitigation agreed with relevant authorities**	

Row ID	Requirement title	Requirement level	Requirement type	Status	Reasons/Explanations	Exceptions ("Unless")	Notes
REQ030	**Route must minimise residential and commercial property take wherever practicable**	1: Principle	**3. Mandatory - Must**	**3: Live**	**To minimise risk of objection, cost, reputational damage and because it is the right thing to do**	**There are significant societal benefits to be gained by doing so or disproportional costs incurred by adopting an alternative.**	**No property should be taken without a clear and compelling reason for doing so - articulated and signed off before that route is adopted for development.**
REQ031	**Route and stations must minimise land take of designated recreational land (e.g. community playing fields) wherever reasonably practicable**	1: Principle	**3. Mandatory - Must**	**3: Live**	**To minimise risk of objection, cost, reputational damage and because it is the right thing to do**	**There are significant societal benefits to be gained by doing so or disproportional costs incurred by adopting an alternative.**	**No property should be taken without a clear and compelling reason for doing so - articulated and signed off before that route is adopted for development.**
REQ032	Station car parks could incorporate sufficient spaces for at least 100% of the ten-year demand estimate at first day of operation	1: Principle	1. Desirable - Could	3: Live	To provide a minimum design life of ten years before other measures to be undertaken		We may not have the detail to be able to develop car park sizings until a later design stage
REQ033	New stations should be located to maximise integration and access to sustainable travel options- especially active travel and bus services	2: Strategic	2. Targeted - Should	3: Live	This is in line with the vision and policies of OCC's new LTCP	Only known/ planned linkages can be taken into account at present	This will need to be balanced with engineering feasibilty and other constraints
REQ034	New stations should be located to maximise access to existing and proposed (as delivered through new housing sites) populations	2: Strategic	2. Targeted - Should	3: Live	This is in line with the vision and policies of OCC's new LTCP	Only planned new development can be taken into account at this time	This will need to be balanced with engineering feasibilty and other constraints
REQ035	New stations should be designed to integrate sustainable options, as per OCC emerging policy on transport hubs	1: Principle	2. Targeted - Should	3: Live			

A.2 Project technical assumptions

[Data extracted 07 Mar 2023]

Assumptions are listed where there is neither the time or detail to confirm the correct position. As the design progresses, some assumptions can be turned into requirements or design constraints or refined further. A subsequent change to these assumptions could result in changes to the design.

