

Royal Borough of Greenwich

Proposed DLR Extension: Canning Town to Kidbrooke / Eltham / Falconwood

Feasibility Study

Addressing TfL's most pressing questions



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Executive Summary

Following a review of earlier work and meetings with TfL/DLR, it was agreed that the proposed scope of this study should focus on TfL's "most pressing questions" concerning the merits of a DLR extension from South Greenwich to north of the River. These are:

- 1) **Demonstration of Need:** An explanation of the key north-south transport issues and objectives we are seeking to address.
- 2) **Options Appraisal:** using TfL's Strategic Assessment Framework (SAF), appraise various light rapid transport options (DLR, a rapid bus and tram based solutions) commenting on how the preferred solution best meets the key objectives.
- 3) **The River Crossing and Links to the Existing Network:** to assess the existing constraints on linkage to the existing DLR network north of the River and subsequent operational issues, and to propose possible solutions.
- 4) **Buildability;** a commentary on the structural requirements, constraints and implications of the preferred system alignment, with reference to scaled plans, and provisional costs.

Demonstration of Need

Royal Greenwich is part of the "Thames Gateway" that by 2030 it is expected to have four major business centres employing 250,000. By then Greenwich Peninsula will provide 3.5 million square feet of commercial space. RBG is within the poorest 9% of English boroughs with an ethnically diverse population of 246,000 that is getting younger, so the demand for employment is growing. It is hoped that the new "Royal" Borough status and the Olympics legacy will drive forward regeneration, but this is partly dependent on securing the infrastructure needed to stimulate business confidence.

A recent study found that public transport links between the south and the north of the Royal Borough are under-developed, and that residents of Stratford or Central London have better access to new job opportunities on Greenwich Peninsula than do most RBG residents living south of Shooters Hill Road. RBG will see proportionately fewer new jobs created in the future than most neighbouring boroughs, but a proportionately higher increase in population - much of it in new homes planned for Kidbrooke to the south. This means that many more RBG residents will have to travel outside the Borough to find employment - largely to the major business centres north of the River.

This mismatch between the future location of new homes and new jobs will be remedied only through improved north-south transport links, without which south Greenwich residents would be disadvantaged relative to those from other parts of London. These issues are recognised by the Mayor's Transport Strategy and the Sub Regional Transport Plan which sees new River crossings in East London as key to improving the resilience of the transport network and business confidence.

The Silvertown Link initially should ease current congestion on the existing Blackwall Tunnel crossing, but this may be short-lived unless accompanied by appropriate public transport improvements. The new road will encourage traffic growth as and when new developments come on stream, which could quickly exhaust the new tunnel capacity and exacerbate congestion on the local road network.

From an assessment of the existing and proposed transport provisions in RBG, the key north – south travel issues are identified as follows:

- a) The main focus of the existing rail routes is to serve the City and the West End, essentially east - west movements. North-south links are mostly bus-based services which do not offer the more favourable trip speeds or journey time reliability of fixed track (rail) services.
- b) Many Royal Greenwich residents experience a general inability to make rapid and relatively seamless journeys to other parts of Greater London by public transport. The lack of satisfactory connections to employment opportunities in Greenwich Peninsula, East London and the Thames Gateway is an impediment to growth and investment in the Royal Borough.
- c) Current river crossing proposals (the Silvertown Link) show an over dependency on road based travel which, unless demand-managed, could have adverse consequences for traffic growth, sustainability and the local environment.

These highlight an urgent need for the highest possible quality public transport system that will deliver the following key objectives:

- i. support RBG's strategy for sustainable growth by giving its residents levels of access to new jobs in the Thames Gateway major business centres (including Greenwich Peninsula) comparable to those already enjoyed in most boroughs north of the River,

- ii. ease traffic congestion on the River crossings and local road network by extending travel choices that will deliver modal transfer and accommodate most new development related travel demands *sustainably*, with significant environmental benefits,
- iii. improve access for RBG residents to the Greater London public transport system, making it easier to reach all parts of the capital, so helping to deliver the Convergence Agenda supported by the Mayor of London.

LRT Options Appraisal

Further to TfL's "Strategic Assessment Framework" (SAF), a number of light rapid transit (LRT) options have been appraised for possible deployment on a route running generally parallel to the A2-A102. It has been concluded that a DLR solution is the most consistent with the key objectives, for the following reasons:

- DLR is a high quality, high capacity rapid transport system that, like heavy rail and London Underground, has the potential to compete with car use in terms of journey times.
- Unlike the possible alternatives these benefits are achieved by virtue of a system that is automated and completely segregated from other travel modes, which affords consistency of service and unrivalled journey time reliability. It is quick, clean, safe and generally reliable.
- The potential flexibility benefits of greater routing options that may be offered by other systems would be eroded significantly where buses/trams have to compete for space on an already congested local road network.
- A bus/tram solution, following a similar *segregated* corridor as the proposed DLR could not link as seamlessly into the extensive DLR network north of the river to provide the highest possible quality connections to the wider Thames Gateway and Greater London.
- These constraints mean that the alternative systems could not achieve comparable reliable journey times to DLR to rival those achievable by car, which means less modal transfer of future car trips.
- DLR, therefore, offers more environmental benefits and fewer net CO2 emissions than other system, so affords a more sustainable long-term solution.

All the LRT options were assessed against 16 key transport challenges identified by the SAF. It was found that the DLR extension provided the most well rounded solution, well outperforming all the other options.

The River Crossing and Links to the Existing Network

Having regard to the existing network constraints and service schedules, it appears possible to connect a DLR extension from Greenwich Peninsula to the Stratford International line just south of Canning Town Station. The Stratford line has a good deal of spare capacity at present. In the foreseeable future it will require an upgraded service which could partly be provided by Greenwich Peninsula trains. This alignment makes more sense than routing the proposed extension onto the already busy Poplar line.

TfL currently is planning a deep bored tunnel river crossing for the Silvertown Link. If this plan goes ahead, the DLR Extension would require a separate bored tunnel the required alignment of which (while feasible) would conflict with other infrastructure. The problems could be simplified if TfL adopted an immersed tube solution for the Silvertown Link, into which the DLR could also be routed. The DLR would then cross the River at a much shallower depth affording significant reductions in the approach structures and fewer property impacts. It is considered that an immersed tube is the right option for both modes given that a combined structure should show considerable savings over separate bored tunnels in terms of cost and environmental impact.

TfL currently holds to the view that there would need to be *"a very strong case for the DLR Extension to deflect from delivering the Silvertown (bored) tunnel, which is supported by national, London-wide and local policies, and for which TfL currently have a mandate from the Mayor to progress"*. To reverse this position, the feasibility study has sought to answer TfL's "most pressing questions" (see above).

Buildability and Costs

Hyder has focussed on the opportunities for a DLR Extension via the A2-A102 corridor as far as Falconwood. The proposed alignment details indicate that for most of the route as far as Kidbrooke it is feasible to fit the DLR tracks on to vacant land adjacent to the major road with relatively few property impacts. East of Kidbrooke the alignment would be on railway land with disproportionately higher costs.

The construction costs of the various route options have been estimated as follows:

Extension Options - Totals	Cost (x £ million)
Canning Town - Falconwood (bored tunnel)	817.9
Canning Town - Falconwood (immersed tube combined with S. Link)	752.2
Canning Town - Eltham (bored tunnel)	683.3
Canning Town - Eltham (immersed tube combined with S. Link)	617.6
Canning Town - Kidbrooke (bored tunnel)	520.3
Canning Town -Kidbrooke (immersed tube combined with S. Link)	454.6

In addition to the above, all 'Extension Options' carry additional cost for rolling stock, operation and maintenance. Assuming a 'bored tunnel' the following table shows 30 years revenues/costs ratios based on preliminary estimates of passengers generated by each of the Options, it will be seen that all three Options would achieve revenues/costs parity over 30 years, which figures would look better with lower construction costs afforded by a 'shared tube' tunnel on the River crossing.

