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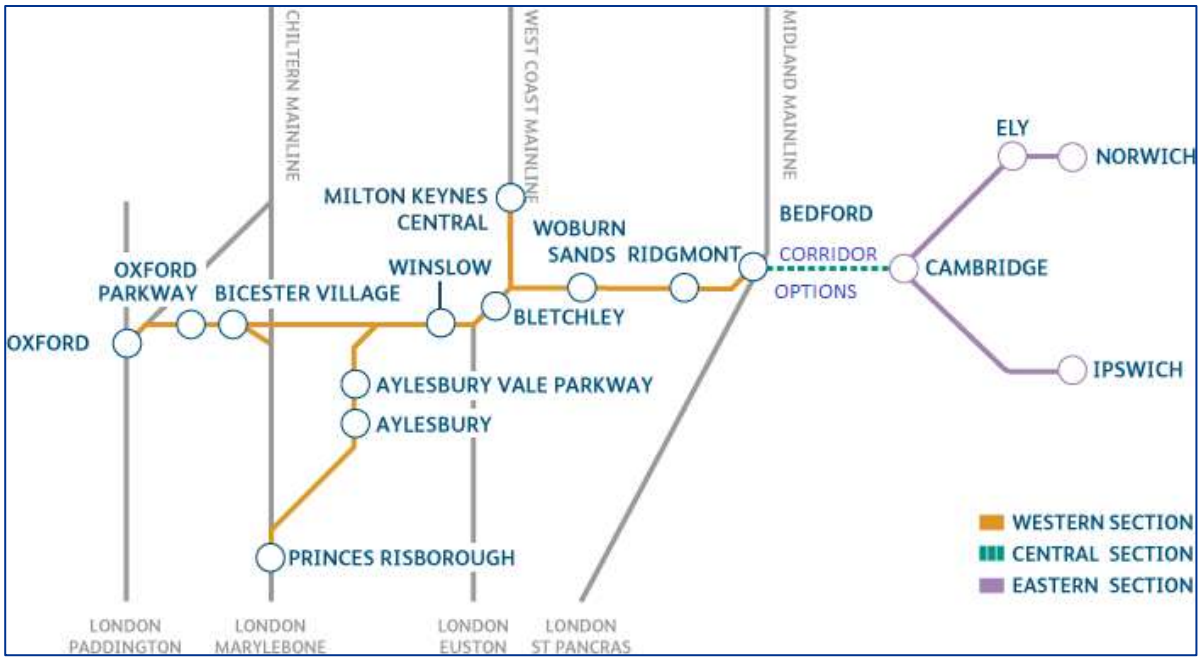
# East West Rail – Central Section

## Engineering Summary Report

B22380FA – 0001

15 February 2016



# Document control sheet

**Rail (EHR F17.1)**
**July 2015**

| | | | |
|---|---|---|---|
| **Project:** | **East West Rail – Central Section** | | |
| **Client:** | **Network Rail** | **Project Number:** | **B22380FA** |
| **Document Title:** | Strategic Options Report | | |
| **Doc. No:** | B22380FA – 0001 | | |

| | | Originated by | | Checked by | | Reviewed by | |
|---|---|---|---|---|---|---|---|
| **ORIGINAL** | **ISSUE B01** | NAME [redacted] | Initials **JM** | NAME [redacted] | Initials **MC** | NAME [redacted] | Initials **CQ** |
| **Approved by** | | NAME **Chris Chantler** | | I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue** | | | INITIALS |
| DATE | **20/05/2016** | **Document status: Issued for Client Approval** | | | | | |

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|---|---|---|---|---|---|---|---|
| **REVISION** | **ISSUE B02** | NAME [redacted] | Initials **JM** | NAME [redacted] | Initials | NAME [redacted] | Initials |
| **Approved by** | | NAME | | I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue** | | | INITIALS |
| DATE | **6th July 2016** | **Document status: Client Revisions** | | | | | |

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| **REVISION** | **ISSUE** | NAME [redacted] | Initials | NAME [redacted] | Initials | NAME [redacted] | Initials |
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| DATE | | **Document status** | | | | | |

# STRATEGIC OPTIONS REPORT: EAST WEST RAIL – CENTRAL SECTION

## 1. INTRODUCTION

1. The East West Rail (EWR) project is intended to provide a strategic rail corridor connecting East Anglia with central, southern and western England.

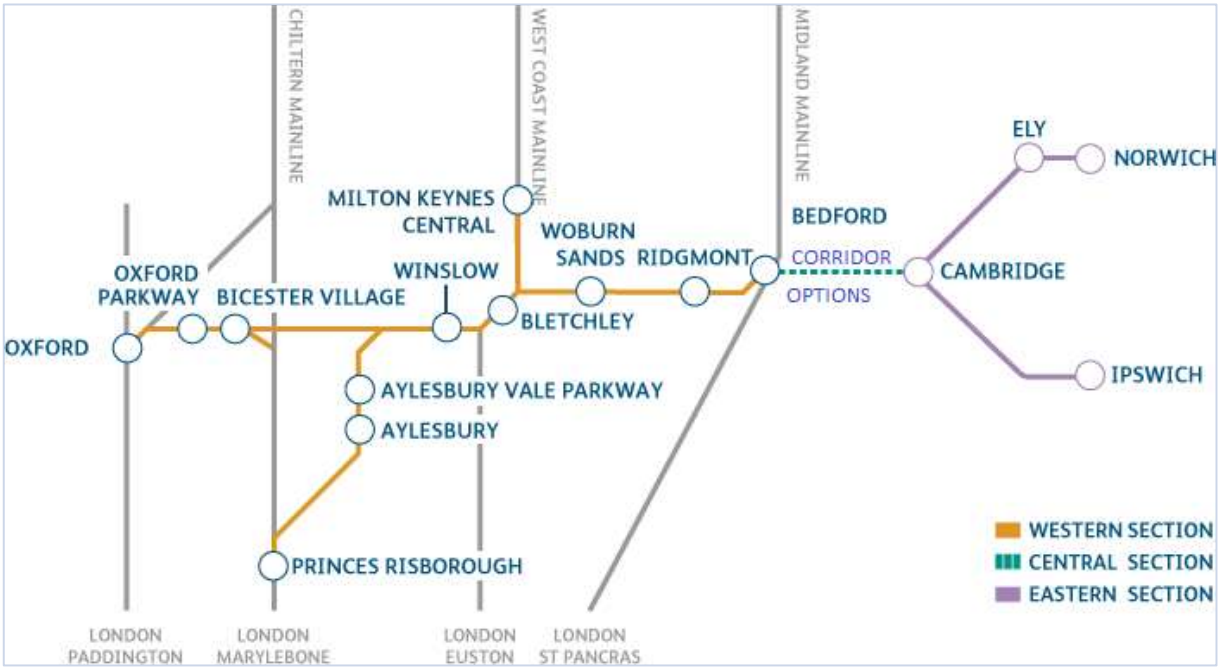
2. EWR has strong support from the Department for Transport (DfT) and Network Rail. Stakeholder organisation is provided by the East West Rail Consortium (EWRC), which is a group of local authorities and business representatives with an interest in improving access to and from East Anglia and the Milton Keynes South Midlands growth area. Membership of the consortium can be found at: www.eastwestrail.org.uk.

3. EWR encompasses a corridor shown in the figure below between Oxford and Norwich/Ipswich, with connections to Aylesbury, Milton Keynes, Bedford, and Cambridge. Divided into three sections, which are in different states of development, EWR comprises:

    - The **Western Section** between Oxford and Bedford and Aylesbury. Upgrading this route is a committed scheme and train operations have begun from Oxford Parkway to London Marylebone via Bicester Village, to be followed later with connections to Bedford.

    - The **Central Section** between the EWR western section and Cambridge, where there is now little or no existing rail infrastructure following the closure of the former Varsity Line in 1967.

    - The **Eastern Section** between Cambridge and Norwich and Ipswich, where an operational railway already exists.




4. Feasibility studies into the **Central Section** of EWR have been progressed in three phases. The first phase was managed by the EWRC, while Phases 2a and 2b have been delivered by Network Rail. The activities and outcomes from the work to date are presented in this Strategic Options Report.

## 2. PHASE 1 – EWRC and the CONDITIONAL OUTPUT SPECIFICATION

5. The EWRC carried out an initial analysis for the East West Rail - Central Section (EWR-CS) to establish whether there was a case for investment; this resulted in the production of a Conditional Output Statement (COS) in August 2014.

6. The COS comprises an initial set of economic analyses that provide an outline case for better connecting the towns and cities along the EWR-CS corridor. The assessment took into account the economic benefits of enabling improved rail travel between locations, whilst not making any assumptions about specific routes, or the rail infrastructure required to do so.

7. In developing the conditional outputs the EWRC defined the following set of strategic objectives that are specific to the EWR-CS business case, and also align with Network Rail's long term planning criteria:

    - improve east west public transport connectivity;
    - increase economic growth, prosperity and employment within the South-East of England through improvements to east west rail links;
    - provide faster, more reliable and additional rail links from the west to Cambridge, Norwich and Ipswich;
    - improve journey times and reliability of inter-regional and commuter journeys;
    - increase capacity for inter-regional and commuter journeys;
    - maintain and enhance capacity for rail freight; and
    - contribute to tackling climate change

8. The COS considered potential origin and destination locations along the route and journeys between these so-called 'journey pairs' were then assessed to identify the potential benefits. The COS used an established industry methodology for assessing passenger benefits (including journey time savings), freight transport benefits, and wider economic benefits focussed through a Gross Value Added (GVA) analysis. Although it was not designed to produce an overall business case, this approach allowed different journey pairs to be assessed on their relative values. The result was a set of journey-pair outputs that were ranked in terms of passenger and freight value, and economic priority.

9. Key findings from the COS are:

    - The initial consideration suggests that a EWR-CS scheme that delivered a service specification consistent with the conditional outputs has genuine potential to generate sufficient benefits to justify the capital investment that may be associated with the scheme.

    - EWR-CS has the potential to provide vital additional capacity to the Strategic Freight Network to cater for the forecast increases in intermodal and bulk rail freight.

10. The COS recommended the development of EWR Service Scenarios for freight and for passenger services. This would then allow the production of indicative timetables for an Outline Business Case supported by technical studies as required by the DfT.

11. In August 2014 the DfT asked Network Rail to take the lead on EWR-CS development activities through its Long Term Planning Process (LTPP). The LTPP considers the role of the railway in supporting the UK economy and comprises activities that address the future market demands on the rail network over the next 30 years, whilst capturing aspirations for new train services and presenting investment choices for funders.

12. Network Rail welcomed the development of the COS conditional outputs and undertook to assess how they aligned with the outputs required by the Network Rail LTPP.

13. In developing railway infrastructure enhancements, the rail industry places emphasis on the ability of potential schemes to show how benefits can be achieved in the following areas:

- the environment and carbon reduction;
- economic growth through connecting businesses with each other, and people with jobs;
- quality of life by improving connectivity for passengers; and
- value-for-money and the reduction of public subsidy.

14. These broad criteria are used to focus long term planning and they form the basis of market studies that seek to understand future demand.