Table 10: Table of assumptions

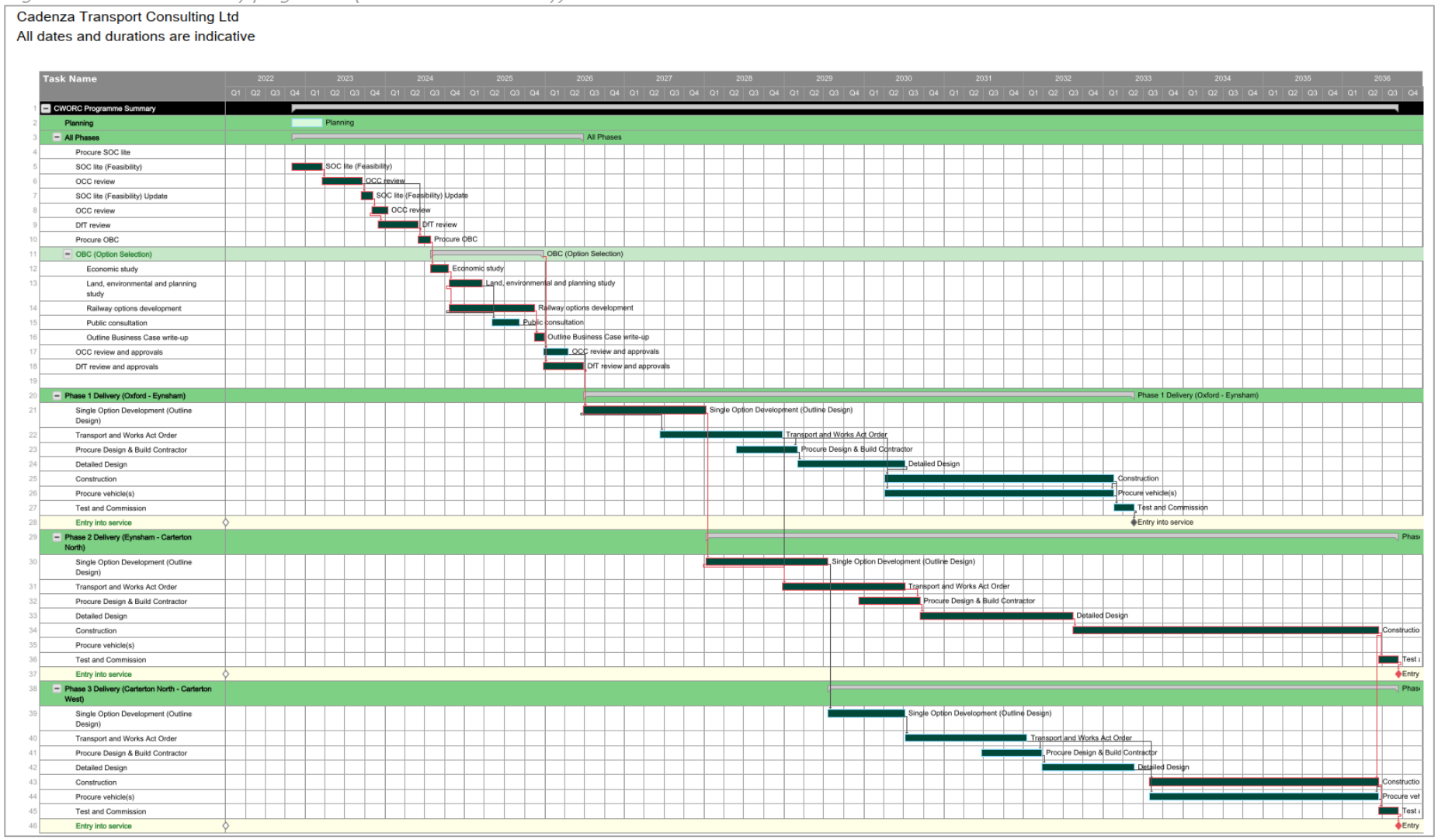
Ref	Assumption topic	Category	Assumption statement	Basis of assumption
001	Service provision	Operations	A minimum of a half-hourly service should be provided	Anything less than half-hourly is unattractive to achieve a modal shift.
002	Traction power	Infrastructure	Passive provision for future electrification should be considered	With wiring expected to Oxford within the next 10 years, and some terminating services there available for extension, it would seem short-sighted not to make such provision
004	Station locations	Infrastructure	The settlements of Carterton, Witney, and Eynsham should be served by proposed stations	Key population/demand centres
005	Oxford station	Operations	A connection to Oxford mainline railway station should be provided.	Essential for interchange with other rail services
006	Dwell times	Operations	Although 45s should be sufficient, timetable 1 minute for now	Includes a small allowance
007	Turnaround times	Operations	A minimum turnround time of 7 minutes should be targeted	Typical assumption across the network for shuttle-type services. Reduction to 6 OK, provided opposite end of route has 8.
008	Journey time	Operations	Total journey time is assumed to be 22 + 1 minutes from Carterton (North) to Oxford.	1 minute recovery time
011	Number of tracks	Infrastructure	Generally to be a single-track route	Minimises infrastructure costs; except for a passing loop, more tracks not needed to sustain service
012	Station provision	Infrastructure	Stations to be unstaffed & hence without significant buildings (category F)	Minimises infrastructure costs; greater facilities not needed for this type of service
013	Station provision	Infrastructure	Although Witney & Carterton (North) to be single-platform stations, Eynsham station to be in two-track section and to have two platforms when the service extends beyond Eynsham. If constructed, Carterton West may need to have two platforms, in order to enable appropriate timetabling, and to allow sufficient time for battery charging	Ability to pass services on the branch line essential; helpful to do so in a station area where speeds are lower, and where any delays can be achieved whilst trains remain in the platform (enabling access/egress)
014	Track layout	Infrastructure	Provide a stabling siding beyond Carterton North, if that is the terminus of the line	Enables storage of failed or engineering train without significant service disruption