Extension Option	Estimated passengers/year (million)	Assumed average fare	30 Year Costs (£m)	30 Year Revenues	Revenues/ Costs Ratio
Canning Town - Falconwood	21.00	£3.00	£995	£1,021	1.03
Canning Town - Eltham	19.00	£3.00	£835	£925	1.11
Canning Town - Kidbrooke	17.00	£3.00	£656	£829	1.26

The longer extensions, of course, could be expected to attract more passengers than the Canning Town – Kidbrooke option, but the extra revenues from these would not cover all the costs of the additional construction. It follows that it would be more difficult to establish a business case for the longer options than for the Canning Town – Kidbrooke option.

Extending the DLR to Kidbrooke would bring an estimated 50,000 residents within 20 minutes walk of DLR services, while at least a further 100,000 would be no more than 20 minutes away via a single bus, train or cycle trip. It seems realistic, therefore, that the DLR Extension to Kidbrooke could attract the required number of daily trips needed to cover its construction and operational cost over a 30 year period.

Recommendations

It is recommended that R B Greenwich endorses the findings of this study and requests TfL and the Mayor of London to:

- 1) note the social and geographic context of Royal Greenwich and the findings of previous studies that confirm a need for a high quality north-south public transport network to serve existing and future residents the Royal Borough,
- 2) endorse Hyder's preliminary findings that a DLR Extension, between Canning Town – Kidbrooke for the present, offers the most appropriate solution at for improving north-south transport links and connecting Royal Greenwich most sustainably with the wider Thames Gateway and Greater London,
- 3) approve in principle the connection of the proposed DLR Extension to the Stratford International Line immediately to the South of Canning Town Station,
- 4) instruct the designers of the currently proposed Silvertown Link River crossing to consider in full the benefits of an "immersed tube" that could also accommodate a DLR crossing at less cost than two independent bored tunnels,
- 5) provide funding to R B Greenwich, and technical assistance with passenger demand modelling, in order to expedite a full business case assessment of the proposed DLR Extension
- 6) subject to a positive business case, provide further funding to complete the requisite geotechnical and topographic surveys, an Environmental Impact Assessment and preliminary design of the preferred route for full public consultation.

1 INTRODUCTION

1.1 Initial Brief

- 1.1.1 On 13th December 2011, an initial (“pre-feasibility”) study into the technical feasibility of providing an extension of the DLR from Silvertown to Falconwood was considered by the R B Greenwich Cabinet. The Cabinet agreed that further work should be carried out into the alternative options identified in the report with a view to establishing an economic/business case for such a line.
- 1.1.2 Hyder Consulting was retained to carry out this work with the following initial brief:
- To explore in greater detail the feasibility of the alternative options for delivering a DLR extension from north of the River to Kidbrooke, Eltham or Falconwood
 - To consider both the logistical and practical issues for the proposed alignment and the environmental impact of both construction and its operation
 - To provide an estimate of the capital cost of building the extension
 - To consider how best the line would link into the existing network and where the line would terminate at its northern end
 - To consider the economic and business case for the provision of a line
 - To discuss the proposals with TfL

1.2 Revised Scope of Work and Deliverables

- 1.2.1 Following a meeting with TfL/DLR on 23 January 2012, (see Appendix 5) it was agreed that the proposed scope of work should focus the available resources on the following areas of study, as recommended by Rob Niven (TfL/DLR), to answer TfL's most pressing questions about the project:
- 1) A demonstration of the need for a new light rapid transit (LRT) system
 - 2) Options appraisal - a consideration of alternative LRT systems.
 - 3) The River Crossing and links to the existing DLR network.
 - 4) The buildability of the preferred system having regard to cost considerations
- 1.2.2 In an email dated 11 April 2012 (see Appendix 2), Tony Wilson of TfL Planning further stated, *“If your work is able to articulate the specific problem which you are seeking to address, how this scheme would address it, and what other ways of addressing it have been considered, it would be very helpful”*.
- 1.2.3 The initial brief, therefore, was revised to reflect the following project deliverables,
- 1) **Demonstration of Need:** An explanation of the key north-south transport issues and objectives we are seeking to address.
 - 2) **Options Appraisal:** using TfL's Strategic Assessment Framework (SAF), appraise various light rapid transport options (DLR, a rapid bus and tram based solutions), commenting on how the preferred solution best meets the key objectives.
 - 3) **The River Crossing and Links to the Existing Network:** to assess the existing constraints on linkage to the existing DLR network north of the River and subsequent operational issues, and to propose possible solutions.
 - 4) **Buildability;** a commentary on the structural requirements, constraints and implications of the preferred system alignment, with reference to scaled plans, and provisional costs.

1.2.4 A flow chart summarising the planning methodology adopted for the development of this project is shown in Figure 1.1. The above tasks – the subject of this report - constitute Stages 1 – 5 of the process, further to which a full business case assessment will be required prior to other detailed components of the Action Plan.