15. All options for the EWR-CS would involve the construction of new sections of railway of more than 2km in length t on land which does not form part of Network Rail's existing operational land. Therefore the construction of EWR-CS would be a Nationally Significant Infrastructure Project (NSIP), as defined by the Planning Act 2008 (the 2008 Act) and so would require authorisation by way of a Development Consent Order under the 2008 Act. The National Networks National Policy Statement for rail NSIPs sets out the need for an Options Appraisal and the work being led by Network Rail will contribute to this.

16. The aim of the Network Rail led work was to progress the benefits analysis prepared by the EWRC by considering the relationship between strategic objectives and conditional outputs, and developing solution options that could demonstrate value for money.

17. The rest of this Strategic Options Report presents a summary of the extensive work done for the EWR-CS by Network Rail during two subsequent phases of work, Phases 2a and 2b, over a two year period from 2014 to 2016.

## 3. PHASE 2a AND PHASE 2b – CORRIDOR ANALYSIS AND BUSINESS CASE BY NETWORK RAIL

### a) Reviewed documents

18. Network Rail, working with the EWRC, generated a wide cross-section of options which would provide connectivity across the EWR-CS. These options were assessed in terms of their business case and alignment to the COS.

19. During **Phase 2a** potential railway corridor options for the EWR-CS were identified and then assessed and rationalised. Twenty corridors were identified and assessed. Subsequent rationalisation reduced this number to seven corridors and two of the corridors were then identified for further assessment in Phase 2b. This work was reported in the **East West Rail - Central Section Phase 2a Report** dated 4th August 2015.

20. During **Phase 2b** Network Rail investigated potential corridor constraints and demand analysis, which informed the calculation of Benefit Cost Ratios (BCR) for each of the two corridors identified in Phase 2a. The outputs from the Phase 2b studies consist of nine Technical Notes. The economic work was supported by seven Engineering Corridor studies and associated journey time calculation reports. The data contained in the Technical Notes and engineering studies was collated and presented in the **East West Rail Central Section Phase 2B Final Report** dated 19th February 2016 in Draft and in its final issue dated 26th April 2016. The result of Phase 2b was the identification of one preferred corridor for EWR-CS.

21. The reviewed documents produced in Phases 2a and 2b are listed in Appendix A and the work done is summarised in the following sections.

### b) The Phase 2a Report

22. The work to identify and rationalise the number of feasible corridor options was presented in The **East West Rail - Central Section Phase 2a Report** dated 4th August 2015. The Report describes how the

potential corridors were rationalised from twenty to seven, which were further assessed using defined criteria so that two corridors could be recommended for more detailed assessment.

### c) The Rail Industry Workshop

23. The Phase 2a work commenced with a rail industry workshop held on the 22nd August 2014, which included delegates from Network Rail, the EWRC and Atkins (the Phase 1 Consultants). A full record of attendees is contained in the Network Rail Phase 2a Report dated 4th August 2015.

24. The workshop participants selected the following criteria for success:

- Local Economic Growth Benefits Realisation
- Key Growth Location Connectivity
- Strategic Long Distance Passenger Service Potential
- Long Distance Freight Strategy
- Planning / Environmental Constraints
- Operational Issues and Constraints
- Infrastructure Requirements (existing railway)
- Infrastructure Requirements (new railway)
- Comparative Cost

25. The workshop identified twenty possible corridor options for EWR-CS within a geographic boundary between the southern limit of St Albans/Harlow and a northern limit of Peterborough. The twenty possible corridors identified by the workshop are listed in Appendix B together with the colour coded assessment ranking against the listed success criteria. Reference can also be made to the Workshop Output Report dated 3rd September 2014 listed in Appendix A.

26. The identification of the twenty potential corridors was achieved by splitting each corridor into new or upgraded Rail Links created by new or existing railway infrastructure to make a connection between Nodes, which consist of existing stations or existing railway infrastructure.

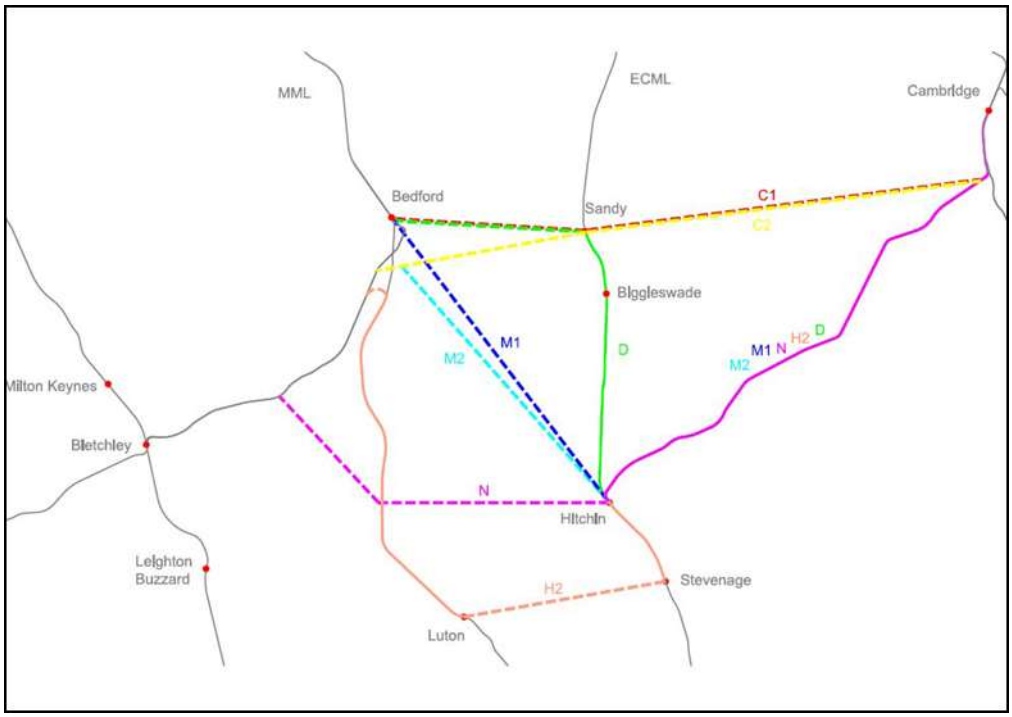
27. The workshop delegates used the previous COS work by the EWRC as a basis, along with engineering judgement, to identify and assess the station nodes, rail links and the interfaces with existing railways for the twenty possible corridors.

28. The nodes, links and existing railway constraints for the twenty possible corridors were selected for the purposes of economic evaluation for each corridor and are not exhaustive. There are other route options that might require a different combination but the workshop considered that those selected were sufficient to test the performance of each corridor against the criteria set out in paragraph 24 above.

29. The conclusion reached by the workshop delegates was that seven of the twenty corridor options should be further considered. These corridors are listed below:

- C1 - Bedford Central – Sandy – Cambridge
- C2 - Bedford South- Sandy - Cambridge
- D - Bedford Central – Sandy – Hitchin – Cambridge
- H2 - Bletchley - Luton - Stevenage – Cambridge
- M1 - Bedford Central – Hitchin - Cambridge
- M2 - Bedford South – Hitchin - Cambridge
- N - Bletchley – Harlington – Hitchin - Cambridge

30. The selected corridors are shown in the map below.




### d) Assessment of the Selected Corridors

31. The selected corridors were assessed in terms of the engineering and environmental aspects of the interventions needed for each corridor. Interventions, defined as new or altered infrastructure, are tabulated below for the seven corridors.

| Corridors | Station Nodes | Rail Links | Existing Railway Constraints |
|---|---|---|---|
| C1, C2<br>D<br>H2<br>M1, M2 | • Bedford Midland and South – 6 options<br>• Hitchin – 12 options<br>• Harlington – 4 options<br>• Luton – 2 options<br>• Sandy – 4 options | • Bedford – Sandy<br>• Sandy – Cambridge<br>• Bedford – Hitchin<br>• Ridgemont – Harlington<br>• Harlington – Hitchin<br>• Luton to Stevenage<br>• Stewartby Chord | • Midland Main Line (MML)<br>• East Coast Main Line (ECML)<br>• Cambridge to Hitchin Branch (SBR), including affected stations and level crossings<br>• Cambridge on the West Anglia Main Line (WAML)<br>• Marston Vale Line (BBM) |

### e) Station Nodes

32. Of the six possible station node options at Bedford two options were highlighted as offering more benefits. These were the Bedford South (Wi2) Hitchin Alignment and the Bedford (Be4) Bedford Parkway Station option. The workshop delegates concluded that the latter with its new split-level parkway station serving the EWR-CS and Midland Main Line (MML) south of Bedford offered the most economic benefits mainly because of improved east-west journey times. Also, this preferred option is suitable for more Corridors, namely; C1, C2 D, M1 and M2 when compared to the other option, which is suitable only for Corridors C2 and M2.

33. Of the twelve possible station node options at Hitchin, two were considered to offer the best economic benefits. Both are north of Hitchin and both are without a connection to Hitchin station (suitable for

Corridor D and Corridors M & N). Only Corridor D provides a connection from the East Coast Main Line (ECML) to the Shepreth Branch (SBR) from Hitchin to Cambridge.

34. The four Harlington station options (suitable for Corridors H2 and N) required extensive station works, station closure (either to relocate the station to the north or south), or 4-tracking of the Midland Main Line (MML). The economic benefits were considered to be poor mainly because of a lack of significant future growth prospects.

35. Corridor H2 would utilise the MML southwards to Luton before branching off to Stevenage as shown in the diagram in paragraph 24 above. The connection between this branch and the MML would need to be formed as a grade separated junction (where the lines cross each other at different heights) rather than an at-grade or flat junction because this arrangement would limit the route capacity on the MML.

36. Four options for economic evaluation were identified for Sandy. Three of the options crossed the ECML to the north of the town and one crossed to the south. Two options to the north (Sa1/1a and Sa4) were selected for further analysis; the former flying over the ECML at a new station and the latter making a segregated connection to the ECML with new platforms at Sandy Station.

### f) New Rail Links

37. The possible rail links between station nodes are listed in the table in paragraph 31 above and a short description of them is provided in the following paragraphs.

38. **Bedford Central/South to Sandy**: This twin track railway section is approximately 20km long and would leave the Marston Vale Line (BBM) before joining the ECML Slow lines, southbound, at a grade separated junction north of Sandy. Restoration of the original alignment is difficult because of significant development on and adjacent to the old line has taken place.

39. **Sandy – Cambridge**: From Sandy the railway would follow a new alignment that is likely to include a tunnel of approximately 3.7km length, before joining the former Sandy to Cambridge railway route towards Cambridge using short sections of new connecting lines.

40. **Bedford Central/South to Hitchin**: A new alignment from the Stewartby area could run eastwards for approximately six miles before turning south onto the former Bedford to Hitchin alignment, including the reopening of the Old Warden Tunnel, before joining one of the Hitchin Node options. The former alignment has had significant development on it. Significant remedial work would likely be required to reopen the Old Warden Tunnel.

41. **Ridgemont – Harlington:** This rail link could leave the Marston Vale Line (BBM) at Ridgemont and follow the approximate line of the M1 motorway until the vicinity of Harlington, requiring crossings of the A507 and A5129 roads.

42. **Harlington to Hitchin**: This railway alignment is approximately 16km long and could run between the Harlington node and the Hitchin node using a short section of the ECML and a flyover of the MML. A crossing of the A6 would likely be necessary.

