

Chapter 6

Route development and alternatives

6.1 Introduction

- 6.1.1 The EIA Directive and the EIA Regulations require that the Environmental Statement contains “an outline of the main alternatives studied by the applicant or appellant and an indication of the main reasons for his choice, taking into account the environmental effects”. In compliance with this requirement, the following sections provide:
- Section 6.2 – an overview of the development of the Crossrail concept and the main alternatives to it that have been considered;
 - Section 6.3 – an outline of the alternative Crossrail routes that were considered in defining the preferred project;
 - Section 6.4 – an overview of the route-wide stabling and depot options considered and the reasons for the selection of the preferred sites for these facilities; and
 - Section 6.5 – an outline of the reasons for the selection of the preferred electrification system for Crossrail.
- 6.1.2 Documents referred to in this chapter are listed in Section 6.5.
- 6.1.3 Alternative locations for Crossrail stations, ventilation shafts, tunnel portals and other infrastructure elements have also been prepared and appraised during the development of the preferred project. These alternative designs and the reasons for their rejection are reported in the relevant route window sections of Chapters 8 to 11. In carrying out such appraisals, the options were considered in a consistent and systematic manner, taking account of factors including engineering and environmental considerations. Environmental input was made through meetings between the design teams and the environmental specialists who provided information on sensitive environmental receptors that might be affected by the options.

6.2 Development of the Crossrail Concept

Introduction

- 6.2.1 The concept of an east to west cross-London rail link was first advanced in the early part of the 20th Century and was revisited after the Second World War in the Abercrombie Plan for London (1945). The original ‘CrossRail’ concept was developed following the 1989 Central London Rail Study (DoT et al) and a Direction was issued to safeguard the alignment. A private Bill deposited in Parliament in 1991 was rejected but the route was protected from incompatible development.
- 6.2.2 In December 1999, the Deputy Prime Minister asked the then Shadow Strategic Rail Authority (sSRA) to carry out a review of current and future issues relating to rail travel on an east-west axis across London and to propose outline solutions. The findings of this review, published as the London East-West Study (LEWS) (sSRA 2000) led to the planning and development work for the current Crossrail project.

Strategic Options

- 6.2.3 The LEWS investigated a range of strategic options for increasing east-west travel capacity across London. These options were appraised within two main categories, namely (LEWS, Section 4.1.1):
- upgrading of existing rail infrastructure, including linking the northern half of the Circle line to the National Rail network; and
 - construction of new rail tunnels, in particular:
 - Paddington to Liverpool Street;
 - Wimbledon to Liverpool Street; and
 - Wimbledon to Hackney.
- 6.2.4 As part of the consideration of these new rail tunnel options, the study also focused on the type of service that would operate through them. There was a choice between two service types (LEWS, Section 4.1.2):
- a 'Regional Express', serving some London stations but also serving longer distance passengers and using parts of the National Rail network shared with other operators; or
 - a 'Regional Metro', serving the area roughly bounded by the M25 corridor and central London, with services generally stopping at all stations and as far as possible operating on dedicated tracks to maximise service reliability.
- 6.2.5 Consideration was also given to non-heavy rail alternatives, including enhanced bus services and light rail options (LEWS, Section 1.4).

Assessment of Strategic Options

Non-Heavy Rail Alternatives

- 6.2.6 The LEWS examined non-heavy rail options, including bus and light rail, for improving east-west capacity across London. It concluded (Section 1.4) that:
- "Although most of these schemes have potentially important roles as feeders and distributors for any new East-West route and are very significant in their immediate locality, they are not felt to be particularly significant in the overall movement of passengers on the East-West axis."*
- 6.2.7 In comparison to heavy rail solutions, both bus and light rail based alternatives suffer from the same drawback that they are relatively slow, especially over longer distances, and require significant amounts of dedicated road space if high speeds are to be achieved. In addition, the capacities of these modes are substantially lower than those of a heavy rail system. Table 6.1 compares the total capacity of heavy rail, light rail and bus-based systems assuming that each operates a 24 vehicle per hour service.

Table 6.1 Comparison of System Capacities

System	Capacity per train / tram / bus	Total Capacity (per hour, one direction)
Underground/Heavy Rail	600 - 1100	14,400 - 26,000
Light Rail	300	7,200
Bus	140	3,400

Source: Cross London Rail Links Ltd

Upgrading of Existing Rail Infrastructure

6.2.8 The LEWS examined a number of options for providing additional rail capacity by lengthening platforms, running higher frequency services or by adding additional rail tracks. The most radical option for upgrading existing rail infrastructure centred on linking the northern section of the Circle line to the National Rail network. This had been previously proposed by Railtrack plc in 1999 with a view to achieving two main objectives:

- reducing the need for interchange at London termini by introducing through-running services from the National Rail network; and
- increasing central area capacity by lengthening platforms and using longer trains than those operated by London Underground.

6.2.9 The LEWS concluded (in Section 4.1.1) that there was little opportunity to increase significantly rail network capacity to support the forecast growth in rail travel by upgrading the existing system. The report recognised that although these options could make a contribution to the relief of local congestion, or could form part of a larger project, they would fail to deliver the additional capacity required to significantly reduce overcrowding on the Underground system within central London.

Construction of New Rail Tunnels

6.2.10 Accepting the limitations of these other options, the LEWS recognised the benefits of constructing new cross-London tunnels, which would allow the through-running of heavy rail services that currently terminate on the edges of London's central area. In particular, the study highlighted (Section 4.1.1):

- the significant additional passenger capacity provided to the cross-London rail system by the new tunnelled route;
- the benefits to passengers of bringing them closer to their final destinations without the need for interchange; and
- the release of capacity on the existing London rail network and at the central termini, allowing additional trains to run.