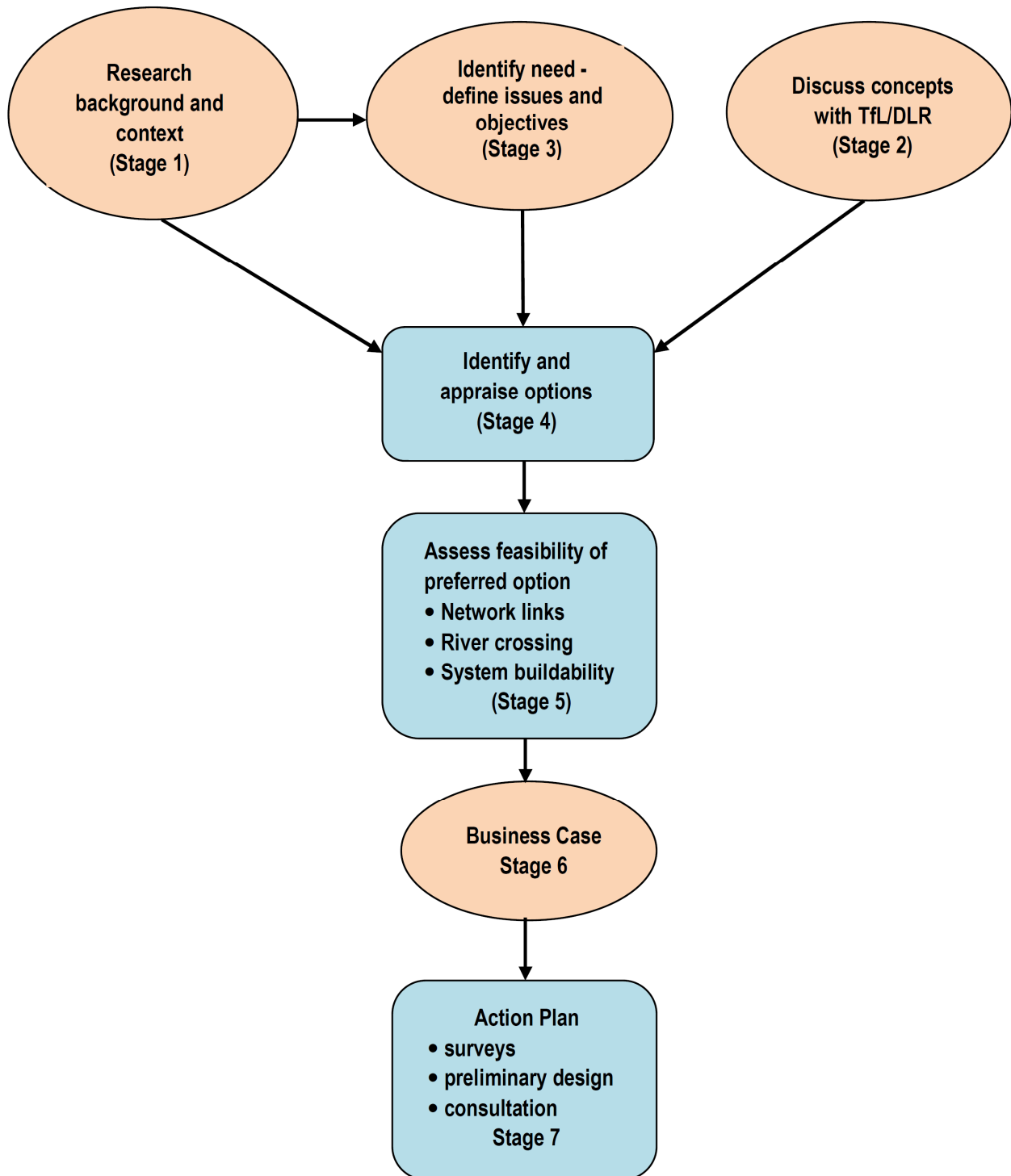


Figure 1.1: DLR Extension – Planning Methodology

1.3 Structure of this Report

- 1.3.1 Chapter 2 – “Background”, starts by outlining the geographic and social context of Royal Greenwich and the hopes for future regeneration. This is followed by a review of earlier work, which précis the findings of several relevant studies. Chapter 2 continues by summarising the discussions held to date with TfL/DLR. It concludes with a commentary on the existing public transport network, its deficiencies and other committed schemes.
- 1.3.2 Chapter 3 – “Demonstration of Need” – summarises a recent report that assesses the need for better north-south transport links, before reviewing the Mayor’s Transport Strategy and the Sub Regional Transport Plan. In the light of this dialogue the key issues relating to the required north-south links improvements are identified and the key objectives are defined.
- 1.3.3 With the assistance of TfL’s Strategic Assessment Framework’ (SAF) tool, Chapter 4 – “Possible LRT Solutions – Options Appraisal” assesses several light rapid transit options for linking north and south Greenwich. It explains why an extension to the DLR is considered to offer the best strategic fit that out-performs any bus-based or a tram-based system with reference to TfL’s 16 “transport challenges”.
- 1.3.4 Chapter 5 describes the existing DLR Network, its, service patterns, possible future extensions, track capacity and anticipated growth. On the basis of this information, Chapter 6 discusses the options for connecting the proposed DLR extension to the existing network, and for crossing the River.
- 1.3.5 Chapter 7 – “Buildability of DLR Extension” describes the proposed route in more detail and outlines the considerations that have helped determine the ‘preferred alignment’, for which preliminary plans have been prepared.
- 1.3.6 A preliminary assessment of the costs associated with the various DLR extension options (to Kidbrooke, Eltham or Falconwood) is considered in Chapter 7, from which a basic financial model has been prepared to assess revenues/costs implications. The report ends with Chapter 8 - ‘Conclusions’, and Chapter 9 - ‘Recommendations’.

2 BACKGROUND

2.1 Royal Greenwich – The Geographic and Social Context

- 2.1.1 The Royal Borough of Greenwich is an Inner London Borough situated to the east of Central London on the south bank of the Thames. It covers an area of more than 5,000 hectares, extending about 10 km between its east and west extremities and 10 km between its north and south extremities. To the north it has the longest river frontage of any London borough and is bounded by the boroughs of Lewisham, Bromley and Bexley to the west, south and east.
- 2.1.2 Royal Greenwich is part of the “Thames Gateway”- the East London sub-region that has been earmarked for particular growth under the direction of the “London Thames Gateway Development Corporation”. By 2030 it is expected that the Thames Gateway will have four major business centres employing a quarter of a million people at Stratford, Canary Wharf, The Royals and Greenwich Peninsula. Greenwich Peninsula will provide a total of 3.5 million square feet of commercial space in 14 buildings over the next 20 years. The Thames Gateway offers a large source of new job opportunities but, as yet, still lacks the transport connections needed to make these jobs easily accessible to many Royal Greenwich residents.
- 2.1.3 The population of Royal Greenwich is about 246,000 of which 22% is aged under 15 and 11% is aged over 65. Some 53.6% of households are family households and 46.4% are ‘one-person’ or ‘other’ households. 30.2% of households contain dependent children, of which 10.5% are lone parent households. Pensioners make up 19.7% of all households but the proportion of older people in the borough is decreasing. In 1991 residents aged over 60 made up 19% of the total population. This figure was 16.9% in 2001 and 15% in 2011. The population of Royal Borough is therefore getting younger, so the demand for employment is growing.
- 2.1.4 Measured on the “Index of Multiple Deprivation 2010”, Royal Greenwich is ranked 27th out of 326 districts in England, i.e. it is within the poorest 9% of English boroughs. According to the RBG website, other important demographic statistics include
- 33% of the Royal Greenwich's population is from black and ethnic minority communities.
 - Approximately 5% of the population receives disability living allowance, i.e. has a long-term illness.
 - About 72% of the Royal Borough's population was born in the UK.
 - About 14% of working age population lacks any qualifications.
 - Around 67% of residents are employed.
 - Around 197 languages are spoken in the Royal Borough.
 - The crime rate in Greenwich is one in ten, below the national average of one in seven.
- 2.1.5 It is clear, therefore, that access to large numbers of jobs of various skill types is needed to raise living standards and lift many Royal Greenwich residents out of poverty. These needs are compounded by the projected growth in population. Over the next 10 years it is expected that some 18,000 new homes will be constructed in Royal Greenwich. The Greater London Authority anticipates a population increase of 52,200 (21%) by 2021 and 64,500 (26%) by 2031. Much of this growth will be concentrated in southern parts of the borough (particularly Kidbrooke) with low public transport accessibility levels at the present time.

2.2 The Royal Connection and Olympics Legacy

- 2.2.1 On 2 February 2012, the Queen made Greenwich a Royal Borough to mark her Diamond Jubilee. Greenwich became the first boroughs to be granted royal status in more than 80 years and is one of only four in the country. The honour was conferred to recognise the close links between Greenwich and royalty since the middle ages. Greenwich's buildings with royal links include Greenwich Palace, Eltham Palace and the Royal Military Barracks, in addition to others within the World Heritage Site.
- 2.2.2 Greenwich will be one of six boroughs to host the London 2012 Games which start on 27 July. It is hoped that the new Royal Borough status and the Olympics legacy will drive forward record levels of regeneration and cement Greenwich's role as a key international destination for businesses and visitors from across the globe. The future regeneration of Royal Greenwich, however, is partly dependent on securing appropriate investment in the essential infrastructure needed to stimulate business confidence and growth in the local economy.
- 2.2.3 Royal Greenwich is regarded as an "Inner London" borough, but its general level of public transport (PT) accessibility is lower than most other Inner London boroughs. A recent north - south links study (see 3.1) identified better PT connections in the northern half of the Royal Borough than in the southern half, but even those in the north leave something to be desired.