43. **Luton to Stevenage**: This new twin track section of approximate length 16km could connect into the MML and the Hertford Loop using double junctions and grade separation of the ECML. The topography means that the alignment would potentially require a 5km long tunnel at the western end, while the eastern end would potentially be in a 4km long tunnel. The approximate 7km long central section would likely be on embankments and in cuttings with a large bridge over the Mimram River valley.

### g) Existing Railway Constraints

44. The existing railway infrastructure in the area of the EWR-CS comprises the Midland Main Line (MML), the East Coast Main Line (ECML), the Shepreth Branch (SBR), the Cambridge to Hitchin West Anglia Main Line (WAML), and the Bletchley to Bedford (BBM) or Marston Vale Line.

45. The available capacity on each existing line was assessed under current train operations and against the capacity requirements of EWR-CS set out in paragraph 74 and paragraph 75 of this report, for "Do-Something" and "Do-Minimum" scenarios.

46. Corridor H2 would require train paths on the MML from a selected station location at Bedford to a selected station at Luton. The Development Timetable (DTT) 2020 for the MML indicates that up to four paths could be available but the times for these are fixed and they would therefore dictate the EWR-CS timetable. Recognising that this constraint would lead to difficulties in achieving an efficient timetable for EWR-CS, Network Rail considered possible signalling improvements and the benefits of a future and higher capacity digital railway, along with additional infrastructure capacity provision including 6-tracking of the MML. However, it was found that these interventions were unlikely to be sufficient to enable EWR-CS services to work efficiently with existing and future MML services.

47. Corridor D and H2 would require paths on the ECML and initial assessment indicated that capacity on the ECML could provide for the EWR services. However, opportunities to provide through-services to Cambridge on the existing SBR without capacity improvements on that line would not be readily available.

48. For the purposes of the Phase 2a studies it was assumed that all level crossings on existing affected lines would be closed and be replaced by grade separated crossings. This was because of the increased train frequency resulting from the future EWR-CS services (applicable to Corridors D, M1, M2 and N) and the extended periods during which the barrier would be closed. This would result in increased disruption to road traffic and reduced safety.

49. An operational restriction on the SBR Cambridge Branch is the difference in running time for fast and semi-fast services (19 minutes versus 30 minutes), which is further emphasised by three stations in a single 3-mile section and the need to provide a freight path. The different train speeds and stopping patterns means that the line capacity of a twin track railway is reduced and initial capacity modelling showed that the railway between Foxton and Meldreth would need to be doubled to 4-tracks to accommodate the level and mix of services.

50. All identified corridor options would require substantial capacity enhancement work on the West Anglia Main Line (WAML) between Shepreth Junction and Cambridge to accommodate increased services arising from the EWR-CS corridors. The existing 2 and 3-track railway would need to be increased to 4 tracks over a distance of 4.5km with recognition that the existing Overhead Line Equipment (OLE) and existing bridges might need adjustment for the increased track width.

51. A further consideration is that in order to provide the fourth track into Cambridge station, the existing reception siding may need to be converted to a running line and alternative facilities provided for the storage of trains.

52. Using the listed criteria in paragraph 24 above the benefits and dis-benefits of each option were examined at the Rail & Consortium Workshop held in August 2014, and the twenty possible corridors were reduced to eight, then seven because one was a minor variation of Corridor M. Two of the seven remaining options were also variations of Corridors C and M.

### h) Initial Business Case Analysis

53. The seven corridors identified at the workshop were considered further in order to identify constraints and opportunities. The seven corridors are listed in paragraph 55 below are also shown graphically in paragraph 25 above.

54. Anticipated Final Costs (AFC) for the seven options were developed, for comparative purposes only, to enable business case analysis to be undertaken, with the intention of identifying the corridors which offered the best value to take forward for further development. At this stage the AFC calculation did not include the Wider Area Benefits discussed later.

55. The seven corridors are tabulated below along with their indicative journey times and AFCs with resulting Benefit Cost Ratio (BCR).

| Corridor | Description | Journey Times in minutes (Fast/Semi-Fast) | AFC | Benefit Cost Ratio (Base/high growth) |
|---|---|---|---|---|
| C | C1 - Bedford Central – Sandy – Cambridge. | 64/77 | £1.361bn | 1.49/1.63 |
| | C2 - Bedford South- Sandy – Cambridge. | | £1.264bn | |
| D | D - Bedford Central – Sandy – Hitchin – Cambridge | 99/107 | £1.064bn | 1.08/1.16 |
| H2 | H2: Bletchley –Stewartby- Luton - Stevenage – Cambridge | 97/111 | £2.536bn | 0.77/0.81 |
| M | M1 - Bedford Central – Hitchin – Cambridge | 82/94 | £0.988bn | 1.33/1.43 |
| | M2 - Bedford South – Hitchin - Cambridge | | £0.925bn | |
| N | N - Bletchley – Harlington – Hitchin - Cambridge | 77/90 | £1.247bn | 1.11/1.18 |

56. The AFC calculations used a 2014/15 base and with project risks set at Network Rail's lowest level of certainty, which attracts the UK Treasury's Optimism Bias correction of plus 66%. This allowance will reduce once more understanding is developed for the project options.

57. The economic analysis was modelled on a 60 year period from 2024 to 2083 using standard and high growth scenarios. The former is derived from the National Trip Ends Model (NTEM) and the latter is from the Local Enterprise Plan Partnerships' growth calculations. Both scenarios gave similar future discounted benefits (*current value of future benefits taking inflation into account)* for the corridors, varying from £3.7bn to £4.6bn with future discounted costs benefits (*current value of future costs taking inflation into account*) ranging from £3.1bn to £4.9bn.

58. The analysis indicated that Corridors C and M provide the highest BCRs for both base and high growth scenarios. The BCR for Corridor C was calculated to be 1.49 and 1.63 respectively, while the BCR for Corridor M was calculated to be 1.33 and 1.43 respectively.

59. Corridor D and H2 had low BCR scores and longer journey times. Corridor N had the lowest overall score because of the combination of high cost and poor long distance journey times, resulting in overall low benefits.

60. Corridor C was found to have the greatest requirement for new infrastructure and consequently a high capital cost, although it had the highest potential to meet the other success criteria listed in paragraph 24 above.

61. It should be noted that the comparative costs are affected by unresolved issues around options at stations such as Bedford, Sandy, and Hitchin, where trade-offs exist between providing fast journey times to through passengers, optimal access to the local catchment area, and convenient interchange with other services. A potential new station at Addenbrookes, to the south of Cambridge on the WAML, was also considered, which was found to have similar impacts on BCR scores for all options.

62. Corridor M was presented with the lowest capital cost.

63. At the end of Phase 2a and based on the economic analysis carried out, it was recommended by Atkins that Corridors C and M should be taken forward for more detailed development and that work on the other corridors should be paused. This was endorsed later by the Rail Industry Steering Group at a meeting held on 2nd September 2015 with agreement to further assess Corridors C and M in the next stage of the work described as Phase 2b in the following sections of this summary report.

### i) Phase 2b–Further Engineering & Business Case Analysis for Corridors C and M

64. The aim of Phase 2b was to identify a single preferred corridor. As part of that process, potential constraints along Corridors C and M were identified and avoidance or mitigation solutions developed in line with the EWR-CS success criteria set out in paragraph 24 above.

65. A series of seven desk-top studies were carried out during 2015 for route options within Corridors C and M, including a study into the SBR upgrade required for the Corridor M options. These studies sought to identify the likely issues associated with the two preferred corridors. The routes were chosen to highlight the significant potential variations within the corridors, not to attempt to identify a preferred route.

    The options (with two variations for Corridors M1-4 and M2-3) are described in the table below and reference can be made to Appendix C for their alignment diagrams.

| Option | Outline Alignment |
|---|---|
| C1-1 | Bletchley – Bedford St Johns – Sandy – Cambridge |
| C1-8 | Bletchley – Bedford Midland – Sandy – Cambridge |
| C1-9 | Bletchley – Bedford Midland – Sandy* - Cambridge |
| C2-2 | Bletchley – Bedford South Parkway – Sandy – Cambridge |
| M1-4H | Bletchley – Bedford Midland – Hitchin – Cambridge |
| M1-4L | Bletchley – Bedford Midland – Letchworth – Cambridge |
| M2-3H | Bletchley – Bedford South Parkway – Hitchin – Cambridge |
| M2-3L | Bletchley – Bedford South Parkway – Letchworth – Cambridge |

*New site between existing Sandy and St Neots

66. A description of each route and the key findings from the desk-top studies is provided in the table below. It is noted that all options were assessed using the assumption that the Bethnal Green to Kings Lynn (BGK) line from Shepreth Junction to Cambridge (a section of the WAML) would need to be 4-tracked with track slewing, reconstruction of overbridges and underbridges, and other structures. Furthermore, for all these options, the assumption is that other than providing platforms on the ECML, there is no major impact on this line.

| Corridor | Route | Rail Link | Route Description | Key Aspects |
|---|---|---|---|---|
| C | **C1-1** (BstJ-Sn-C) | Bletchley - Bedford St Johns-Sandy-Cambridge | From Bletchley Station northwards on the existing Bletchley to Bedford (BBM) Line then diverging immediately south of Bedford St. John onto the former Bedford to Sandy formation and continuing east over the ECML. A new station perpendicular to the existing Bedford St. John station would provide a Bedford stop and a relocated Sandy Station would be provided to the north of Sandy. Joining the SBR line near to Foxton Station the route then joins the BGK route north of Shelford Station and completes the C1-1 route at Cambridge Station. | Route length is 72km, with 38km of new twin track railway. Relocate Bedford St Johns Station and new split level Sandy ECML station. Route planning to consider 22 overbridges, 9 underbridges, and 39 culverts with landfill sites and Quarries, 8 watercourses, flood zones and alluvial deposits. Would generate an estimated 1.05million $m^3$ earthwork surplus. Involves work near one SSSI. There are 7 Scheduled Monuments within 300m of the centreline of this potential route and 6 Grade II buildings; a path and cycle route is maintained along the former Bedford to Sandy railway route; and 33 residential, 7 industrial and 18 commercial buildings. [redacted] |
| | **C1-8** (BM-S exist) | Bletchley - Bedford Midland-Sandy-Cambridge | From Bletchley Station on the existing BBM line this potential route continues to Bedford St. Johns Station and then Bedford Midland Station. The route then splits from the MML around the north of Bedford and onto a relocated split level Sandy Station. It joins the existing SBR near to Foxton Station then joins the BGK route north of Shelford Station and completes the C1-8 route at Cambridge Station. | Route is 81km long with 42km of new twin track railway, additional platform at Bedford St Johns Station, a stop at Bedford Midland station and a new Sandy split level Station at ECML, 100m south of existing Sandy Station with 250m long viaduct.<br><br>Station remodelling would require disruptive possessions for new through track, platforms and signalling affecting the BBM and MML. Route planning to consider 17 overbridges, 21 underbridges, & 43 culverts; landfill sites and quarries with 8 watercourses, flood zones and alluvial deposits. Construction would generate an estimated 1.0m $m^3$ earthwork surplus. Within 300m of the centreline, there is one SSSI near woodland, three Scheduled Monuments; a waste water treatment works near Bedford; underground reservoir and Aviation Fuel Depot east of Sandy; residential properties and a cemetery west of Sandy, 80 residential, 13 industrial and 13 commercial buildings. [redacted] |
| | **C1-9** (BM-Sn-C) | Bletchley – Bedford Midland– Tempsford (nr Sandy)-Cambridge | From Bletchley Station on the existing BBM line the route continues to Bedford St. Johns Station and then Bedford Midland Station before diverting eastwards around the north of Bedford. It then crosses the ECML north of Tempsford and carries on eastwards around the northern edge of Wimpole Estate to join the existing SBR | Route is 71km long with 44km of new twin track railway, additional platform at Bedford St Johns Station, a remodelled Bedford Midland station and a new Sandy split level Station at ECML, 6km north of the existing station.<br><br>Station remodelling would require disruptive possessions for new through track, platforms and signalling affecting BBM and MML. Route |