- 6.2.11 In order to identify the optimal central London tunnel route, a strategic assessment of each of the three tunnel routes listed above was carried out, with each route being examined assuming a Regional Express and Regional Metro-type service pattern. The criteria for selection of the preferred option included (LEWS, Section 4.1.4):
- the impact on rail passengers, in particular the impact on reducing journey times, the need to interchange and overcrowding;
 - the impact on car use and environmental objectives;
 - the impact on regeneration and social objectives; and
 - operability.
- 6.2.12 The strategic assessment of each of the six options (three routes and two service patterns) showed that all were viable with positive net present values and acceptable benefit to cost ratios. Each option would also make a contribution, in varying degrees, to meeting the key objectives listed above, including reducing overcrowding and supporting regeneration (LEWS, Section 4.1.4).
- 6.2.13 As part of the process for selecting the optimal central London tunnel route, the LEWS compared the benefits of operating a Regional Metro versus Regional Express type of service pattern across central London. Although the Regional Express concept had benefits in terms of higher revenue generation and improved modal transfer from private transport, the study recommended that a Regional Metro service pattern should be developed. This was based on (LEWS, Section 4.1.6):
- greater operational robustness due to greater opportunities for segregation of services;
 - a greater contribution to long-term sustainability, consistency with land use planning policy and social inclusion objectives; and
 - consistency with the Mayor's Transport Strategy.
- 6.2.14 Based on this assessment, the LEWS recommended that the Paddington to Liverpool Street Regional Metro option should be progressed to a more detailed design stage. The reasons for selecting this option included the following (LEWS, Section 4.1.7):
- it would provide significant relief to overcrowding in central London;
 - it would provide direct access from the east to the West End and from the west to the City;
 - it would assist regeneration in the Thames Gateway and parts of west London;
 - it would utilise an already safeguarded alignment in parts of central London and would thereby provide a lower level construction risk than some of the other options; and
 - the likely programme leading to the opening of the scheme would be shorter than for other options given the preparatory work already carried out as part of the 1991 Bill submission.

The LEWS – Conclusion and Next Steps

- 6.2.15 The LEWS concluded that the Paddington to Liverpool Street Regional Metro scheme should progress to project definition and design development stage (LEWS, Section 4.1.7). This conclusion was accepted by Government (Hansard, 2001) and in 2001, CLRLL was set up to carry out the task.
- 6.2.16 On formation, CLRLL commenced two main work streams, as follows.
- Refinement of the safeguarded alignment route between Paddington and Liverpool Street to reflect changes in design standards and alterations to station designs.
 - Identification and appraisal of route and service pattern options for Crossrail. This workstream is discussed in detail in the following section.

6.3 Alternative Crossrail Routes

Introduction

- 6.3.1 This section discusses the alternative Crossrail route options that were considered during the project definition stage of the project. The approach to appraising the options is described below, followed by a description of the options considered and the reasons for selecting the preferred project. For the alternative options considered, these have been divided into three categories:
- whole-route alternatives, where both the central London alignment and outer corridors varied from the preferred scheme;
 - central London route alternatives; and
 - eastern and western corridor alternatives.

Approach to the Appraisal of Alternative Routes

- 6.3.2 The route options considered as part of the development of the Crossrail project were appraised in a manner consistent with the Government's New Approach to Appraisal (NATA). The NATA was developed following publication in 1998 of the White Paper on integrated transport entitled *A New Deal for Transport: Better for Everyone* (DETR, 1998). The purpose of the NATA is to provide a consistent framework for comparing different transportation options for solving the same problem and, in so doing, to inform decisions about the selection of an appropriate option.
- 6.3.3 Guidance on applying the NATA to multi-modal plans and projects is given in *Guidance on the Methodology for Multi-Modal Studies (GOMMMS)* (DETR, 2000a) and, since 2003, in the web-based *Transport Analysis Guidance (WebTAG)*¹. The then DETR issued guidance on applying the NATA to the appraisal of major public transport schemes as part of the process of preparing Local Transport Plans and Interim Transport Plans. This is contained in *Appraisal of Major Public Transport Schemes: Detailed Guidance*, which draws directly on GOMMMS (DETR, 2000b).

- 6.3.4 The GOMMMS framework was generally used as the basis for appraising the options, with particular consideration also being given to ease of construction, reflecting the nature of the Crossrail project.
- 6.3.5 GOMMMS and TAG list 10 environmental sub-objectives to be considered in appraisal (WebTAG, Unit 3.3). These are to:
- reduce noise;
 - improve local air quality;
 - reduce greenhouse gases;
 - protect and enhance the landscape;
 - protect and enhance the townscape;
 - protect the heritage value of historic resources;
 - support biodiversity;
 - protect the water environment;
 - encourage physical fitness; and
 - improve journey ambience.
- 6.3.6 GOMMMS criteria of economy, safety, accessibility and integration include the following specific sub-objectives:
- Economy (WebTAG, Unit 3.5):
 - improve transport economic efficiency;
 - provide beneficial wider economic impacts; and
 - improve reliability.
 - Safety (WebTAG, Unit 3.3):
 - reduce accidents; and
 - improve security.
 - Accessibility (WebTAG, Unit 3.6):
 - increase option values;
 - reduce severance; and
 - improve access to the transport system.
 - Integration (WebTAG, Unit 3.7):
 - improve transport interchange;
 - integrate transport policy with land-use policy; and
 - integrate transport policy with other Government policies.

Whole Route Alternatives

Super Crossrail and Superlink

- 6.3.7 In 2002, a whole-route alternative for the project was proposed by GB Rail and called 'Super Crossrail'. This proposal was based upon the construction of much longer lengths of new rail line, cross-country through the Green Belt. The new lines would serve up to seven destinations at each end of the network and use the River Thames corridor as the central London alignment for Crossrail. The alignment of "Super Crossrail" through central London can be seen in Figure 6.1.
- 6.3.8 CLRLL considered the potential environmental impacts of 'Super Crossrail' both in central London and in the outer sections. Analysis showed that in the central area, there would be major issues surrounding the feasibility of construction, particularly relating to the provision of coffer dams in the River Thames. In the outer areas, in addition to the impacts associated with construction through open countryside such as visual intrusion and noise, it was considered that it was likely that there would be significant difficulties in obtaining consent for major works in the Green Belt.
- 6.3.9 CLRLL also considered that there would be major operational difficulties associated with the scheme. In particular, the fact that there would be up to seven destinations at each end of the network, many of which would involve joint running with other operators, would make it difficult to maintain service reliability through the central area.
- 6.3.10 In December 2004, a variant of the 'Super Crossrail' scheme, known as 'Superlink' was put forward by Superlink Ltd (Superlink, 2004). This scheme would comprise a 550 km network, serving locations including Northampton, Reading, Basingstoke/Guildford, Cambridge, Ipswich, Southend and Tilbury. The promoter also shows options to extend the system to Ebbsfleet and to continue services beyond the core network to the south and east coasts.
- 6.3.11 This scheme is broadly similar to 'Super Crossrail' but proposes use of either the safeguarded alignment or a more northerly route via King's Cross in place of the Thames corridor. Although "Superlink" would be more expensive to construct and operate than Crossrail, its promoters claim that it would generate higher benefits to passengers and increased revenue.