2.3 Review of Earlier Work

2.3.1 Bus Rapid Transit Options, North Greenwich - Bromley

- 2.3.1.1 In 2006, the South East London Transport Strategy Group (SELTRANS) commissioned Integrated Transport Planning (ITP) to consider Bus Rapid Transit Options between North Greenwich, Eltham and Bromley. The report concluded that North Greenwich underground station is a gateway to the wider underground network but is poorly accessible by bus to those living in the south of Greenwich including Eltham and Kidbrooke. This effectively constrains the benefits generated by the ongoing regeneration in East London and the development of the Peninsula and Thames Gateway from reaching areas to the south.
- 2.3.1.2 The deficiency in quality public transport in this area is a major local concern. Housing regeneration in the Eltham and Kidbrooke areas is dependent upon job accessibility and there is a clear logic that the two should be linked by a high quality public transport route to North Greenwich. It was opined that a conventional bus approach would not meet the central objectives of offering a viable alternative to the car through quality, reliability and accessibility, nor would it contribute to regeneration through bringing added confidence and investment to areas of social deprivation.
- 2.3.1.3 A Bus Rapid Transit (BRT) was put forward as the preferred solution. BRT requires a whole system approach to address vehicle quality, information, stop side infrastructure, payment and marketing/branding. If sufficiently segregated from other traffic, it offers journey time reliability and a run time that is competitive with the car.
- 2.3.1.4 However examination of the corridors showed significant constraint to providing effective segregation, and that large sections of delay could only be overcome through off-highway routes (should there be sufficient justification and 'appetite' for their pursuit). The ITP study proposed a 2-stage process, the first being a bus priority based scheme, which would lead to the second involving higher levels of segregation.
- 2.3.1.5 Accessibility analysis suggested significant potential demand for travel in the proposed route corridor. The ability to unlock the potential would be enhanced by adopting 'high

transit ideals', i.e. the Stage 2, "maximum segregation" option. But unlocking this potential would also carry greater implementation challenges and delivery risks.

2.3.1.6 Partnerships for further development and delivery were considered essential, with TfL as lead partner. It was envisaged that significant funding would need to be drawn from TfL but development and regeneration funding might also play a significant role.

2.3.1.7 Corollary: To date TfL has shown no interest to act as lead partner for the development of a bus-based rapid transit route between North Greenwich and Bromley. Some of the required measures (e.g. high occupancy vehicle lanes on the congested A102) would have far-reaching impacts on the strategic road network which could be difficult to ameliorate. As part of this study Hyder has applied TfL's Strategic Assessment Framework (SAF) tool to assess a Rapid Bus Transit concept alongside other LRT options – a DLR extension and a tram-based system (see Chapter 4).

2.3.2 Royal Borough of Greenwich – North-South Travel - An Overview of the Current Situation

2.3.2.1 This report details the findings of a study commissioned by RBG and undertaken by Hyder in 2011, to assess the transport connections between the north and south of the borough. It comprises an assessment of:

- the transport modes available to residents of Greenwich
- the key trends that will affect transport demand in the future (population growth, job opportunities, planned developments)
- the current transport supply for different residents in Greenwich

2.3.2.2 The study identified a mismatch between the location of proposed new homes in R B Greenwich, mostly in the south, and new job opportunities largely confined to the north. It demonstrated that there is an urgent need for a high quality sustainable public transport system to improve the existing poor north-south links. The finding of this report are summarised in 3.1.

2.3.3 Greenwich Waterfront Transit Alternatives – Bus Priority Measures

2.3.3.1 In 2011 RBG commissioned Hyder to carry out a study into the GWT alternatives. The main recommendations were for the provision of bus or high occupancy vehicle lanes on much of the dual carriageway network between Greenwich Peninsula and Thamesmead (where there is reserve capacity). It was suggested that a properly formulated strategy of bus (or HOV lanes) could meet many sustainable transport objectives offering a practical low-cost alternative to the GWT insofar as this could:

- encourage car sharing, reducing car-borne travel demands and CO2 emissions
- reduce peak hour traffic and congestion over the wider Thames Gateway road network south of the River
- provide a relatively fast de-congested corridor for bus movement
- afford additional bus service capacity to accommodate future development travel needs
- reduce general traffic speeds with corresponding benefits for collision reduction and accident severity.

2.3.3.2 While these proposals could further serve to strengthen east-west links along the southern bank of the Thames Gateway (mainly to the benefit of residents living in the north of the Royal Borough), they would do nothing to address the loss of the Thames Gateway Bridge project or strengthen connections with important developments north of the River.

2.3.4 DLR Extension Silvertown – Falconwood, Pre-Feasibility Study - Elevated Alignment on A2 - BTSA Centre Line

- 2.3.4.1 Having previously considered other Docklands Light Railway (DLR) extension options, R B Greenwich commissioned Hyder in 2010 to conduct a pre-feasibility assessment of constructing a DLR extension between Silvertown and Falconwood. As part of this study we were asked to consider how such an extension might follow the centre line of the A2 Rochester Way Relief Road and the A102 Blackwall Tunnel Southern Approach (A2-BTSA) with a view to minimising property impacts and avoiding tunnelling. This implied the construction of a long viaduct from the Greenwich Peninsula to Falconwood. But the study also considered the relative merits of other options, including some tunnelling, that could be constructed largely outside the limits of the carriageway to avoid significant impact on the operation of the existing road.
- 2.3.4.2 We concluded that an extension of the DLR generally following the line of A2-BTSA, potentially offers considerable benefits to residents and businesses in Royal Greenwich. It would vastly improve north-south public transport links and connect large swathes of the Borough with existing fixed-track services to/from Central London and other parts of the Capital.
- 2.3.4.3 Where feasible the construction of an elevated DLR extension along the line of the A2-BTSA, would provide a very visible, high profile facility along a recognised transport corridor with good legibility and minimum land-take. The multi-modal use of transport corridors in this way can be advantageous if the provisions can be designed collectively as part of an integrated land-use/transportation masterplan for a major settlement. But attempting to retro-fit a proposed fixed rail facility along the centre line of an existing principal road corridor would be much more difficult. Such would have appreciable traffic impacts that would likely be resisted by TfL/Network Management.
- 2.3.4.4 We suggested that the rigid application of an elevated DLR concept along the A2–BTSA centre line could result in disproportionate costs and would be particularly expensive to achieve at the crossings of Woolwich Road, Westthorne Avenue and the Eltham Tunnel. High-impact structural solutions would be needed at these locations. It was important, therefore, to consider alternative alignments.
- 2.3.4.5 For the purposes of mitigating additional noise nuisance and visual intrusion, we suggested that a tunnelling (or cut-and-cover) option may be more appropriate in locations that would otherwise require the construction of high-level flyovers of existing over-bridges, such as the Sun in the Sands. Plans illustrating an alignment for the A2-BTSA centre line concept, therefore, also indicated an alternative parallel alignment that would present fewer environmental constraints and technical hurdles.
- 2.3.4.6 As prequel to these deliberations, some thought was given to the challenge and associated costs of crossing the River and connecting to the existing DLR Network. The Greenwich UDP designates a Thames Crossing Safeguarded Area at Bugsby's Reach between North Greenwich and Silvertown for a road/rail crossing (the Silvertown Link). This tunnel proposal was the subject of feasibility work by TfL which was not well advanced at the time.
- 2.3.4.7 We argued that a DLR extension could also be envisaged from a junction south of Canning Town, ramping down to cross under the Thames adjacent to the envisaged road tunnel, and rising to the surface south of North Greenwich station. On the assumption that the DLR adopted this alignment, we included it in our preliminary costs for the envisaged Silvertown – Falconwood Extension.
- 2.3.4.8 Corollary: After further consultation with TfL, it is now clear that the vehicle restraint system needed to protect the DLR substructure, would effectively occupy a lane in each direction, along almost the entire route. Such a solution would demand closures

and diversions during construction and major reconstruction of the highway. The huge associated costs effectively preclude further consideration of an A2-BTSA centreline alignment.