| | | | | |
|---|---|---|---|---|
| | | | alignment near to Harston. It then joins the BGK route north of Shelford Station and completes the C1-9 route at Cambridge Station. | planning to consider 11 overbridges, 18 underbridges, & 38 culverts, landfill sites and quarries, watercourses, flood zones and alluvial deposits. Construction would generate an estimated 8.6m $m^3$ earthwork surplus. Within 300m of the centreline there are 2 SSSI, two areas of ancient woodland, a Source Protection Zone, and 17 Grade II listed buildings.<br><br>[redacted] |
| | **C2-2** (BS-Ss-C) | Bletchley - Bedford Parkway-South Sandy-Cambridge | From Bletchley Station the route is on the existing BBM line until south of Bedford where it diverts to the east onto the potential new alignment crossing the MML and ECML, with new split level stations at Bedford Parkway and a relocated Sandy Station. It joins the existing SBR near to Foxton Station and joins the BGK route north of Shelford Station to complete the CC2-2 route at Cambridge Station. | Route is 50km long with 39km of new twin track railway, new split level stations at Bedford Parkway (south of Bedford at intersection of MML) and a new (south of) Sandy split level Station at ECML . Route planning to consider a 1000m viaduct. 3 overbridges, 24 underbridges, & 49 culverts are affected.<br><br>Within the Corridor there are landfill sites and quarries, watercourses, flood zones and alluvial deposits. Construction would generate an estimated 2.7million $m^3$ earthwork surplus. Construction would divide RAF Bassingbourne Barracks. Within 300m of the centreline, there are 2 Ancient Woodlands, one Scheduled Monument, 16 Grade II listed buildings, 2 registered parks, numerous flooding areas, 2 Countryside Right of Way (CRoW), 13 residential, 6 industrial, and 7 commercial buildings.<br><br>[redacted] |
| M | M1 - 4 | Bedford Midland – Hitchin/ Letchworth – Cambridge. | There are two identified options for the M1-4 corridor connecting Bedford with Cambridge using an upgraded Shepreth Branch (SBR); either option M1-4**L** or option M1-4**H**.<br><br>Option M1-4L would connect Bletchley to Bedford Midland Station before reversing south along the same route and separating from the BBM to the south of the A421 road crossing. The route continues cross-country on a new alignment, crossing the ECML north of Hitchin and connecting with the Shepreth Branch (SBR) before Letchworth Station.<br><br>Option M1-4H would join the ECML using a grade-separated connection | Route is 57.6km long with 26km new for M1-4**L** and 67.2km with 35.6km new for M1-4**H**. Bedford Midland and St John Stations is remodelled for double tracking. Route planning for Option M1-4L to consider 7 overbridges, 11 underbridges, and 25 culverts, 4 landfill sites and 4 quarries ( 3), 7 watercourses, flood zones and alluvial deposits.<br>Route planning for Option M1-4H to consider 8 overbridges, 11 underbridges, and 29 culverts, 4 landfill sites and 3 quarries and 7 watercourses, flood zones and alluvial deposits.<br><br>Construction would generate an estimated 0.23m $m^3$ earthwork deficit for option M1-4L and 0.49m $m^3$ surplus for M1-4H. Both options would need a twin 7.0m diameter tunnel, 4km |

| | | | | |
|---|---|---|---|---|
| | | | north of Hitchin and runs to and south of Hitchin Station where it separates from the ECML to join the SBR from a southerly approach before Letchworth Station. To avoid freight trains going through Hitchin Station a 2.6km long freight chord on the M1-4L alignment is considered necessary.<br><br>Both M1-4 options would require the upgrade to the SBR line, as described in the SBR Phase 2b Report, to provide a complete Bedford to Cambridge route option. | long with a single vent shaft or a 45m deep cutting.<br><br>Construction would divide RAF Bassingbourne Barracks and within 300m of the centreline there is 1 Ancient Woodland, 3 Scheduled Monuments, 16 Grade II listed buildings, 2 registered parks, numerous flooding areas, 1 CRoWs; and 13 residential, 6 industrial, and 7 commercial buildings.<br><br>[redacted] |
| | M2 - 3 | Bletchley – Bedford Parkway – Hitchin/ Letchworth - Cambridge | From Bletchley Station the M2-3 route would follow the existing Bletchley to Bedford (BBM) Line. South of Bedford the route separates from the BBM onto a new alignment heading east, before heading south east near Harrowden. The route continues south east toward Shefford and Hitchin. North of Ickleford Village, the route turns east crossing the ECML.<br><br>There are two options for the continuation of the route to connect with the Shepreth Branch (SBR) west of Letchworth Station; either option M2-3L or option M2-3H.<br><br>The M2-3L option would cross the ECML, without providing connectivity, and join directly to the SBR alignment, as a twin track chord, before Letchworth Station. Option M2-3H would join to the ECML alignment with grade separated connections, the new lines running parallel to the ECML into Hitchin Station. South of Hitchin the M2-3H alignment would leave the ECML using a grade separated alignment and travel north to join the SBR prior to Letchworth Station.<br><br>Both M2-3 options would require the upgraded SBR to complete the alignment from Hitchin/Letchworth to Cambridge. | Route is 57.6km long with 26km new for M2-3L and 67.2km with 35.6km new for M2-3H. Both options have a new Bedford South Parkway Station at the intersection with the MML.<br><br>Bedford Midland and St John Station would need to be remodelled for double tracking. M2-3L needs 9 new over-bridges, 15 under-bridges and 14 culverts. M2-3H needs 10 new overbridges, 23 underbridges, 20 culverts. Both use sections of dismantled railway and require either extensive works to the existing disused Old Warden Tunnel or new tunnel construction alongside. The corridor includes landfill sites and quarries , an crossing of watercourses, flood zones and alluvial deposits.<br><br>Construction would generate an estimated 2.2 million $m^3$ earthwork deficit for M2-3L and a 2.8 million $m^3$ deficit for M2-3H .<br><br>On the route there are ancient woodlands, Scheduled Monuments, 16 Grade II listed buildings, registered parks & gardens, numerous flooding areas. |

67. For the Corridor assessment it was necessary to make a number of design assumptions, which included the following:

- Rail over River proposed alignment levels are at a height of at least 2m.
- Rail over Road proposed alignment levels are at a height of at least 7m.

- Rail always passes over major roads (motorways and A roads). Minor roads are diverted over or under the new railway.
- Proposed railway gradients are typically at a maximum of 1:125.
- Where the alignment passes below ground level it is assumed that cuttings / tunnels can be constructed.
- Reasonable efforts have been made to avoid and amend the potential alignment away from the identified constraints. However, there may be instances where this was unavoidable such as the Risk of Flooding from Rivers and Sea (RoFRS) areas.
- Buried services information has not been consulted.
- Future proposed developments or schemes being developed in parallel with this scheme were not considered.
- Feasibility of track geometry alignment and junction configurations were designed in concept but further design development is required.
- There will be no new level crossings and existing crossings will be closed.
- For new lines the desired line speed is 125mph, unless circumstances dictate it is impracticable or economically unjustifiable.
- Three passenger train paths and one train freight path is required per hour in each direction on new routes. (On the existing (SBR) route this would be additional to paths already provided).
- The introduction of the future digital railway technology (ERTMS) is assumed.
- Electrification of all new routes is required, including its distribution and systems.
- Line Speed Improvement (LSI) solutions on the SBR will be limited to those within the existing Network Rail footprint and those that can be economically justified.
- Where new corridors cross existing operational railway lines, a flyover/dive under was assumed with facilities for passenger connectivity.
- The new route will meet the Interoperability Regulations.

68. Until further investigation is complete it is assumed that the disused railway tunnel within the M2-3 Corridor and which is in known as the Old Warden Tunnel (OWT) is in a fair to poor condition. With no tunnel dimensions available it is not possible to determine the suitability of the proposed route gauge and major works might be necessary, perhaps including an additional tunnel next to the existing tunnel to allow for one road in each direction, or alternatively over-boring to increase the diameter. It is noted that the area around the tunnel is a nature reserve, which is managed by Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire.

69. The Table below sets out the routing options within Corridor C and M together with key quantities to enable a comparison to be made between them. Bletchley Station is taken as the start of the route at 0km for all routing options in both Corridors.

| Route | Bletchley to Cambridge km | New Route Length km | Cut M $m^3$ | Fill M $m^3$ | Over bridge No. | Under bridge No. | Culverts No. | Highway m | Tunnels No. |
|---|---|---|---|---|---|---|---|---|---|
| **C2-2** (BS-Ss-C) | 71.6 | 38.7 | 0.9 | 3.6 | 3 | 24 | 49 | 2690 | 0 |
| **C1-1** (BstJ-Sn-C) | 73.6 | 38.0 | 4.9 | 3.9 | 22 | 9 | 39 | 1300 | 0 |
| **C1-9** (BM-Sn-C) | 80.0 | 44.0 | 13.0 | 4.4 | 11 | 18 | 38 | 1810 | 0 |
| **C1-8** (BM-S exist) | 81.5 | 42.0 | 7.2 | 6.2 | 17 | 21 | 43 | 1810 | 0 |
| **M2-3** (BS-L) | 87.5 | 28.0 | 1.5 | 3.7 | 9 | 15 | 14 | 800 | Enlarge OWT |
| **M2-3** (BS-H) | 96.0 | 35.5 | 1.4 | 4.2 | 10 | 23 | 20 | 800 | Enlarge |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | OWT |
| **M1-4** (BM-L) | 92.0 | 23.4 | 2.2 | 2.7 | 7 | 11 | 25 | Not Estimated | 2x7m diam. 7728m |
| **M1-4** (BM-H) | 99.0 | 28.4 | 2.9 | 2.7 | 8 | 11 | 29 | Not Estimated | 2x7m diam. 7728m |
| **SBR** | Included in Corridor M options. | 15.1 | 0.002 | 0.05 | 11 | 24 | 26 | Not Estimated | 0 |

70. Train journey times analysis for fast and semi-fast services was prepared by Network Rail in December 2015 for each route as part of the Phase 2a assessment with journey time in minutes. Not surprisingly, Corridor C was found to have the shortest journey times (64 minutes Fast and 77 minutes semi Fast) given its comparatively short length.