- 6.3.12 Following a review of 'Superlink', it is concluded that this proposal would have similar difficulties to those associated with the earlier 'Super Crossrail' scheme, namely:
- The number of proposed routes, multiple starting points and long distances that trains would have to travel, is operationally incompatible with the requirement to provide a reliable, high frequency service through central London. These difficulties would be further compounded by the high degree of track sharing with other rail services proposed on large sections of the "Superlink" network. The DfT-sponsored review of the Crossrail business case (DfT, 2004) highlighted the difficulties of integrating Crossrail with existing services due to poor punctuality and the problems of dedicating train paths. It is considered that these problems would be multiplied many times with "Superlink".
 - There are many environmental and consent risks associated with the scheme, which would be over four times the length of Crossrail. It would require construction of an additional 7km of tunnel and new lengths of surface tracks, including 17km of track between Hainault and the M25 to the east of London. This construction would need to take place primarily within the Green Belt.
- 6.3.13 A major advantage over Crossrail claimed by the promoters of "Superlink" is that their scheme would serve major growth areas in the South East of England including Milton Keynes/East Midlands and the London –Stansted/M11 corridor. Although new developments in these areas will undoubtedly increase commuting into London, plans for growth in these areas are based on sustainable development principles and it is not the intention for housing growth to be dependent upon longer distance trip making. Instead, policy on development in the South East of England, outlined in such documents as Regional Spatial Strategy (RPG9, and the RTS, July 2004), Draft PPS1 and PPS7 promote balanced communities with local employment opportunities and facilities. In addition, there are already existing plans to increase rail capacity into London from many of these growth areas, primarily by operating longer trains.
- 6.3.14 Although it has not been possible to verify the construction and operating costs for "Superlink", it is noted that for a network that is over four times the length of Crossrail, construction and operating costs are shown to increase by around 33%. Operating costs alone are shown to increase by less than 50%, which is not commensurate with the scale of the network proposed. It is likely that the overall cost of "Superlink" is a considerable underestimate that does not take account of the higher risks associated with the undeveloped nature of the scheme.

London Regional Metro

6.3.15 London Regional Metro (LRM), a private consortium, has proposed an alternative east-west rail link under central London, initially comprising of a limited “core route” with provision for additional branches to be added later. This proposal has many similarities to the Crossrail scheme, namely:

- use of the central London safeguarded alignment between Liverpool Street and Paddington;
- construction of rail connections to the central tunnel from the Great Eastern and Great Western corridors; and
- construction of a tunnelled route from Liverpool Street to the Isle of Dogs via Whitechapel.

6.3.16 CLRLL has examined the LRM proposals and concluded that they do not represent a materially different project to the Crossrail proposals. The main difference lies in the incremental approach to construction proposed by LRM which would allow the additional branches to be added to the “core route” through separate financing arrangements. The inherent similarity of the Crossrail and LRM proposals was recognised by the DfT-commissioned review of the Crossrail business case which concluded that:

“The LRM scheme does not represent substantially new thinking, except in proposing a less ambitious Crossrail scheme to that proposed by CLRLL.”
(DfT, 2004, para. 299).

Central London Route Options

6.3.17 The LEWS recommended that the existing safeguarded alignment between Paddington and Liverpool Street and serving intermediate stations at Bond Street, Tottenham Court Road and Farringdon should be taken forward for further development. The study noted:

“To connect the central London termini requires a tunnel for which there are relatively few feasible alignments due to the presence of building foundations, existing Underground tunnels and obstructions” (LEWS, section 4.1.1).

6.3.18 The study also noted that this central London alignment was already highly designed and its adoption would minimise construction and consents risks (LEWS, Section 4.1.7).

6.3.19 An alternative option was proposed for central London by the Residents Association of Mayfair (RAM), as shown in Figure 6.1. This is a long-standing proposal and was first considered at the time of the previous Crossrail submission to Parliament in 1991 and has been re-examined. This alignment varies from that safeguarded between Paddington and Farringdon by following a more northerly route via Marylebone/Baker Street and Euston/King’s Cross stations. To the east of Liverpool Street, the RAM alignment would be similar to the safeguarded route. Work carried out by CLRLL established that the option was feasible in engineering terms (CLRLL, 2002).