2.4 Discussions with TfL and DLR Stakeholders

2.4.1 As a prequel to this study, a series of meetings was held with TfL/DLR personnel to obtain data and ascertain the main issues that needed to be addressed. Notes of these meetings are included in Appendix 5 of this report.

2.5 Local Public Transport Network and Deficiencies

2.5.1 Mainline Rail

2.5.1.1 Royal Greenwich is served by three railway lines:

- The North Kent line: via Greenwich, Charlton and Woolwich
- The Bexleyheath line: via Lewisham (change for DLR) and Eltham
- The Dartford Loop: via Lewisham and New Eltham/Sicup.

2.5.1.2 All these lines converge on London Bridge and also serve Cannon Street, Waterloo and Charing Cross. These essentially fulfil a sub-regional function but also serve local cross-borough movements predominantly in an east-west direction. None of these lines directly serve the Greenwich Peninsula growth centre, the best access to which currently is a bus link from the North Kent line at Charlton.

2.5.2 DLR Links

2.5.2.1 The Dockland Light Railway: accesses the Royal Borough on two separate branch lines, both of which interchange with the North Kent Line:

- the DLR Lewisham line - serves Greenwich and Canary Wharf,
- the DLR Woolwich Arsenal line - serves City Airport, Canning Town and Bank

2.5.2.2 Figure 2.1 below is included to illustrate how the Greenwich and Woolwich links ties in geographically to the wider DLR network. (Note: the proposed Gallions Reach to Dagenham Dock line, also illustrated, is as yet uncommitted).

2.5.2.3 The network has recently grown with the opening of the Stratford International – Canning Town section replacing the North London line service, and the addition of new stations at Stratford and Heron Quays. A new interchange has been formed with High Speed One at Stratford International (which also serves the Olympics complex). The DLR finalised its three-car upgrade in May 2011. There are no other committed extension proposals at the present time. The existing DLR Network is further described in Chapter 5.



Figure 2.1 – The DLR Network

2.5.3 Jubilee Line

2.5.3.1 Greenwich Peninsula is served by the Jubilee Line at North Greenwich which is accessed by eight bus routes. This is the only London Underground station in the Royal Borough situated near the tip of the Peninsula. It has limited park-and-ride facilities, which have contracted in recent years as land around the station has been developed.

2.5.3.2 Capacity on the Jubilee Line has been increased with completion of the signalling upgrade and train lengthening to seven cars. We understand that crowding is increasing again and that further capacity upgrades are extremely difficult.

2.5.4 Bus Network

2.5.4.1 For the present transport links to the main commercial growth points on Greenwich Peninsula, including the O2 centre and North Greenwich station, remain heavily dependent on bus-based travel. The bus network more generally comprises local and radial routes that focus on other main centres of employment, i.e. Woolwich (including Queen Elizabeth Hospital to the south), Greenwich Town Centre, Lewisham, Thamesmead and Eltham. There are some bus priority measures (e.g. bus lanes on Woolwich Road and the South Circular) but no systematic bus network strategy for the Royal Borough.

2.5.4.2 The southern part of RBG is served by bus routes that are mostly focussed on Woolwich (166,178,122,386). Eltham is served by north-south routes 122 and 161 to Plumstead and Woolwich respectively via Well Hall Road. Buses terminating at Eltham interchange feed the railway from the south and connect the station and the shopping centre. The Kidbrooke regeneration area has two bus routes: 178 (Lewisham-Kidbrooke-QEH-Woolwich) and B16 (Kidbrooke Station-Eltham-Eltham Park-Falconwood-Welling-Bexleyheath).

- 2.5.4.3 In the south of the Royal Borough, along the Kidbrooke-Falconwood railway corridor, all trains serve Lewisham for interchange with the DLR, while buses also link to Lewisham (122, 178) and to Greenwich (286,386). Route 132 links this area with the Greenwich Peninsula and North Greenwich Underground station. This service provides up to 6 buses per hour serving Bexleyheath–Bexley–Eltham–Rochester Way–A102–North Greenwich. Although route 132 serves Rochester Way, it does not directly serve Kidbrooke Station or the regeneration area. Between Avery Hill and the Sun in the Sands, route 132 is paralleled by route 286 which then serves Westcombe Park and Woolwich Road and runs via Westcombe Hill, not via the A102.
- 2.5.4.4 For access to jobs north of the Thames particularly in Canary Wharf, Stratford and the Thames Gateway, existing public transport options are to use rail or bus to Lewisham or Greenwich for the DLR, or route 132 to North Greenwich then the Jubilee Line. When the A102 is clear, bus route 132 appears a fairly attractive option with a scheduled run time of 16 minutes from Kidbrooke to North Greenwich. This makes a journey from the Kidbrooke area to Stratford possible in about 35-40 minutes with one change. However, route 132 does not serve the Kidbrooke regeneration area and can be delayed on the A102 by traffic queues. It could be diverted to serve Kidbrooke Station and the regeneration area but this would impose a penalty on through passengers. A new route or the extension of route B16 towards North Greenwich may be more attractive.
- 2.5.4.5 Access to the Thames Gateway area north of the Thames is not attractive by public transport. From the Kidbrooke/Eltham area, buses link to Woolwich Arsenal DLR (routes 122,161,178 and 386) providing ready access to employment in Royal Victoria and City Airport, but access to the Thames Gateway north and east of here is more difficult. One possibility is bus 132 to North Greenwich, Jubilee Line to Canning Town or West Ham then onward connections, which involves at least two interchanges.

2.6 Other Committed Public Transport Schemes

2.6.1 Crossrail

- 2.6.1.1 Running east-west to relieve the Central Line and provide new high speed suburban rail services, Crossrail will link Great Eastern suburban services with those at Paddington. It will have a branch serving Canary Wharf, Woolwich and Abbey Wood. There will be an interchange with the DLR Beckton line at Custom House. Valuable as these services are, they will not improve the north-south links in Royal Greenwich.

2.6.2 Thameslink

- 2.6.2.1 After years of delay, work on this scheme is in hand, including the extra tracks at Borough Market Junction, London Bridge. There is now uncertainty over the ordering of new trains for the scheme which may mean further delays. In any event, the Thameslink Programme is a strategic sub-regional mainline rail initiative, which offers only limited local transport benefits to Royal Greenwich.

2.6.3 Emirates Air Line

- 2.6.3.1 From summer 2012, the Emirates Air Line cable car (EAL), indicated on Figure 2.2, will allow pedestrians, wheelchair users and cyclists to cross the River Thames within five minutes between terminals at Greenwich Peninsula and the Royal Docks. The cable car could provide a crossing every 15 seconds carrying up to 2,500 passengers per hour in each direction (compared to 14,000 pph design capacity available on DLR),

2.6.3.2 The EAL will encourage regeneration in the area and provide access to visitor attractions. It will not, however, provide the necessary public transport capacity or level of service to meet most future commuter travel needs between Royal Greenwich, North London and the wider Thames Gateway. Moreover, as a discreet crossing the EAL needs to be served, for which it will be reliant on buses and other means of transport.

2.6.4 Silvertown Link

2.6.4.1 TfL is currently proposing 2 x 12.1m bored tunnels for the Silvertown Link. The tunnel alignment (see Figure 2.2) passes under the former access lock to Victoria Dock, between DLR viaduct piers and under the Airport DLR line, avoiding the foundations of the “Emirates Airline” cable car piers. At the time of writing TfL is working on the approach road alignment options.