### j) Business Case Analysis

71. The Business Case for the EWR-CS scheme was developed over the course of 2015 through the production of the nine Technical Notes, two of which related to commercial issues and are excluded from the Appendix A listing. The Technical Notes covered a range of issues, including:

    a. **Option Testing.** (Note 2: 22/01/15). Business Case performance was tested against the Conditional Outputs for the seven shortlisted corridor options (Corridors {C1, C2}, D, H2, {M1, M2}, and N).

    b. **Summary of Results.** (Note 3: 8/5/15). This Technical Note summarises Phase 2a outputs and describes the tools used to model travel demand including a spreadsheet for short distances and the PLANET model for longer journeys, as well as an Operating Cost model and an Economic Appraisal model for Business Case analysis in compliance with WebTAG to produce Benefit Cost Ratios (BCRs). The interim conclusion was that EWR –CS has clear potential to develop into a viable scheme and Corridors C via Sandy and Corridor M via Hitchin, with high-growth BCRs of 1.71 and 1.43 respectively, should be taken forward.

    c. **Luton Stevenage Corridor.** (Note 4: 20/5/15). Corridor H2 (Stewartby-Luton-Stevenage-Hitchin-Cambridge) performed poorly in the modelling, with a high-growth BCR of only 0.81. However, the Study Team recognised that a Luton Stevenage section could provide good passenger flows, with the potential expansion of Luton Airport a consideration, which might be captured with a different solution. Analysis including airport passenger effects raised the BCR to 0.88 but this was still deemed insufficient for this option to be taken forward.

    d. **Wider Economic Impacts Assessment Results**. (Note 6: 23/6/15). A WebTAG Impact Assessment on Agglomeration, Output Change, and Labour Supply was undertaken. Agglomeration was found to have the greater impact of the three. When ranked, Corridor C came first with an improved high-growth BCR of 1.82 and Corridor M came second with an improved BCR of 1.58.

    e. **Funding EWR-CS.** (Note 8: 23/12/15). This Technical Note recognised that Private Sector Investment could be a useful additional source of project funding to traditional sources from Network Rail, DfT and Government sources.

    f. **Revenue Subsidy Calculations.** (Note 914/01/15). In this Technical Note, potential revenue generated by EWR and abstracted from other services was compared against operating costs.

g. **Results from Phase 2b Business Case.** (Note 7 revised: 13/01/16). This Technical Note confirmed that the two Corridors identified in Phase 2a were assessed in Phase 2b (with - four per corridor) and the Business Case developed as before using the described modelling tools. It reported the interim conclusion that the Corridor C options perform better than M for three key reasons: Corridor C gives higher benefits and revenue; Corridor C has lower operating costs due to lower mileage; and there is no capital cost advantage of Corridor M over Corridor C. The latter finding is because of substantially higher cost of constructing the Stewartby–Hitchin section, particularly the tunnelled section.

72. The work presented in these Technical Notes was used as the basis of the Business Case Analysis for Corridors C and M.

73. The output from the Business Case Analysis is presented in the **East West Rail Central Section Phase 2B Final Report,** which focuses on findings of Phase 2B of the project. The two corridors, C and M, were developed into 8 routing options – 4 options for each corridor. These were developed to capture a range of variations within each corridor, to enable the 2 corridors to be compared in a robust manner.

74. For Business Case appraisal purposes, a common set of 'Do Something' passenger services as well as a single freight service per hour was assumed for all corridor options as shown here:

- 1 train per hour (tph) London Paddington – Oxford – Cambridge semi-fast (an extension of the 'Do-Minimum' London Paddington – Bedford service;
- 1 tph Bletchley – Cambridge semi-fast; and
- 1 tph Bristol – Cambridge, with alternate trains extended to Norwich or Ipswich.

75. Each 'Do Something' scenario was built upon a common 'Do Minimum' scenario that included the following passenger services as well as a single freight service per hour:

- Thameslink December 2018 specimen timetable
- IEP specimen Timetable on the ECML
- Chiltern Evergreen 3
- East West Rail Western Section (EWR WS):

  - 1 tph Paddington – Oxford – Milton Keynes
  - 1 tph Paddington – Oxford – Bedford
  - 1 tph Marylebone – Milton Keynes
  - 1 tph Bournemouth – Manchester diverted via EWR WS and West Coast Main Line (with backfilling between Oxford and Birmingham and between Birmingham and Manchester)

76. The 'Do Minimum' assumes that there is a new station at Addenbrookes and that all EWR services would call there.

77. Maximum running speed was assumed to be 100 mph for the semi-fast services and 125 mph for the fast service over new infrastructure. Existing speeds were assumed for any sections over existing infrastructure.

78. Preliminary modelling showed that journey times between Oxford and Cambridge differ slightly from previous work because of increased knowledge of the route characteristics and are as follows:

| Option | Oxford – Cambridge journey time (mins) | |
|---|---|---|
| | Fast service | Semi Fast |
| C1-1 | 76 | 79 |
| C1-8 | 82 | 89 |
| C1-9 | 82 | 89 |
| C2-2 | 75 | 79 |
| M1-4H | 106 | 107 |
| M1-4L | 95 | 98 |
| M2-3H* | 92 | 92 |
| M2-3L* | 85 | 86 |

79. Demand and revenue forecasting computer models for short and long distance journeys indicate that the EWR-CS railway would generate up to 10,000 additional daily trips in 2031. Cambridge was shown to be a significant generator. The highest potential journey time savings are between Cambridge and Manchester and Cambridge and Birmingham.

80. The Economic Appraisal for the 60 year period from 2024 to 2083 calculated monetised benefits from WebTAG values of time and presented discounted benefits and costs, using core and high growth scenarios. This showed that the eight corridor options have core Present Value of Benefits (PVB) of £2.7bn and £4.0bn with costs of £2.7bn and £3.6bn.

81. When Wider Economic Benefits (WEB) are added, as allowed in a WebTAG compliant Business Case, then BCRs are increased. For example, the BCR for option C2-2 of 1.38 increased to 1.70 when the WEB allowance of £905m was added. The results for all eight route options are shown in the tables below and it should be noted that these do not include Wider Area Benefits but do include UK Treasury Optimism Bias.

**Summary Appraisal Results – NTEM growth (£m, 2010 prices, discounted to 2010)**

| Option | C1-1 | C1-8 | C1-9 | C2-2 | M1-4H | M1-4L | M2-3H | M2-3L |
|---|---|---|---|---|---|---|---|---|
| Present Value of Benefits | 3,571 | 3,684 | 3,587 | 3,936 | 2,765 | 2,773 | 3,207 | 3,058 |
| Present Value of Costs | 2,776 | 3,230 | 3,560 | 2,847 | 3,588 | 3,370 | 3,511 | 3,050 |
| **Present Value** | 795 | 455 | 27 | 1,089 | -823 | -597 | -304 | 8 |
| Benefit Cost Ratio | 1.29 | 1.14 | 1.01 | **1.38** | 0.77 | 0.82 | 0.91 | 1.00 |
| Wider Economic Benefits | 821 | 847 | 825 | 905 | 525 | 527 | 609 | 581 |
| **Adjusted BCR** (including WEBs) | **1.58** | **1.40** | **1.24** | **1.70** | **0.92** | **0.98** | **1.09** | **1.19** |

**Summary Appraisal Results – high growth (£m, 2010 prices, discounted to 2010)**

| Option | C1-1 | C1-8 | C1-9 | C2-2 | M1-4H | M1-4L | M2-3H | M2-3L |
|---|---|---|---|---|---|---|---|---|
| Present Value of Benefits | 3,913 | 4,035 | 3,930 | 4,322 | 3,049 | 3,071 | 3,544 | 3,383 |
| Present Value of Costs | 2,714 | 3,171 | 3,502 | 2,797 | 3,537 | 3,311 | 3,449 | 2,986 |
| Present Value | 1,199 | 864 | 429 | 1,524 | -489 | -239 | 94 | 397 |
| Benefit Cost Ratio (BCR) | 1.44 | 1.27 | 1.12 | **1.54** | 0.86 | 0.93 | 1.03 | 1.13 |
| Wider Economic Benefits | 1,252 | 1,291 | 1,258 | 1,383 | 762 | 768 | 886 | 846 |
| Adjusted BCR (including WEBs) | 1.90 | 1.68 | 1.48 | 2.04 | 1.08 | 1.16 | 1.28 | 1.42 |

82. The data in the above tables demonstrates that Corridor C outperforms Corridor M in terms of the BCR in a more pronounced fashion than previously in Phase 2a. The reason for this is the higher infrastructure costs for Corridor M between Bedford and Hitchin that have now been identified, especially to upgrade the disused railway tunnel known as the Old Warden Tunnel. The Hitchin station connection was also found to be more costly, while bypassing Hitchin to Letchworth reduced the interchange benefits.

83. The Phase 2a work identified that Cambridge – Birmingham and Cambridge – Manchester services were in the top long-distance flows benefiting from EWR. Accordingly, two sensitivity tests were applied on the best-performing scenario C2-2 superimposed on the standard service pattern:

    - C2-2BHM – An hourly Birmingham – Cambridge service
    - C2-2MAN – An hourly Manchester – Cambridge service.

84. The results of the sensitivity tests are shown in the table below.

| | C2-2 | C2-2BHM | C2-2MAN |
|---|---|---|---|
| Total benefits | 3,936 | 4,511 | 4,363 |
| Total costs | 2,847 | 4,062 | 5,650 |
| NPV | 1,089 | 449 | -1,286 |
| BCR | **1.38** | **1.11** | **0.77** |
| High growth BCR | **1.54** | **1.23** | **0.85** |

**Long distance results summary (£m)**

85. These results demonstrate that the Birmingham option performs better than the Manchester option but running the additional long distance services increases present value of benefits (PVB) and also incurs higher additional operating costs and results in a reduced BCR. A large part of the higher costs is the capacity charge on the West Coast Main Line (WCML).

86. The current capacity charges may not reflect post HS2 market conditions and if they were to be removed BCRs would increase to 1.43 and 1.20 for the Birmingham and Manchester options respectively. However, this only maintains the BCR of C2-2 under the Birmingham option, while the Manchester option still dilutes the overall case.

87. There is potential scope for service optimisation that could deliver much of the benefits at lower cost: including:

    - Removing the 1tph Bletchley – Cambridge shuttle
    - Extend the Bletchley – Cambridge shuttle to Milton Keynes. This would enable Cambridge – Birmingham and Cambridge – Manchester flows to require one change only, instead of two in the base specification, and would avoid much of the capacity charges on the WCML.

88. Although the sensitivity tests show that an additional Birmingham or Manchester service does not enhance the case for EWR-CS, alternative and more cost-effective ways of delivering substantial benefits could be explored.

89. The potential to provide crowding relief on services using the London radial routes was considered and the modelling suggests that for both the MML and for the ECML, approximately 100 passengers are removed on southbound services in each 3-hour morning peak period. It is estimated that services on the MML and ECML would see a net reduction of approximately £30-40m over the 60-year appraisal period of EWR CS, taking into account passengers attracted back onto the service to fill up released capacity. The EWR CS would also remove trips on the WCML (e.g. Milton Keynes – Cambridge) and GWML (e.g. Oxford – Cambridge) and it is expected that the outcome would be similar to those for the MML and ECML.