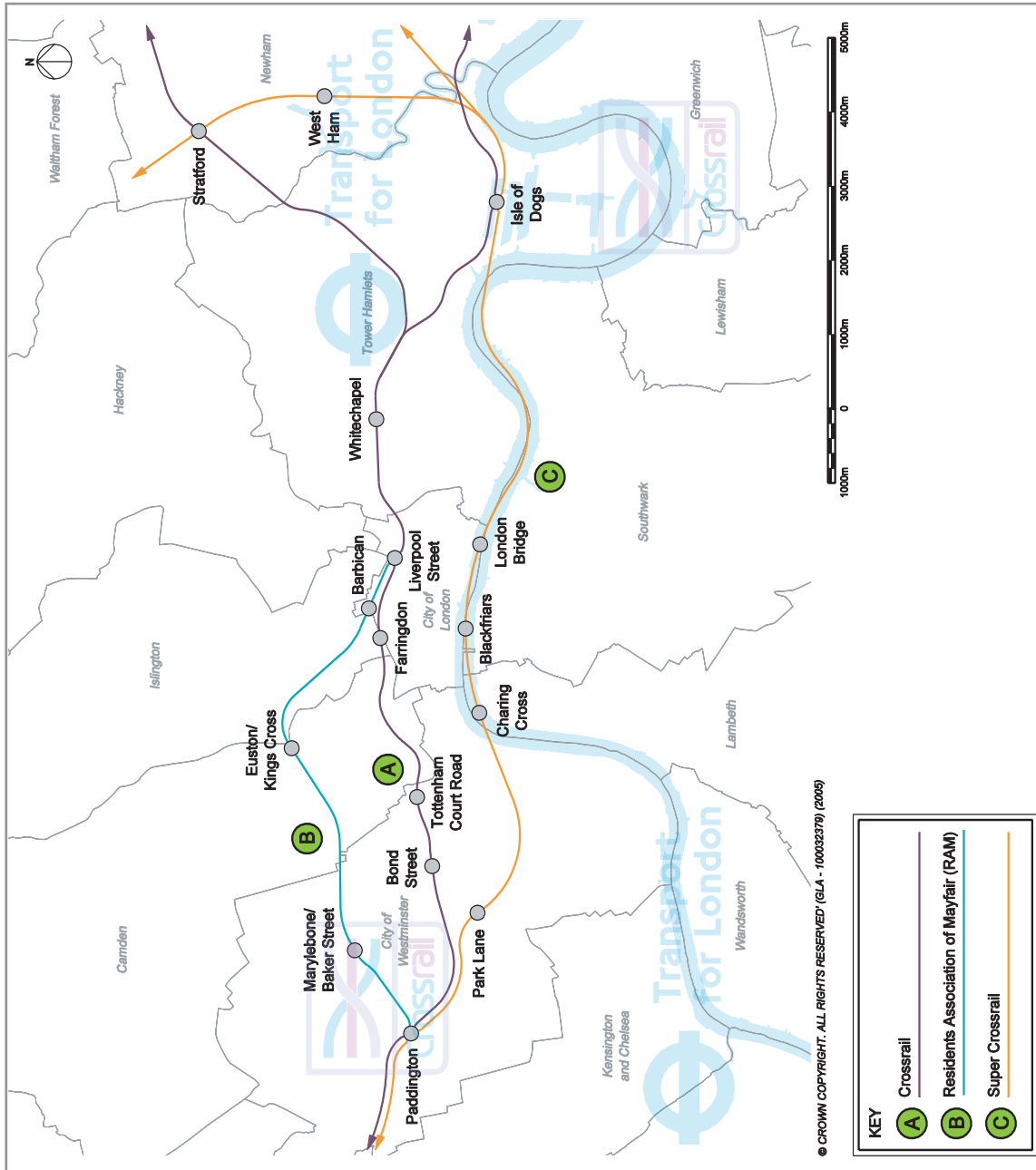


Figure 6.1 Central London Route Options

- 6.3.20 However, in comparison with the safeguarded route, the CLRLL assessment has shown that the RAM alignment would:
- attract fewer passengers;
 - have lower passenger benefits;
 - have higher costs;
 - give less improvement to accessibility in the key area of the West End;
 - necessitate more property demolition; and
 - affect more areas of archaeological importance.
- 6.3.21 The principal difference between the safeguarded alignment and the RAM alignment is the extent to which passengers can reach their final destinations in the employment, business and entertainment areas of the West End. The safeguarded route corridor is centred on destinations in and around Oxford Street, allowing this area to be reached by foot from a Crossrail station. The RAM alignment, focused on the Marylebone and Euston Roads, is up to 1 km from these destinations and would consequently offer fewer journey time savings and would therefore carry fewer passengers. In addition, the RAM alignment was not supported by either of the two local authorities (the City of Westminster and the London Borough of Camden) through which it would run.
- 6.3.22 There was no evidence that further development work could address the inherent disadvantages of the RAM alignment in terms of its inferior transport case, greater property demolition and opposition from the local authorities through which it would run. Accordingly, CLRLL confirmed the choice of the safeguarded alignment as the preferred central London route for Crossrail.

Eastern and Western Corridors

Introduction

- 6.3.23 In 2001, CLRLL defined the broad corridors to the east and west of central London as the starting point for the definition of the preferred Crossrail route. In 2003, a later option to serve Kingston and Richmond was added to the list of corridors agreed for consideration. These corridors were the subject of discussion with a wide range of key stakeholders and to a comprehensive assessment and sifting process using the GOMMMS criteria. Evaluation included a combination of desk-top studies, computer modelling and site visits.
- 6.3.24 An important element of this option assessment work was the consultation that was carried out with stakeholders. The purpose of this consultation included informing people about the process and timescales for making decisions, explaining the criteria by which options would be chosen and seeking views on possible routes and service patterns for Crossrail.

6.3.25 As part of the option assessment process, the LEWS conclusion that Crossrail should operate a Regional Metro rather than Regional Express service pattern was checked. By studying a Crossrail option with services from locations such as Oxford, Newbury, Colchester, Ipswich and Southend, CLRLL concluded that the benefits of higher revenue generation would be offset by lower service reliability and reduced benefits to key London growth and regeneration areas. As a result, CLRLL confirmed the LEWS conclusion and developed a range of Regional Metro proposals for the project.

Western Corridors

6.3.26 Six western corridors were considered for inclusion in the Crossrail preferred scheme:

- Western Corridor A – Watford Junction Line;
- Western Corridor B – Aylesbury Line via Amersham;
- Western Corridor C – High Wycombe Line;
- Western Corridor D – Uxbridge and Watford Metropolitan Line;
- Western Corridor E – Great Western Line; and
- Western Corridor F – Kingston via Richmond.