2.6.4.2 TfL is also considering an immersed tube construction, although this option could have more environmental impact on the Thames. The likely cost of the bored tunnels and approach roads is about £400m.

2.6.4.3 Initially the proposed Silvertown Link would ease the current congestion on the existing Blackwall Tunnel crossing. But unless accompanied by appropriate public transport improvements, this relief may be relatively short-lived. It would also serve to encourage car use and traffic growth as and when new developments come on stream throughout the Royal Borough and Thames Gateway. Any new river crossing capacity moreover could also serve to transfer traffic away from other congested river crossings, particularly the tolled Dartford crossing (unless the river crossings were demand-managed through a unified tolling regime).

2.6.4.4 The likely outcome would be the exhaustion of the Silvertown Link capacity within a relatively short timeframe with exacerbated congestion on the local road network. This could only be mitigated by a new high quality public transport link, such as a DLR Extension, that is capable of securing some modal transfer from the road tunnels while accommodating most of the new development related travel demands sustainably.

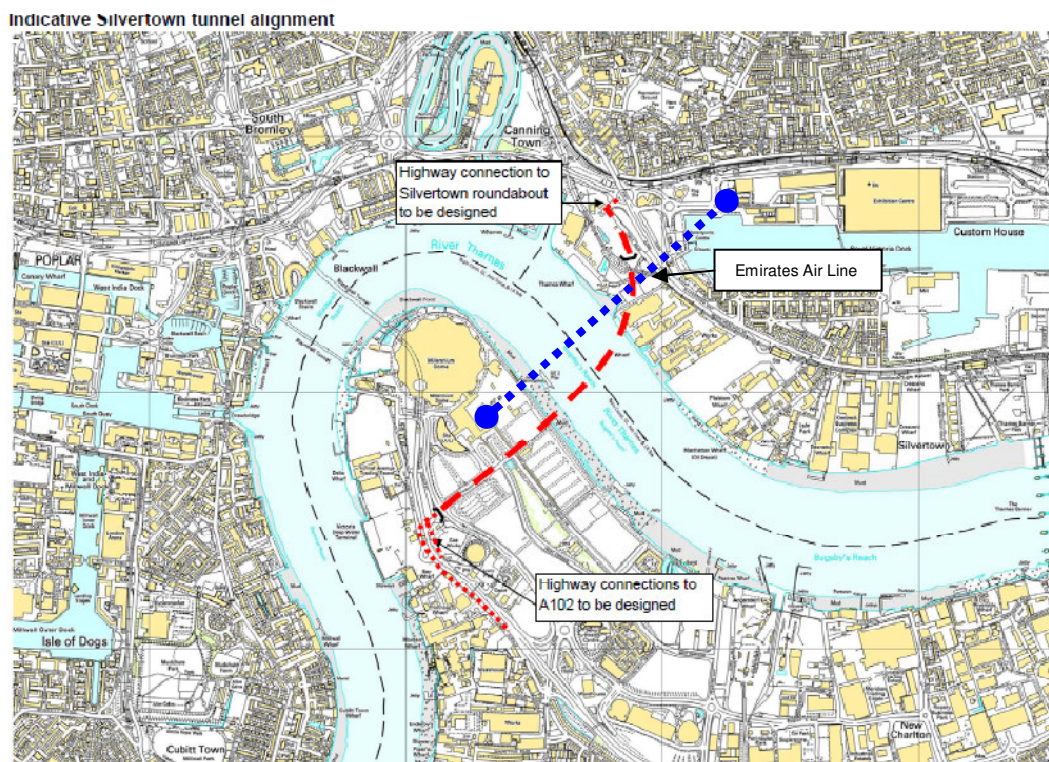


Figure 2.2: Indicative Silvertown Tunnel Alignment and Emirates Air Line

3 DEMONSTRATION OF NEED

3.1 The Case for Better North-South Links

3.1.1 In 2011, R B Greenwich commissioned Hyder to conduct a study of the north-south transport links within the Royal Borough. For the purposes of the study the north-south 'divide' was taken as the A2/A207 Shooters Hill Road. It was found that while both parts of the borough are reasonably well connected to central London by Network Rail and buses, public transport (PT) links between the south and north are comparatively under-developed. This deficiency is particularly acute at night when a south-to-north trip requires a change of bus in Lewisham.

3.1.2 The north part of the borough has more PT options (DLR, underground and buses) than the south. These provide reasonable connections to boroughs north of the River, which will improve with Crossrail. This means that residents of north Greenwich have better access to job opportunities north of the River than those of south Greenwich. Moreover people living in Stratford or Central London currently have better access to new job opportunities on Greenwich Peninsula, via the Jubilee Line, than do most residents of south Greenwich.

3.1.3 The study also found that RBG will see fewer new jobs created in the future than most neighbouring boroughs. Of the new jobs that will be created in Greenwich, a high proportion will be on the Peninsula in the north. By contrast much of the new residential development is planned for the south - mainly Kidbrooke - currently with poor PT links to the Peninsula and beyond.

3.1.4 While expecting fewer new job opportunities, RBG will see a higher than average increase in population, meaning that many new Greenwich residents will have to travel outside the borough to find employment. Clearly there is a mismatch between the future location of new homes and new jobs across Greenwich and the Thames Gateway, illustrated by the figures in Appendix 6 (extracted from the N-S Links Study) which show the distribution of expected employment and population growth across Greater London.

3.1.5 With most of the proposed employment growth spots being in the Thames Gateway (Newham and Tower Hamlets) or Inner London boroughs north of the River, the need for better north-south PT links serving Royal Greenwich becomes even more acute. Without this provision south Greenwich residents would be disadvantaged relative to those from other parts of London with better access to these job opportunities.

3.2 Mayor's Transport Strategy and the London Plan

3.2.1 The current Mayor's Transport Strategy (MTS) was published in April 2010. In responding to earlier consultation R.B. Greenwich made the following key points.

- There is a need for investment in buses and fixed links in the south of the Borough if housing and regeneration potential is to be fully realised.
- Greenwich Borough's ability to deliver maximum benefits from development and regeneration is compromised by the lack of strategic transport plans for Thames Gateway or any commitment to transport investment other than Crossrail.
- The extension of DLR from Woolwich into Thames Gateway and towards Eltham would provide missing orbital links.
- The lack of orbital rail links reduces the ability to deliver modal shift.

3.2.2 The above comments articulate the Borough's concern about the lack of public transport investment, exacerbated by the cancellation of the Greenwich Waterfront

Transit (GWT) project. In the published MTS, Proposal 39 includes the further development of the proposed Silvertown Link Thames crossing to relieve the Blackwall Tunnel.

- 3.2.3 The London Plan (LP) provides the land-use context for the MTS and contains policies setting out the priorities for London's development and associated transport provision. The LP states that North East London, South East London and Thames Gateway are the development priorities for London. It identifies three Opportunity Areas in RBG (policy 2A.5):
- Greenwich Peninsula/Charlton Riverside West,
 - Deptford Creek/Greenwich Riverside,
 - Woolwich/Thamesmead/Charlton Riverside East.
- 3.2.4 It calls for plans for these areas to increase housing delivery and maximise access by public transport. The plan also identifies Areas of Intensification where significant increases in population, employment and other uses can be achieved, which includes Kidbrooke (Policy 2A.6). Both Charlton Riverside and Kidbrooke are identified as areas for regeneration being among the 20% most deprived wards in London.
- 3.2.5 RBG's comments on the LP were that successful regeneration and redevelopment depends on public transport investment and it is not clear how the abandonment of GWT can be replaced. Greenwich argued (*inter alia*) that the LP failed to recognise the Greenwich Peninsula as a major development and employment growth area to 2025. However these issues and the need for improved River crossings have now been acknowledged by TfL and the GLA in both the London Plan and the Mayor's Transport Strategy.