90. Revenue forecasts were carried out for Corridors C2-2 and M2-3L to assess the financial performance of EWR services and subsidy requirements, as well as impact on other services. Demand and revenue forecasts were allocated to the train services. The services analysed were:

    - 1 tph London Paddington – Cambridge via Oxford
    - 1 tph Bletchley - Cambridge
    - 1 tph Cross Country Bristol – Cambridge (with alternate trains to Ipswich and Norwich)

91. There is a high likelihood that revenue carried by EWR-CS services would exceed the cost of operating them and generate an operating surplus over the whole EWR route.

92. The Paddington – Cambridge and the Bristol – Norwich/Ipswich services are shown to generate high level of surpluses but the Bletchley – Cambridge shuttle would require a small subsidy. This suggests that these three sets of services are not evenly utilised, and there is potential to optimise the service pattern.

93. Another consideration is the possibility that the success of the EWR-CS and its attractiveness to the travelling public might result in crowding on the train services. Therefore, the trains may need to be lengthened to cope and this might make a small subsidy necessary. A successful EWR-CS could also abstract customers from other franchises including Cross Country/ Great Western/ Greater Anglia/ and London Radials and this would be a minor dis-benefit in the overall Business Case.

## 4. CONCLUSIONS FROM PHASE 2b ANALYSIS

94. The conclusion from the analysis undertaken to date is that the EWR-CS is technically feasible and would generate significant benefits for the local regional and national economies.

95. EWR-CS has clear potential to develop into a viable scheme and economic analysis suggests that Corridor C performs better than Corridor M for the following reasons:

    - Corridor C provides higher benefits and revenue
    - Corridor C requires lower operating costs due to lower mileage
    - There is no capital cost advantage of Corridor M over Corridor C.

96. Test on long distance service options suggests running Cambridge – Birmingham or Cambridge - Manchester services is unlikely to boost the overall case for EWR CS because the additional operating costs outweigh the additional benefits and revenue. There is scope however for investigating other ways of realising some of these benefits by using lower cost interventions.

97. Diversion of existing passengers away from London radial routes onto East West Rail services, and the resulting revenue loss on existing radial services is now understood to be a minor impact. As a result, the level of crowding relief on these radial routes is very limited.

98. There is a high likelihood of EWR services generating an operating surplus.

99. The best performing routing option (C2-2) achieves a BCR of between 1.4 and 1.5, exclusive of Wider Economic Benefit (WEBs). Adjusted to include WEBs, this increases the BCR for option C2-2 to over 2.0, which falls into the Department for Transport's "high value for money" category.

# Appendix A – Documents Reviewed

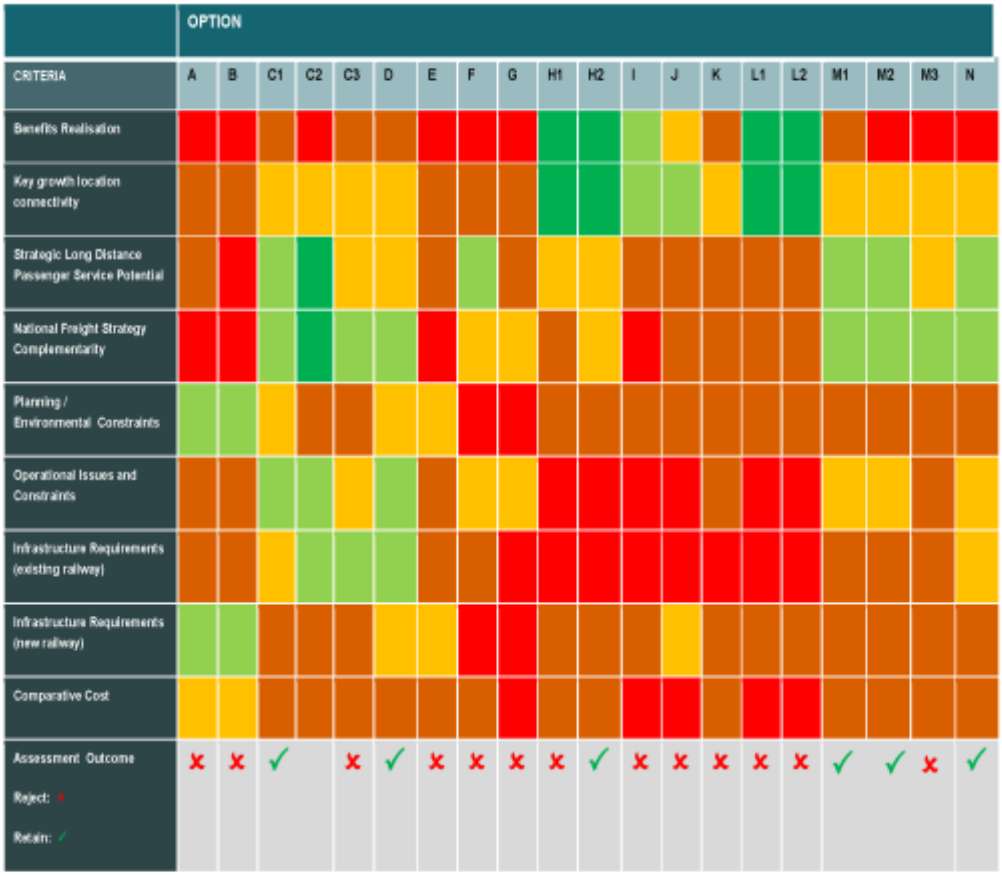
| | | | |
|---|---|---|---|
| [redacted] | | | [redacted] |
| [redacted] | | | |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | | | |

# Appendix B – Corridor Assessment Tables

The twenty possible corridor options assessed at the Workshop on 22nd August 2014 during Phase 2a are listed in the table below and this is followed by the Assessment Tables for each corridor. The Phase 2b work then assessed the seven corridors identified for further investigation and the assessment of these is also shown below.

Phase 2a – Twenty Corridor List and Assessment

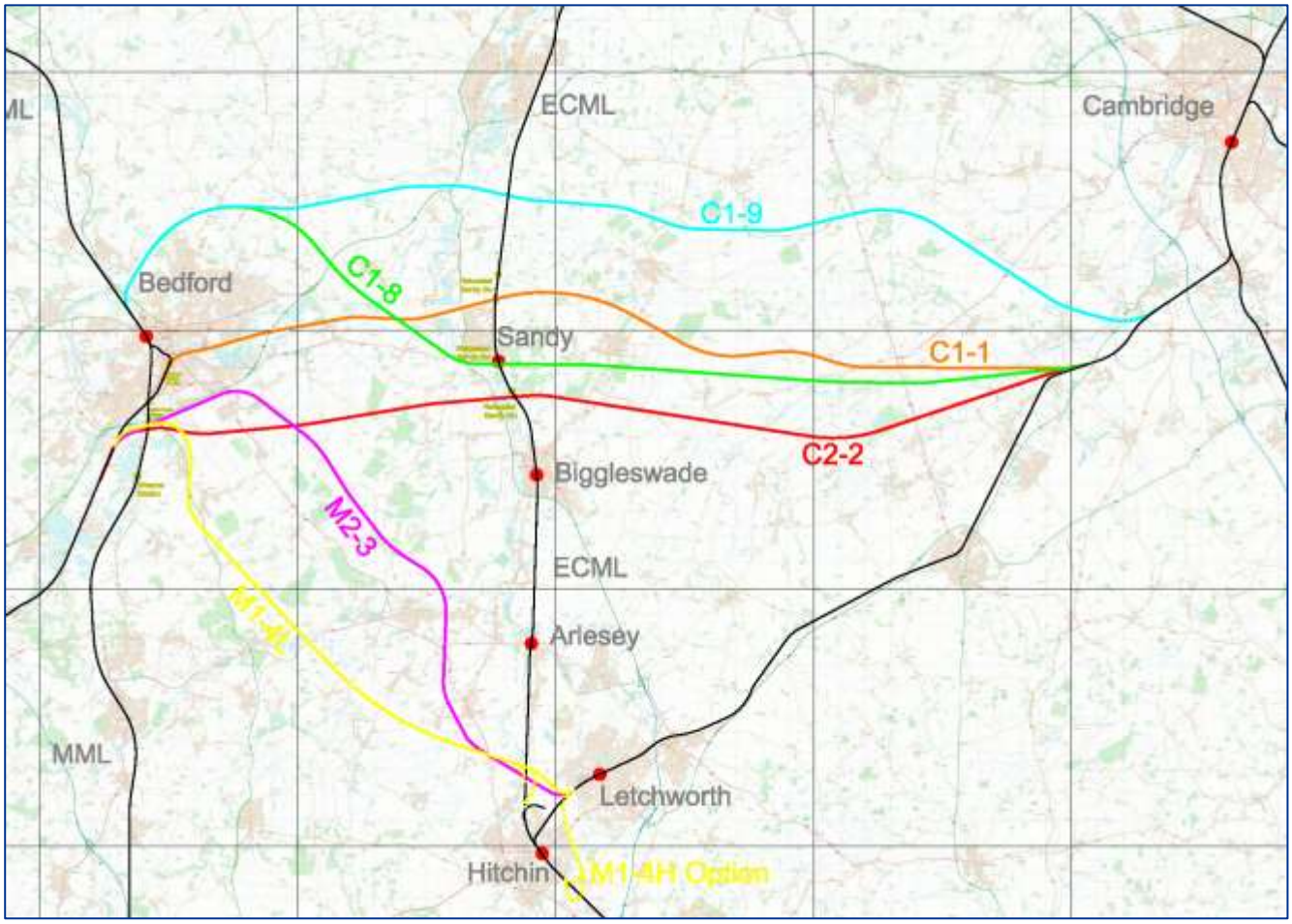
| | |
|---|---|
| A | Bedford-Kettering-Peterborough-Ely-Cambridge |
| B | Bedford-Kettering-Peterborough-Sandy- Hitchin-Cambridge |
| C1 | Bedford-Sandy--Cambridge |
| C2 | Bedford-Sandy-Cambridge |
| C3 | Bedford-Sandy-Cambridge (via Cambourne) |
| D | Bedford-Sandy-Hitchin-Cambridge |
| E | Bedford-Sandy-Peterborough-Cambridge |
| F | Bedford-Peterborough-Ely-Cambridge |
| G | Bedford-Peterborough-Sandy-Hitchin-Cambridge |
| H1 | Bedford-Luton-Stevenage-Hitchin-Cambridge |
| H2 | Bedford-Luton-Stevenage-Hitchin-Cambridge |
| I | Bedford-Luton-Stevenage-Hitchin-Sandy-Peterborough-Cambridge |
| J | Bedford-Luton-St Albans- Hatfield- Welwyn GC-Stevenage-Hitchin-Cambridge |
| K | Bedford-Luton-St Albans- Hatfield- Harlow-Bishops Stortford-Cambridge |
| L1 | Bedford-Luton-Stevenage-Hatfield- Harlow-Cambridge |
| L2 | Bedford (South)-Luton-Stevenage-Hatfield- Harlow-Cambridge |
| M1 | Bedford-Hitchin-Cambridge |
| M2 | Bedford (South) -Hitchin-Cambridge |
| M3 | Bedford (South) -Flitwick-Harllington- Hitchin-Cambridge |
| N | Bletchley-Harlington-Hitchen-Cambridge |