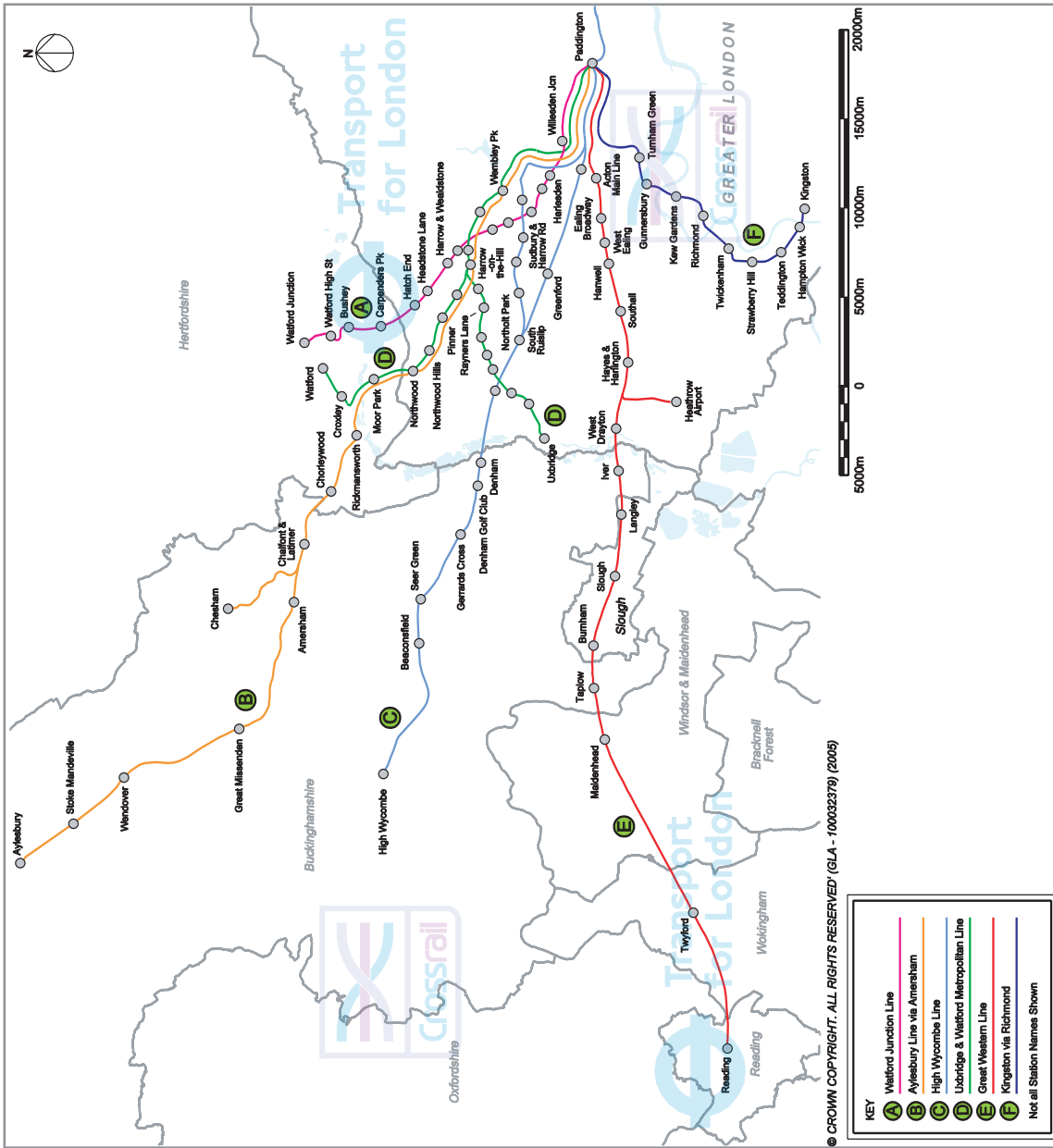


Figure 6.2 Western Route Options

6.3.27 The locations of these corridors are shown in Figure 6.2 and described in Table 6.2.

Table 6.2 Description of Western Corridor Options

Corridor	Description
A	Extend in tunnel from west of Paddington to Willesden Junction to join the Watford Lines and then run to Watford Junction. Crossrail would serve all stations between Willesden Junction and Watford Junction.
B	Extend in tunnel from west of Paddington to join the Chiltern and Metropolitan lines near Wembley Park and run to Aylesbury with a branch to Chesham. Crossrail would serve Wembley Park, Harrow-on-the-Hill, Northwood and all stations to Aylesbury and Chesham.
C	From Paddington, via the predominantly freight-only line through Greenford to South Ruislip. North of South Ruislip, the route would serve all stations to High Wycombe. An alternative sub-option provided two routes to High Wycombe – the one described above plus a route via Sudbury and Harrow Road.
D	Extend in tunnel from Paddington and surface close to Wembley Park to join the Metropolitan line and run to both Watford (Metropolitan line) and Uxbridge. Crossrail would serve all existing Metropolitan line stations between Wembley Park and both Uxbridge and Watford.
E	Extend west over existing tracks from Paddington, with Crossrail terminating at Heathrow Airport and either Slough, Maidenhead or Reading. All existing stations between Paddington and either Reading, Maidenhead or Slough would be served by Crossrail.
F	Extend in tunnel from west from Paddington to Gunnersbury via Turnham Green and join the existing North London Line to serve Gunnersbury, Kew Gardens and Richmond. At Richmond, Crossrail would then join the existing line to Kingston serving all intermediate stations except St Margarets.

Appraisal of Western Corridors

- 6.3.28 This section summarises the results of the option appraisal process carried out for the western corridors and explains the reasons for the selection of the preferred corridors and associated service pattern.
- 6.3.29 The High Wycombe corridor (Corridor C) performed poorly against the GOMMMS sub-objective of transport economic efficiency. This reflected the low level of passenger demand and crowding relief provided by this option relative to other western corridors. In addition, the operation of a high frequency Crossrail service from High Wycombe raised significant concerns about the levels of service reliability that could be achieved for both Crossrail and the Chiltern Trains services that currently operate in the corridor. As a result of these factors, this corridor was not selected for inclusion in the preferred scheme.