3.3 Sub Regional Transport Plan

- 3.3.1 The Sub Regional Transport Plan for the Eastern Region and its Addendum (on which TfL is consulting at the time of writing) also made it clear that new River crossings in East London are key to improving the resilience of the transport network. It states, "*The lack of resilience and choice leads to further delay and congestion for drivers – at the Blackwall Tunnel. This is on average 20 minutes per vehicle in the morning peak. For businesses, it is an additional cost and can discourage investment. Without action now, these problems will only get worse.*"

3.4 Royal Greenwich Unitary Development Plan

- 3.4.1 LBG planning policy is set out in the UDP adopted in July 2006. The vision and key policies relevant to this study are set out in the UDP. The vision for 2010 is set out in the Greenwich Strategy, 2003. It states that the Borough will make a major contribution to London's economy that local people will live in a good and well cared for environment and that communities in the area will be served by effective and coordinated public transport. The UDP sets out the land use implications of this vision. It develops policy round three main themes:
- equality and social inclusion
 - sustainable development
 - regeneration.
- 3.4.2 Sustainable development policy follows guidance in "Planning Policy Statement 1: Delivering Sustainable Development, 2005". Therefore, policies include *a sustainable transport strategy which integrates land use and transport and promotes greater use of public transport, walking and cycling...* Regeneration policy addresses the revitalisation of older, run down parts of the borough, especially those on the Waterfront and in South Greenwich. Care will need to be taken to relate regeneration to infrastructure

and service provision, including improvements, *especially in the public transport network.*

3.4.3 The Strategic policies in the UDP include those for movement which include the following:

SM1 – *To effectively link major transport generators and attractors to the current and foreseeable transport network, at no or minimal cost to the environment.*

SM2 – *To seek equitable levels of mobility and accessibility for all groups....considering pedestrians, people with disabilities, cyclists and public transport users first.....*

SM3 – *to encourage sustainable forms of transport....by restraining road traffic....and safeguarding the environment.....*

SM5 – *to promote a fully integrated public transport system that meets residents' needs....including new infrastructure and services, a high frequency Metro style rail network of turn up and go services, improved interchange and common high standards.*

3.4.4 The UDP is being succeeded by the Local Development Framework. Core strategies are being reviewed for publication in summer 2012. Proposed changes to the UDP were published in late 2010 and consultation is in hand. The need to improve North-South public transport links remains a key issue and received significant support in the consultation.

3.5 Key Issues and Objectives

3.5.1 In the light of the above dialogue, the key north-south transport issues in R B Greenwich can be summarised as follows:

- a) The main focus of the existing rail routes is to serve the City and the West End - essentially east-west movements. North-south links are mostly bus-based services which do not offer the more favourable trip speeds or journey time reliability of fixed track (rail) services.
- b) Many Royal Greenwich residents experience a general inability to make rapid and relatively seamless journeys to other parts of Greater London by public transport. Most journeys to north of the River have to be made indirectly and require changes. It is often necessary to travel towards central London to make relatively local trips so journey times are protracted. The lack of satisfactory direct connections to employment opportunities in Greenwich Peninsula, East London and the Thames Gateway is an impediment to growth and investment in the Royal Borough.
- c) Current river crossing proposals (the Silvertown Link) show an over dependency on road based travel which, unless demand-managed, could have adverse consequences for traffic growth, sustainability and the local environment.

3.5.2 The need for improved transport links between new homes in R.B. Greenwich and new jobs, mostly north of the River, therefore, is incontrovertible and officially recognised at the sub-regional level. The question left to address is what form the links should take to meet these travel needs most sustainably, i.e. with most potential to mitigate private car travel and minimise CO2 emissions. The key issues highlight an urgent need for the highest possible quality public transport system that will deliver the following key objectives:

- i. support RBG's strategy for sustainable growth by giving its residents levels of access to new jobs in the Thames Gateway major business centres (including Greenwich Peninsula) comparable to those already enjoyed in most boroughs north of the River,
- ii. ease traffic congestion on the River crossings and local road network by extending travel choices that will deliver modal transfer and accommodate most new development related travel demands *sustainably*, with significant environmental benefits,
- iii. improve access for RBG residents to the Greater London public transport system, making it easier to reach all parts of the capital, so helping to deliver the Convergence Agenda supported by the Mayor of London.

4 POSSIBLE LRT SOLUTIONS - OPTIONS APPRAISAL

4.1 TfL Strategic Assessment Framework (SAF)

- 4.1.1 The Strategic Assessment Framework (SAF) has been developed by TfL to assess and compare projects and programmes against the goals set out in the Mayor's Transport Strategy (MTS). The SAF can be applied to two different stages in a project namely; the early planning phase, and the project development / implementation phase. In the early planning phase the SAF should be used to support assessment and comparison of options for strategic projects. In the project development / implementation phase, the SAF supports business case development and is embedded into TfL's Business Case Development Manual.
- 4.1.2 The SAF assesses the impact of the proposals on each of the MTS outcomes, based on qualitative or quantitative analysis, considering each of the following elements:
- baseline/reference case,
 - nature of impact,
 - scale of impact,
 - spatial dimension and
 - other considerations / evidence.
- 4.1.3 The "Proposed DLR Extension: Canning Town to Kidbrooke / Eltham / Falconwood" is at the planning phase for the SAF as it has not yet been through TfL's financial approval mechanism, the Corporate Approval Gateway Process (CGAP). At this stage the main aim is to analyse the intervention and to consider all possible intervention options to allow the poorer performing options to be discarded, and then to shape the remaining options so that they deliver the strategic objectives in the most efficient way.
- 4.1.4 For the planning stage, the focus is therefore on the comparative assessment of the options. We were asked by TfL to complete this as far as possible using quantifiable information, and where this was not readily available, to make qualitative statements.

4.2 The Possible Options

- 4.2.1 Hyder was commissioned to consider the feasibility of a cross-river DLR extension broadly following the A102-A2 corridor as far Falconwood. This particular proposal is examined in some detail in later chapters of this report. But in this chapter, we assess a range of light rapid transit options with potential to upgrade public transport in the Falconwood - North Greenwich corridor. To assist this options appraisal we have used TfL's SAF tool to assess each option against the 16 transport challenges incorporated within the SAF methodology.
- 4.2.2 The options for upgrading public transport in the Falconwood - North Greenwich corridor need to be based, as far as possible, on systems already used in London or likely to be relatively easy to implement for London operation. Considering the different levels of investment from the least cost to the most expensive and, very broadly, increasing levels of quality – the options may be listed as follows:
- Increased bus provision;
 - Bus Rapid Transit – conventional busways;
 - Bus Rapid Transit – guided busways;
 - Trams which may be on street or reserved track;
 - Light Rail - DLR;
 - Heavy Rail.

4.2.3 The aim of this public transport initiative is to improve the connectivity along a relatively long local route tying in the south of Greenwich to the north of Greenwich and connecting Greenwich to London. To meet these aims it is considered unlikely that increasing existing bus provision alone would provide the necessary improvements in journey time, journey time reliability or capacity. The initiative is of significant local importance and does not aim to provide regional connections, so it is unlikely that heavy rail would provide an economically viable option. These two options namely increased bus provision and heavy rail have therefore been excluded from further assessments. Sections 4.3 – 4.7 explore the following remaining options in further detail to facilitate comparison and the selection of a preferred scheme:

- Option 1: High Quality Bus Service – On Street
- Option 2: Tram System – On Street
- Option 3: Bus Rapid Transit – Guided Busway
- Option 4: Segregated Tram
- Option 5: DLR Extension

4.2.4 The above possible options have also been assessed with reference to the key issues and objectives outlined in Section 3.4.