OPTION
CRITERIA
A
B
C1
C2
C3
D
E
F
G
H1
H2
I
J
K
L1
L2
M1
M2
M3
N
Benefits Realisation
Key growth location connectivity
Strategic Long Distance Passenger Service Potential
National Freight Strategy Complementarity
Planning / Environmental Constraints
Operational Issues and Constraints
Infrastructure Requirements (existing railway)
Infrastructure Requirements (new railway)
Comparative Cost
Assessment Outcome
Reject:
Retain:


KEY
-3
-2
-1
0
1
2
3

# Appendix C – Maps of Options for Corridors C and M

Maps are extracted from the relevant Phase 2a Reports as listed in Appendix A above under Corridor Studies




Corridors C and Corridor M with assessed Routes (Drg No NE/149725/EAR/DRG/IAB/000

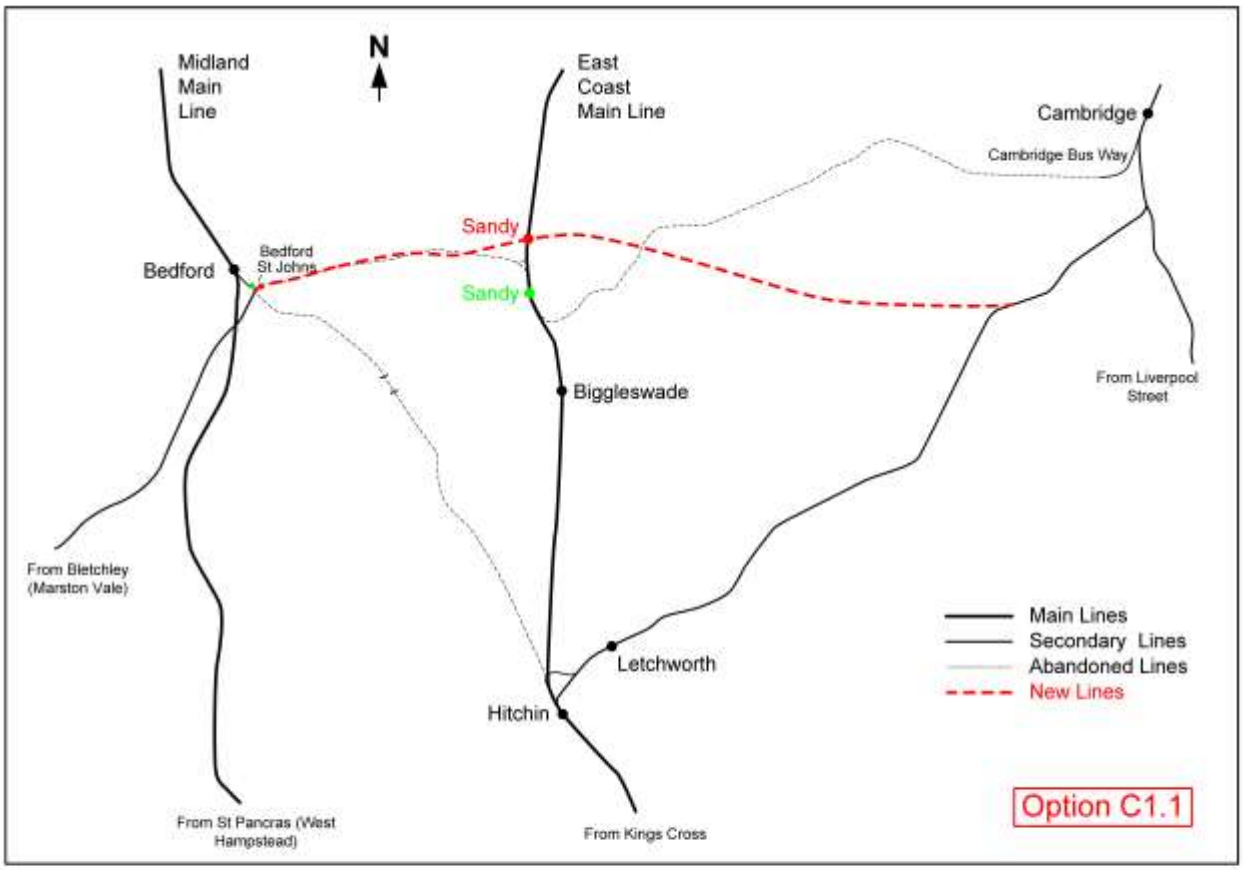



**Figure 1.1 Route C1-1 Phase 2a Alignment**

## Table 1.2 Route Lengths

| | Existing Route Utilised | New Alignment Length | Total Route Length |
|---|---|---|---|
| C1-1 | BBM & SBR | 38km (approx.) | 72km |

* 0km is Bletchley Station

The above figure is extracted from Corridor Study Report:

[redacted]

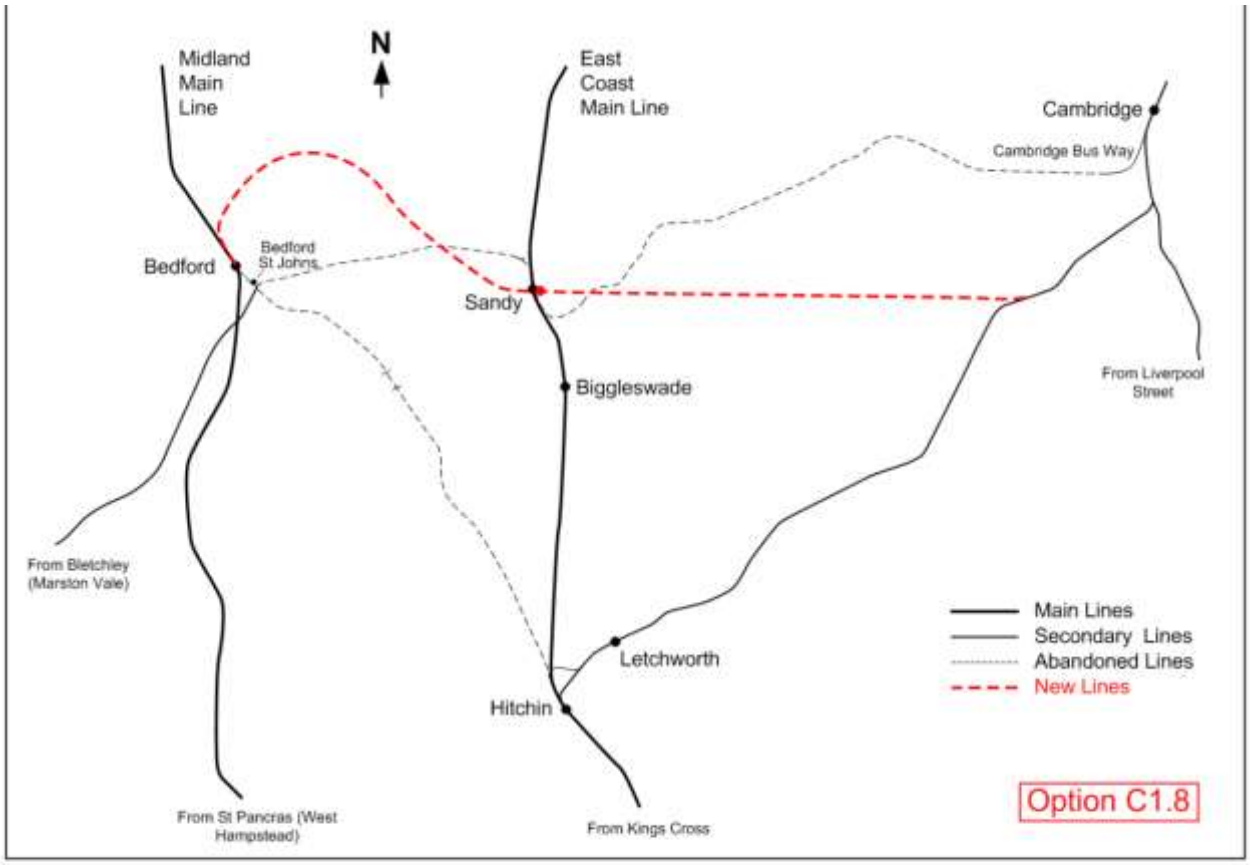



**Figure 1.1 Route C1-8 Alignment**

| | Existing Routes Utilised | New Alignment Length | Total Route Length |
|---|---|---|---|
| C1-8 | BBM, SPC2, SBR & BGK | 42km | 81km |

* 0km is Bletchley Station

The above figure is extracted from Corridor Study Report:

[redacted]

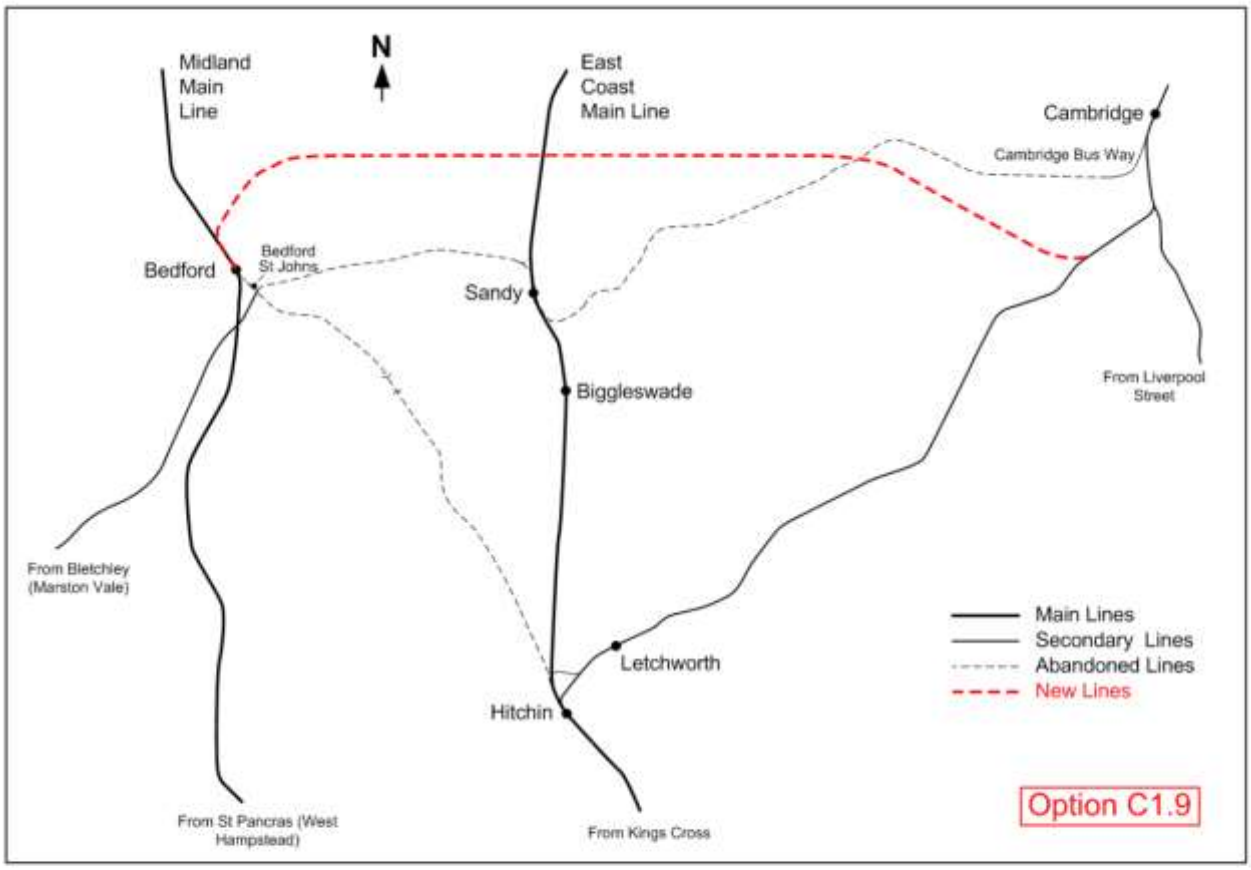



**Figure 1.1 Phase 2a Route C1-9 Alignment**

| | Existing Route Utilised | New Alignment Length | Total Route Length |
|---|---|---|---|
| C1-9 | BBM, SPC2, BGK & SBR | 44km | 71km* |