- 6.3.30 The Uxbridge and Watford Metropolitan line (Corridor D) performed poorly against a number of criteria, particularly the sub-objectives of transport economic efficiency, increasing option values and beneficial wider economic impacts. The poor performance of this corridor reflects the fact that Crossrail would directly replace the existing Metropolitan line service that already provides a high-frequency cross-London service to the City. The benefits to passengers would therefore be low when compared to other corridors where there is no existing direct cross-London service. Based on these factors, this corridor was not selected for inclusion in the preferred scheme.
- 6.3.31 By serving the regeneration and opportunity areas of Wembley and Park Royal, the Watford Junction Line (Corridor A) performed strongly against the sub-objective of beneficial wider economic impacts. However, the performance of this corridor against the sub-objective of transport economic efficiency was reduced by its low contribution towards relieving crowding on the national rail network. In addition, this option requires the permanent relocation of an operational train depot at Willesden to an alternative, unidentified site. Based on these factors, this corridor was not selected for inclusion in the preferred scheme.
- 6.3.32 Although the Aylesbury Line (Corridor B) performed strongly against the sub-objectives of transport economic efficiency and reliability, this corridor was not selected for inclusion in the preferred scheme. This reflects the very significant adverse contractual impacts that Crossrail would impose on the current Chiltern Line franchise and the Metronet (SSL) PPP concession for the Metropolitan line.
- 6.3.33 Corridor F (Kingston via Richmond) performed strongly against the sub-objective of transport economic efficiency, particularly by its contribution towards relieving congestion on National Rail services into Waterloo. A new rail underpass (dive-under) would have been required at Richmond station and would have had a major adverse construction impact on the surrounding residential area. Operational analysis also showed that Crossrail would require the withdrawal of District line services from Richmond and result in extended journey times for some existing passengers. In addition, the interaction of Crossrail and existing South West Trains services between Richmond and Kingston would have adverse reliability impacts on both groups of services. Based on these difficulties, the DfT-commissioned review of the Crossrail business case, published in July 2004, concluded that for this option:
- “There must also be some question as to its deliverability in practice.”*
(DfT 2004, para. 234).
- 6.3.34 Based on these constraints, this corridor was not selected for inclusion in the preferred scheme.
- 6.3.35 The Great Western corridor (Corridor E) was selected for inclusion in the preferred scheme. This was primarily because use of this corridor would allow Crossrail to operate to Heathrow Airport and therefore meet a strategic objective of the project to improve international links. However, for operational reasons, the operation of Crossrail services only to Heathrow in the Great Western corridor would require the withdrawal of the Heathrow Express service to Paddington, a move strongly opposed by airport stakeholders. Additionally, operating Crossrail from Heathrow only would severely limit the number of Great Western stations that could be served by Crossrail, due to the need to accommodate non-Crossrail services in the corridor.

- 6.3.36 As well as serving Heathrow, CLRLL considered the option of running Crossrail services from Slough. This option was rejected because it would require the construction of two additional tracks between Airport Junction (close to Hayes & Harlington) and Ladbroke Grove (close to Paddington) to ensure that stations to the west of Slough did not suffer a loss of frequency and/or significantly lengthened journey times as a result of Crossrail. This infrastructure would be costly to construct and require extensive land take between Airport Junction and Ladbroke Junction.
- 6.3.37 As an alternative to Slough, CLRLL considered the feasibility of running Crossrail services from Reading. However, serving this destination would involve significant additional costs and risks, including the need to re-signal the Reading station area. Analysis showed that these costs would not be justified by the benefits, as passenger demand on Crossrail services would be low due to the existence of alternative fast rail services to Paddington from Reading.
- 6.3.38 Analysis by CLRLL showed that terminating Crossrail at Maidenhead would provide a robust and beneficial service pattern and meet the needs of other rail services, including intercity and freight, that operate in the corridor. The resulting Crossrail service pattern would permit all stations between Maidenhead and Paddington to be served by Crossrail, thereby spreading its benefits over a wide area, as well as allowing the retention of the Heathrow Express service to Paddington.

Eastern Corridors

- 6.3.39 Five eastern corridors were considered for inclusion in the Crossrail project:
- Eastern Corridor A – Great Eastern Line;
 - Eastern Corridor B – Tilbury Line via Forest Gate;
 - Eastern Corridor C – Tilbury Line via Royal Docks;
 - Eastern Corridor D – North Kent Line via Royal Docks; and
 - Eastern Corridor E – North Kent Line via Charlton.
- 6.3.40 The locations of these corridors are shown in Figure 6.3 and described in Table 6.3.