Ref	Assumption topic	Category	Assumption statement	Basis of assumption
015	Route design	Infrastructure	No level crossings	Import too much operational/safety risk to the railway, and unlikely to be acceptable to the Office for Rail and Road
016	Line speed	Infrastructure	70mph (approx 110kph)	Balance between capital cost and need to achieve competitive timings
017	Junction turnout speed	Infrastructure	40mph	Balance between capital cost and need to achieve competitive timings/ avoid undue impact on capacity of Worcester line
018	Normal Max Gradient	Infrastructure	1% to facilitate freight trains (localised gradients may be steeper if necessary in accordance with standards)	Balance between capital cost and ability to sustain speeds
019	Normal Min Curvature	Infrastructure	Suitable for max speed except where operational speeds are likely to be slower e.g. through turnouts or on the approach/departure to stations.	Balance between capital cost and ability to sustain speeds
021	Car park charging	Operations	Car parking will be chargeable	[Subject to confirmation from OCC]
022	Ownership of the stations	Operations	Stations owned by Network Rail	[Subject to confirmation from OCC]
023	Ownership of the car parks	Operations	Car Parks owned by Network Rail	[Subject to confirmation from OCC]
024	Stopping pattern	Operations	All trains will call at all three stations on the branch line	It is unlikely that there would be any benefit to a 'skip-stop' or 'fast' train arrangement
025	Train type	Train	Trains will be Battery Electric Multiple Units (BEMU)	Similar in style to the 'VivaRail' fastcharge battery proposition providing a full charge in 7-8 mins for up to 60-mile range
026	Train charging	Train	Trains will charge in Oxford station using Overhead wires or dedicated facility	OLE power will have been delivered to Oxford station by the time this project comes to fruition

A.3 Indicative delivery programme

(see section 6.2 for discussion)

Figure 34: Indicative delivery programme (dominant elements only)



Please note that this indicative programme is not intended to contain all aspects of the delivery programme, but simply the likely dominant elements. It is subject to strategic decisions on the number and extent of any phases, the bundling of any design and planning activities, and budget/authorisations from OCC.

B Cost estimation notes

B.1 General comments

Any estimate is based on the limitations of the design detail available, as well as key assumptions and exclusions as listed below. Assumptions will be refined and confirmed or changed in subsequent project development so that the estimate can be improved. Similarly, excluded items may be incorporated into the later estimate as sufficient data become available to provide a reasonable basis to estimate. Subsequent design or contextual information may change the assumptions and hence the nature and cost of the project.

B.2 Cost estimate assumptions

- The Pricing Date of the Project is 2023Q1
- The Scope is based on quantities from Google Earth
- The Risk is based on SOC stage
- It is assumed that railway works will be carried out by an experienced railway contractor and the works shall be competitively tendered on a traditional form of contract
- All quantities are assumed until Designs are made available
- All slopes to cuttings and embankments will be at 1 in 3 (1 in 4 is sometimes preferred, but results in significant land take and expense for deep cuttings, where it is assumed that an alternate such as diaphragm wall retained cut would be adopted where cheaper)
- 30% cutting material can be re-used in embankments
- 20% cost savings in embankments from re-use of cutting material
- Land cost allowances are limited to the railway footprint on agricultural land only

B.3 Cost estimate exclusions

- Station Buildings
- Traction Power (Overhead Line Electrification)
- Site Investigation and Ground Investigation
- Allowance for Optimism Bias
- Diversion of existing infrastructure except where explicitly stated
- No allowance has been made for Operational Expenditure (OPEX) or maintenance costs
- No allowance for interfacing with other projects
- Costs associated with phasing of the works
- Park and Ride facilities
- Costs associated with taxes and levies, including VAT
- Costs associated with licenses and all associated costs and fees
- Costs associated with changes in legislation and any form of applicable standards
- Excludes accommodation works associated with the encroachment upon private land
- No allowance has been included for inflation beyond the Price Base
- Trains and train-borne equipment
- Battery charging points
- Land access payments
- Strategic Spares
- Costs associated with rail possessions or road closures
- Costs associated with the temporary or permanent diversion of water courses or water bodies
- Costs associated with temporary or permanent land use beyond the railway footprint
- Any sidings or infrastructure exclusively for the use of the MOD at Carterton/Brize Norton