* 0km is Bletchley Station

The above figure is extracted from Corridor Study Report:

[redacted]

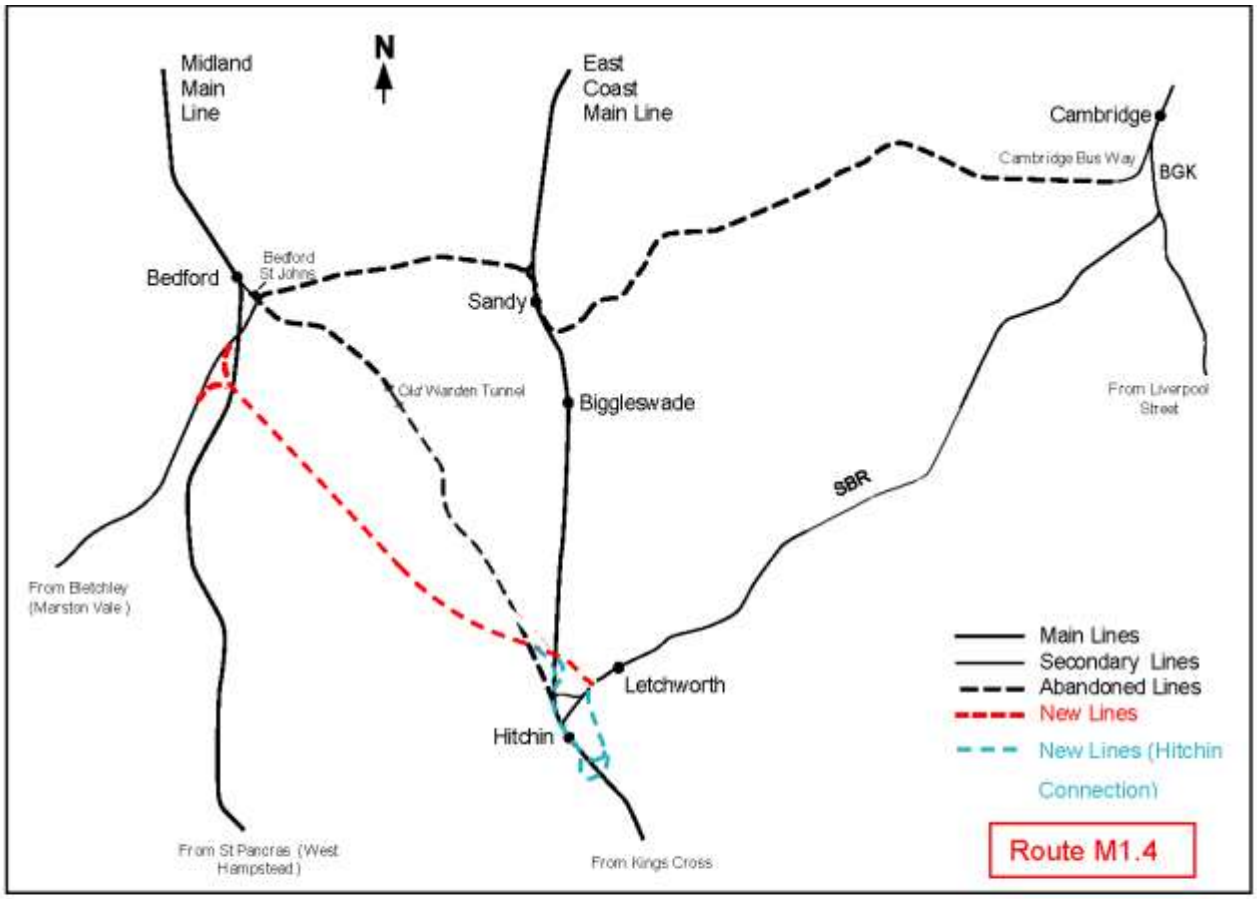



**Figure 1.1 M1-4 Alignment Options**

| Route | Existing Route(s) Utilised | New Alignment Length | Total Route Length |
|---|---|---|---|
| M1-4L | BBM, SBR & BGK | 26.0km | *57.6km |
| M1-4H | BBM, ECML, SBR & BGK | 35.6km | *67.2km |

* 0km is Bletchley Station, total route length is from Bletchley Station to SBR Connection

The above figure is extracted from Corridor Study Report:

[redacted] The corridor variation L and M indicate that the former is via Letchworth and the latter is via Hitchin.

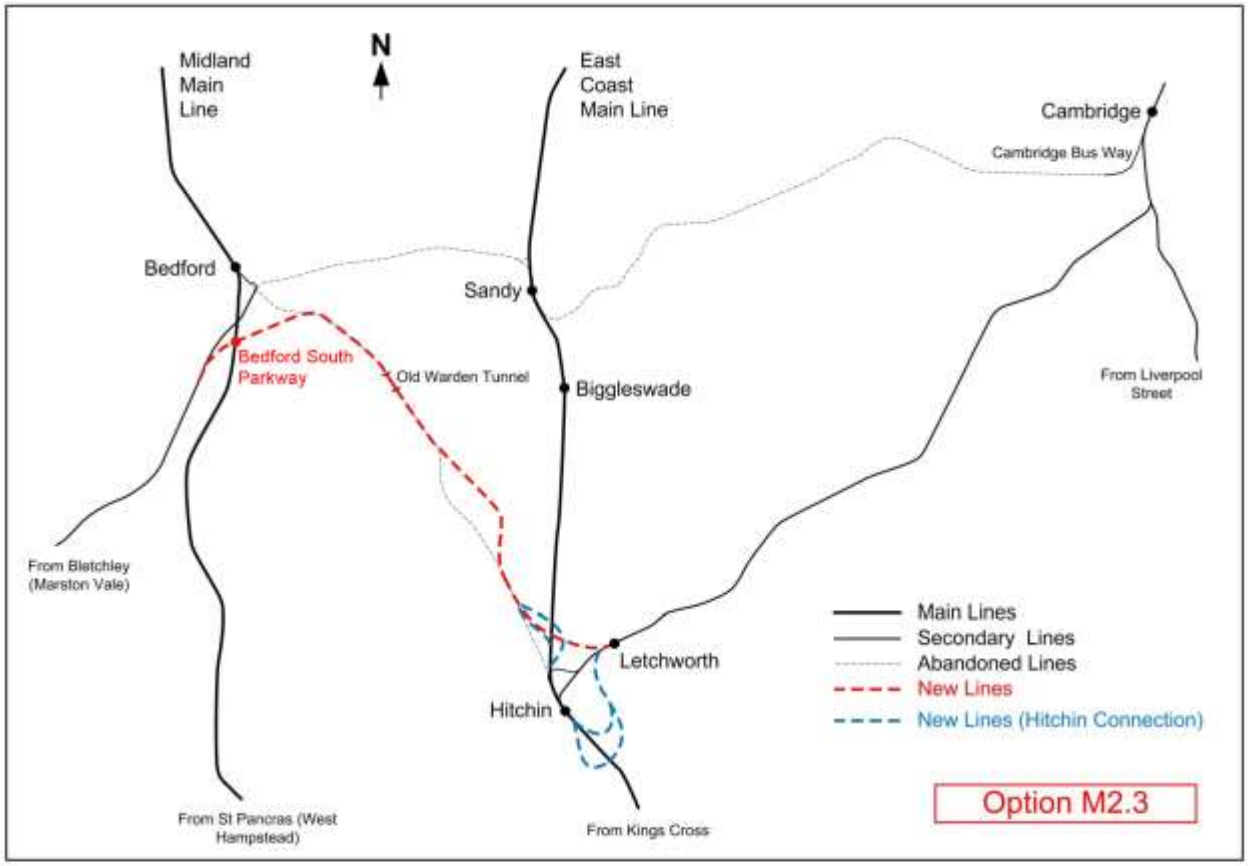



**Figure 1.1 – M2-3 Alignment Options (Phase 2a Report Alignment)**

| | Existing Route Utilised | Alignment Length | Total Route Length |
|---|---|---|---|
| M2-3L | BBM | 28km | 49km* |
| M2-3H | BBM | 35km | 59km* |

* 0km is Bletchley Station

The above figure is extracted from Corridor Study Report:

[redacted]

# Appendix D – Cost Estimate Summary

| | East West Rail Central Section Estimate Summary based on 4Q2015 Rates and Values | | | | | | | | 29/02/2016 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Original Estimate Values as at 4Q2015 | | | | Current Estimate Values as at 4Q2015 | | | | Delta Added to Risk* (Refer to each estimate section 4.01) | |
| Option | Total | | | | Total | | | | | |
| Option C1-1 | 1,582,019,000 | | | | 1,654,308,000 | | | | 72,289,000 | |
| Option C1-8 | 1,927,815,000 | | | | 2,097,614,000 | | | | 169,799,000 | |
| Option C1-9 | 2,290,806,000 | | | | 2,365,440,000 | | | | 74,634,000 | |
| Option C2-2 | 1,530,929,000 | | | | 1,599,800,000 | | | | 68,871,000 | |
| M1-4L | 1,532,509,000 | Exc' LSI | 1,698,704,000 | Inc' LSI | 1,604,309,000 | Exc' LSI | 1,868,179,000 | Inc' LSI | 71,800,000 | Exc LSI |
| M1-4H | 1,661,011,000 | Exc' LSI | 1,827,206,000 | Inc' LSI | 1,744,137,000 | Exc' LSI | 2,008,007,000 | Inc' LSI | 83,126,000 | Exc LSI |
| M2-3L | 1,439,477,000 | Exc' LSI | 1,605,672,000 | Inc' LSI | 1,519,517,000 | Exc' LSI | 1,783,387,000 | Inc' LSI | 80,040,000 | Exc LSI |
| M2-3H | 1,702,544,000 | Exc' LSI | 1,868,739,000 | Inc' LSI | 1,788,318,000 | Exc' LSI | 2,052,188,000 | Inc' LSI | 85,774,000 | Exc LSI |

* Refer to Estimate Review Pack Details Folder for 14/01/16 Estimate Review Meeting Additional Items.

In order to align the estimate values with the option reports, it was decided to include any additional items as discussed at the 14/0116 estimate review meeting as Risk Items.

Each Estimate option contains the original Assumptions / Clarifications / Exclusions, a further list of these has been included which will account for the changes to Scope etc as an outcome of the Estimate Review Meeting in the event that these Additional Risk Items will be required.

The individual estimate option Group Element Cost Summary Reports also include the estimate values escalated to 4Q2019.