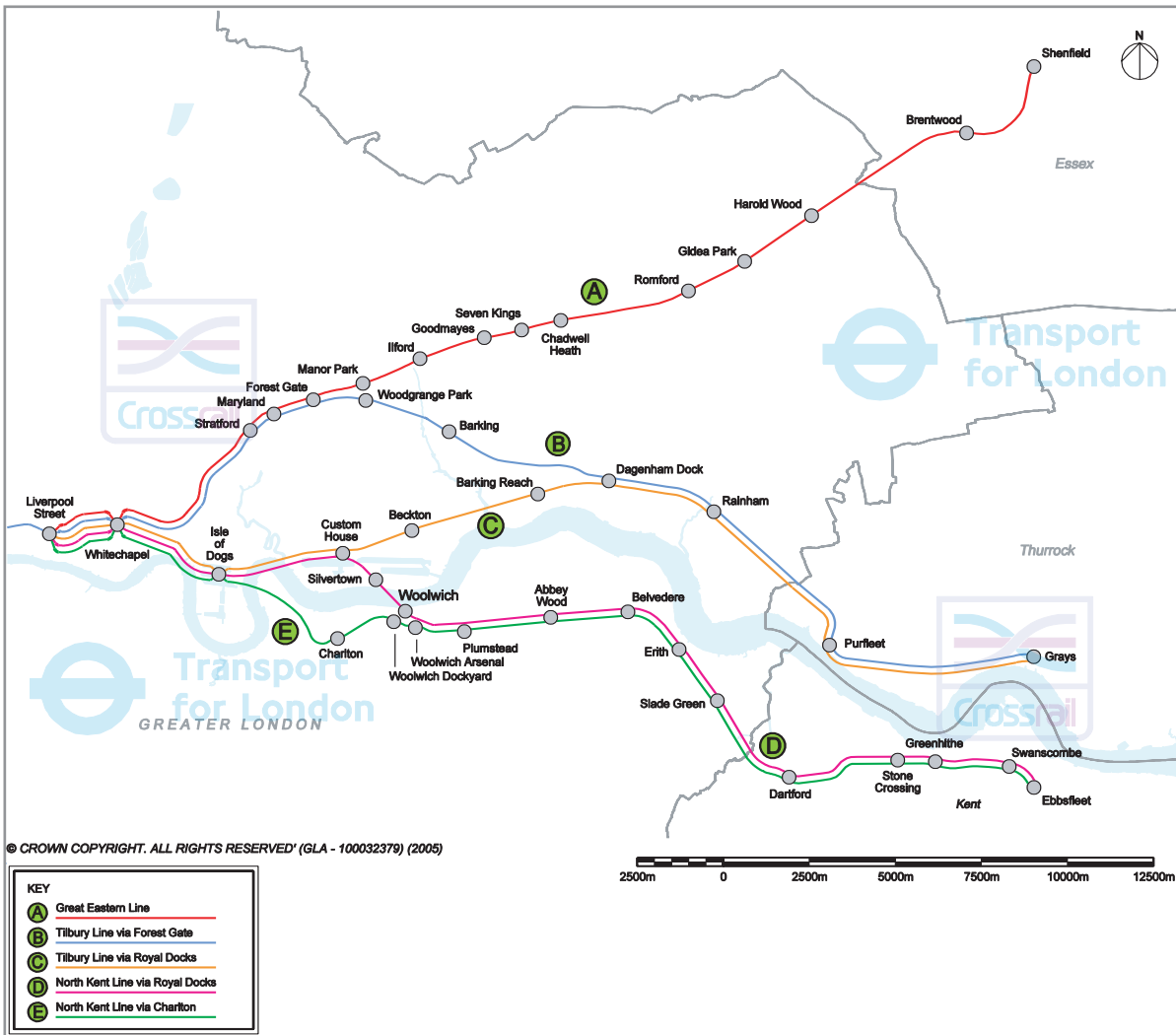


Figure 6.3 Eastern Route Options

Table 6.3 Description of Eastern Corridor Options

Corridor	Description
A	Extend in tunnel from Liverpool Street to Stratford via Whitechapel, with Crossrail services terminating at Shenfield. All existing stations between Stratford and Shenfield (except Maryland) would be served by Crossrail.
B	Extend in tunnel from Liverpool Street to Stratford via Whitechapel, with Crossrail services running via Forest Gate and Barking to terminate at Grays. All existing stations between Stratford and Grays (except Maryland) would be served by Crossrail.
C	Extend in tunnel from Liverpool Street via Whitechapel to the Isle of Dogs and Custom House to join the Tilbury Line at a point close to Barking Reach. Crossrail would then serve all stations to Grays.
D	Extend in tunnel from Liverpool Street via Whitechapel to the Isle of Dogs, Custom House and new Thames tunnel to join the North Kent Line near Abbey Wood. Crossrail services would then serve all stations to Ebbsfleet via Dartford, although the majority of trains would start and terminate at Abbey Wood.
E	Extend in tunnel from Liverpool Street via Whitechapel to the Isle of Dogs and a new Thames tunnel to join the North Kent Line near Charlton. Crossrail would then serve all stations to Ebbsfleet via Woolwich Arsenal and Dartford.

Appraisal of Eastern Corridors

- 6.3.41 This section summarises the results of the option appraisal process carried out for the eastern corridors and explains the reasons for the selection of the preferred corridors and their associated service patterns.
- 6.3.42 The weakest performing of the eastern corridors (in terms of the GOMMMS criteria) were the two corridors from the Tilbury Line (Corridors B and C). Although these corridors performed strongly against the sub-objective of beneficial wider economic impacts by supporting the regeneration and economic objectives of the Northern Thames Gateway area, the corridors serving the Southern Thames Gateway area performed more strongly against this sub-objective.
- 6.3.43 In addition, Corridor B (the Tilbury Line via Forest Gate) would have a major adverse construction impact on a residential area by requiring widespread residential and business property demolition in the Forest Gate area. These works would be necessary to allow Forest Gate Junction to accommodate the proposed Crossrail service frequency as well as the significant freight flows on the line. Corridor B could also only work in conjunction with Corridor A and would therefore preclude serving the Isle of Dogs. Although Corridor C would avoid these impacts at Forest Gate Junction, it performed poorly against the sub-objective of transport economic efficiency, as construction would involve extensive and expensive tunnelling that would not generate comparable benefits. As a result of these deficiencies, neither of these corridors was selected for inclusion in the preferred scheme.

- 6.3.44 Both corridors serving the North Kent Line and Southern Thames Gateway area (Corridors D and E) performed strongly against the sub-objective of beneficial wider economic impacts by supporting regeneration and economic development in the corridor. These corridors also performed strongly against the sub-objective of transport economic efficiency by providing a new high capacity rail link across the River Thames that would generate large journey time savings for passengers travelling to the Isle of Dogs, the City and parts of the West End from southeast London and north Kent. Although the route via Charlton would be cheaper to construct than the route via the Royal Docks, the decision was taken to include the Royal Docks corridor (Corridor D) in the preferred scheme. This decision was based upon:
- the greater beneficial wider economic impacts that would be achieved by serving the Royal Docks as opposed to the Greenwich Peninsula;
 - the avoidance of the need to completely restructure National Rail network services in southeast London and Kent;
 - the avoidance of the very significant permanent environmental impacts that would have occurred in the area around Charlton station, including the demolition of a substantial number of residential and business properties; and
 - the difficulty in identifying a feasible Crossrail station site on the Greenwich Peninsula.
- 6.3.45 For the selected Corridor D, CLRLL considered the option of operating the Crossrail service from Abbey Wood only, rather than projecting a proportion of the service to start at Ebbsfleet. CLRLL concluded that by sharing tracks with other rail services on the North Kent Line between Abbey Wood and Ebbsfleet, there was an unacceptable risk of disruption to Crossrail's high-frequency service pattern. As a result, Abbey Wood rather than Ebbsfleet was selected as the starting point for all Crossrail services in the corridor.
- 6.3.46 The Great Eastern corridor (Corridor A) was also selected for inclusion in the preferred scheme. Although this corridor performed less well than the other eastern corridors against the sub-objective of beneficial wider economic impacts, Crossrail would still have a positive impact on this sub-objective by improving accessibility to Stratford, where significant development is proposed. Inclusion of this corridor also offers significant transport economic efficiency benefits by providing crowding relief to both the National Rail and London Underground networks, as well as releasing additional rail capacity into Liverpool Street terminal station. This additional rail capacity could be used to improve services to destinations on the Lee Valley line between London and Cambridge.

Summary of Route Option Selection Process

- 6.3.47 The route option selection process identified the following corridors for inclusion in the Crossrail preferred project:
- In the centre of London, the safeguarded alignment between Paddington and Liverpool Street was confirmed. This decision reflected this option's lower construction cost, lower adverse environmental impacts and higher passenger benefits than the alternative alignments.
 - To the east of central London, two corridors were included in the preferred scheme. The first was the Great Eastern corridor from Shenfield. Selection of this corridor was based upon its contribution to crowding relief on the National Rail and London Underground networks and its ability to free up capacity at Liverpool Street to allow other train services to be expanded. The North Kent Line via Royal Docks corridor from Abbey Wood was selected on the basis of its role in assisting regeneration and economic development in the Thames Gateway, including the Isle of Dogs and Royal Docks.
 - To the west of central London, the Great Western Line was included in the preferred scheme, with services to both Heathrow and Maidenhead. Use of this corridor would improve links to Heathrow Airport, provide large journey time savings to the City and Isle of Dogs and achieve crowding relief on London Underground lines in west London.

6.4 Alternative Crossrail Stabling and Depot Locations

Introduction

- 6.4.1 The locations of the Crossrail maintenance depot and train stabling sidings will be critical to the efficient and reliable operation of the railway. This section outlines the alternative locations considered by CLRLL for these facilities and explains the reasons for selecting the preferred sites.

Selection of Depot Location

- 6.4.2 CLRLL carried out an initial search to identify whether there were any existing depots suitable for use by Crossrail. This study concluded that the use of existing depot sites was not practical unless the existing users of the depot could be displaced to other locations. However, no depot site was identified where displacement was considered to be a feasible option. Significant costs and environmental impacts associated with modifying existing facilities for Crossrail's requirements would also be incurred.
- 6.4.3 Over twenty depot sites which were not currently in railway use were identified and an assessment of these was carried out using GOMMMS criteria. Two possible depot sites were investigated in greater detail, namely:
- Brentwood, between the M25 and eastern edge of Harold Wood; and
 - Romford Goods Yard and Gasworks.

- 6.4.4 The Brentwood site was rejected because of its adverse impact on Green Belt. Although the appraisal showed that the Romford site would also involve some loss of Green Belt in order to provide a rail underpass for access into the depot site, this was considered acceptable as the depot site itself would be constructed almost entirely on brownfield land.
- 6.4.5 A further consideration in the selection of a depot site arose following consideration of the testing and commissioning of the completed railway. Experience on other projects demonstrates the delays to opening which can result if this is not done properly. For the Crossrail project, commissioning is particularly significant as it is intended to replace existing main line rail services with Crossrail trains and this must be done without any interruption of service.
- 6.4.6 There are only two existing sections of route that will be used by Crossrail that are electrified using the 25kV overhead line electrification system and can therefore be used to gain the in-service experience required. These are the Great Eastern Main Line (GEML) and the lines used by the Heathrow Express between Paddington and the airport. The Crossrail rolling stock would be unsuitable for providing a premium service to the airport as a substitute for Heathrow Express and the proposed Heathrow connect service will not provide sufficient opportunities for in-service operation of the new stock. For this reason the Crossrail plan is based around a commissioning and phased opening strategy that starts with the GEML and works westwards across London.
- 6.4.7 One of the requirements for commissioning and bringing rolling stock into service is access to a depot. Informal advice was sought from rolling stock manufacturers on the kind of facility which would be required for commissioning and it was realised that the facilities for commissioning would almost amount to the permanent ones which were required for operation of the network. The option of providing a temporary depot was therefore not pursued.
- 6.4.8 As a result of these various factors, the Romford Goods Yard and Gasworks site was selected as the site for the Crossrail maintenance depot.

Selection of Stabling Sites

- 6.4.9 To minimise empty train running, train stabling facilities should be sited as close as possible to the stations where trains enter and leave passenger service. For Crossrail, this ideally means that the areas in the vicinity of Maidenhead, Heathrow, Paddington, Shenfield and Abbey Wood would be best suited for stabling facilities.
- 6.4.10 Existing stabling sites, suitable for use by Crossrail, were identified at Old Oak Common, Gidea Park and Shenfield where the Crossrail facilities could be accommodated within or adjacent to similar existing facilities. The Romford maintenance depot was also identified as a suitable site for stabling a number of Crossrail trains.

- 6.4.11 Additional Crossrail stabling locations are proposed for Maidenhead and West Drayton, in both cases on land which is in existing railway use. However, the use of the location at West Drayton would require the displacement of the existing users of the site. To avoid this, two alternative stabling sites were identified in Southall. The first of these sites was shown to be operationally unsuitable for Crossrail while the other would require significant works and have adverse noise and visual intrusion impacts on the surrounding residential area. West Drayton was therefore confirmed as the preferred location for these stabling sidings.

Alternative Electrification System

- 6.4.12 Crossrail will be electrified using the 25kV overhead electric system. This system is already in use on existing sections of the line between Pudding Mill Lane Portal and Shenfield and between Westbourne Park and Stockley Flyover. It has been established railway practice for many years that the 750V third rail system should not be used on new railways unless these could be considered as extensions of an existing third rail system.
- 6.4.13 The reason for this policy is the danger which the uninsulated conductor rails present to trackworkers, trespassers and passengers evacuating from a failed train. Crossrail cannot be considered an extension to an existing third rail system and for this reason the 25kV overhead system has been selected.

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