4.3 Option 1: High Quality Bus Service – On Street

4.3.1 Introduction

4.3.1.1 Upgrading the existing bus routes is likely to provide the lowest cost solution. TfL's East London Transit (ELT) provides a useful illustration of how this could be implemented. The ELT is a modern bus system which aims to meet public transport demand generated by Thames Getaway developments in northeast London. Phase 1 of the ELT opened in 2010 providing a part segregated bus services between; [Ilford](#), [Barking](#), [Thames View Estate](#) and [Dagenham Dock](#). Phase 2 of the ELT is expected to be completed in 2013 and will run between Barking, [Barking Riverside](#) and Dagenham Dock. Two new routes EL1 and EL2 are provided by the ELT and replace existing bus route 369 and part of route 179. The concept is to make every effort to maximise reliability and service quality while using conventional double deck buses. Phase 1 of ELT cost £26m covering selective road widening, the provision of bus lanes, branding, high quality bus stop infrastructure and the passenger information system.

4.3.1.2 A similar approach in the North Greenwich – Kidbrooke corridor could be taken to enhance the quality of existing bus routes and to introduce a dedicated new route. This is envisaged as conventional bus operation but with a series of bus priority and other measures designed to maximise speed and reliability, concentrated on revamping the bus service between Kidbrooke and North Greenwich or Canning Town.

4.3.2 Route Description

4.3.2.1 The South East London Transport Strategy Group (SELTRANS) commissioned a report in 2006 entitled Bus Rapid Transit Options – North Greenwich – Eltham – Bromely”. The report investigated options to meet the significant new travel demands which will be generated by development on the Greenwich Peninsula, Canary Wharf, Docklands and the regeneration at Eltham and Kidbrooke. The report promotes the provision of bus priority options which meet the objectives identified above and which largely follows the A102 / A2 corridor. However as this corridor is subject to significant congestion the report suggests converting the nearside lanes of this strategic route to High Occupancy Vehicle (HOV) lanes to improve bus journey times and journey time

reliability. It is noted that this would significantly reduce the capacity of this road for the flow of general traffic, a situation which is unlikely to be acceptable to TfL as this corridor represents the main north-south strategic artery in this area.

- 4.3.2.2 A route has therefore been considered which connects to the six destinations and runs on the residential streets adjacent to the A2 / A102 corridor. The proposed route is shown in Figure 4.1. The entire route would need to be assessed to establish areas of congestion and to establish appropriate bus priority measures to improve bus journey times and journey time reliability.
- 4.3.2.3 Starting from the north, the route commences at Canning Town DLR LU station, it then connects to the proposed Silvertown Link via a new road crossing of the DLR Beckton line. It is then proposed that a new short section bus lane is provided between the portal of the Silvertown Link to Bugsbys Way to allow buses to connect the employment areas and bus interchange opportunities in this area.
- 4.3.2.4 The route then connects to Comberdale Road via the existing grade separated roundabout at the junction between the A102 and Woolwich Road. The provision of bus priority measures at this junction would be required to improve bus journey times and journey time reliability through this junction. This section is utilised by numerous bus routes all of which would benefit from the additional bus priority measures which would need to be brought forward as part of these proposals. The route then continues along Westcombe Hill and Stratheden Road until it reaches Shooters Hill Road at which point it goes along Shooters Hill Road towards the Sun in the Sands Roundabout.
- 4.3.2.5 An alternative route is shown which would help to improve the directness of this route. The diversion utilises Seibert Road and Invicta Road and after crossing Charlton Road would be facilitated by new carriageway construction over the rail tunnel to connect to Shooters Hill Road. The engineering feasibility and the environmental and social impacts of this diversion, and the journey time improvements, are outside the scope of this report and could be assessed by future studies. The route then continues along Kidbrooke Park Road.
- 4.3.2.6 Buses could then continue along either Rochester Way or Kidbrooke Park Road. The route then diverges to allow one service to access the development areas in Kidbrooke whilst the other service continues on towards Falconwood Station via Rochester Way. The Kidbrooke route continues on the A2213 and then turns left onto Eltham Hill and finally on to Eltham High Street.
- 4.3.2.7 Further investigation would be needed to establish the congestion hot spots on the routes proposed so bus priority measure were developed to target these areas, and to allow for the development of a cost benefit analysis.
- 4.3.2.8 Through the provision of bus priority measures on the proposed route it is assumed that average bus speeds could be increased by 10% faster than average bus speed in inner suburban London i.e. 16 kph instead of 14 kph (TfL Congestion Charging Monitoring report, 2008).

4.3.3 Key features of the service

- 4.3.3.1 The high quality bus service would ease Public Transport (PT) capacity issues at North Greenwich Underground station by offering an alternative PT link between Greenwich and London North of the Thames. Specifically it would strengthen north - south public transport provision for residents within 640m of the service, the maximum walk distance recognised by TfL's Public Transport Accessibility Level PTAL methodology. The enhanced connectivity would provide more Greenwich residents with direct public

transport access to the shops and services and job opportunities on the Greenwich Peninsula, the wider Thames Gateway and Central London.

- 4.3.3.2 The proposed bus service would be based on established bus priority techniques and would be largely implemented within the public highway with relatively few stakeholders and therefore relatively simple to implement. The bus priority measures brought forward should significantly improve the attractiveness of the bus service by improving bus journey time and journey time reliability. However it is recognised that as this option runs on the existing highway, it would still be liable to delays due to congestion. The priority measures would also enhance the current and existing services and improve their financial viability. It is noted that the measures may result in reductions in the capacity for general traffic although these impacts should be small as the majority of the bus route is away from the A102/A2 strategic road corridor.
- 4.3.3.3 Cyclists could benefit from the proposals in two main ways, firstly folded bikes are allowed on buses at the driver's discretion which would allow cycles to make up a portion of the journey which may not be currently possible. Secondly, the bus priority measures could incorporate cycle facilities to improve north-south cycle connectivity within Greenwich. The proposed bus service could provide similar improvements for pedestrians by allowing walking to make up part their journey, and also by providing improved pedestrian facilities at junctions as bus priority measures are brought forward.
- 4.3.3.4 Although buses are equipped with CCTV the waiting areas are not; the service is therefore unlikely to provide a reduction in crime rates or the perception of safety.
- 4.3.3.5 Located within the Royal Borough of Greenwich an Olympics Host Borough the bus service would support regeneration in this borough and the rest of London, particularly the Thames Gateway as it better integrates this area.

4.3.4 Summary

- 4.3.4.1 This section provides a summary of the main advantages and disadvantages of the proposed Option 1: High Quality Bus Service – On Street, when compared to the other options under consideration. It also provides a list of further considerations should this scheme be pursued further and an illustration of the costs relating to the scheme.
- 4.3.4.2 Advantages:
- Cheapest option
 - Lowest Infrastructure requirements
 - Simple planning process
 - Flexible routing and delivery
 - Could utilise the proposed Silvertown Tunnel to interchange at Canning Town
 - Low environmental impact
- 4.3.4.3 Disadvantages:
- Not likely to provide the step change in service required to meet the aims of the initiative
 - Only accessible within 640m
 - Longest and least reliable journey times of options considered

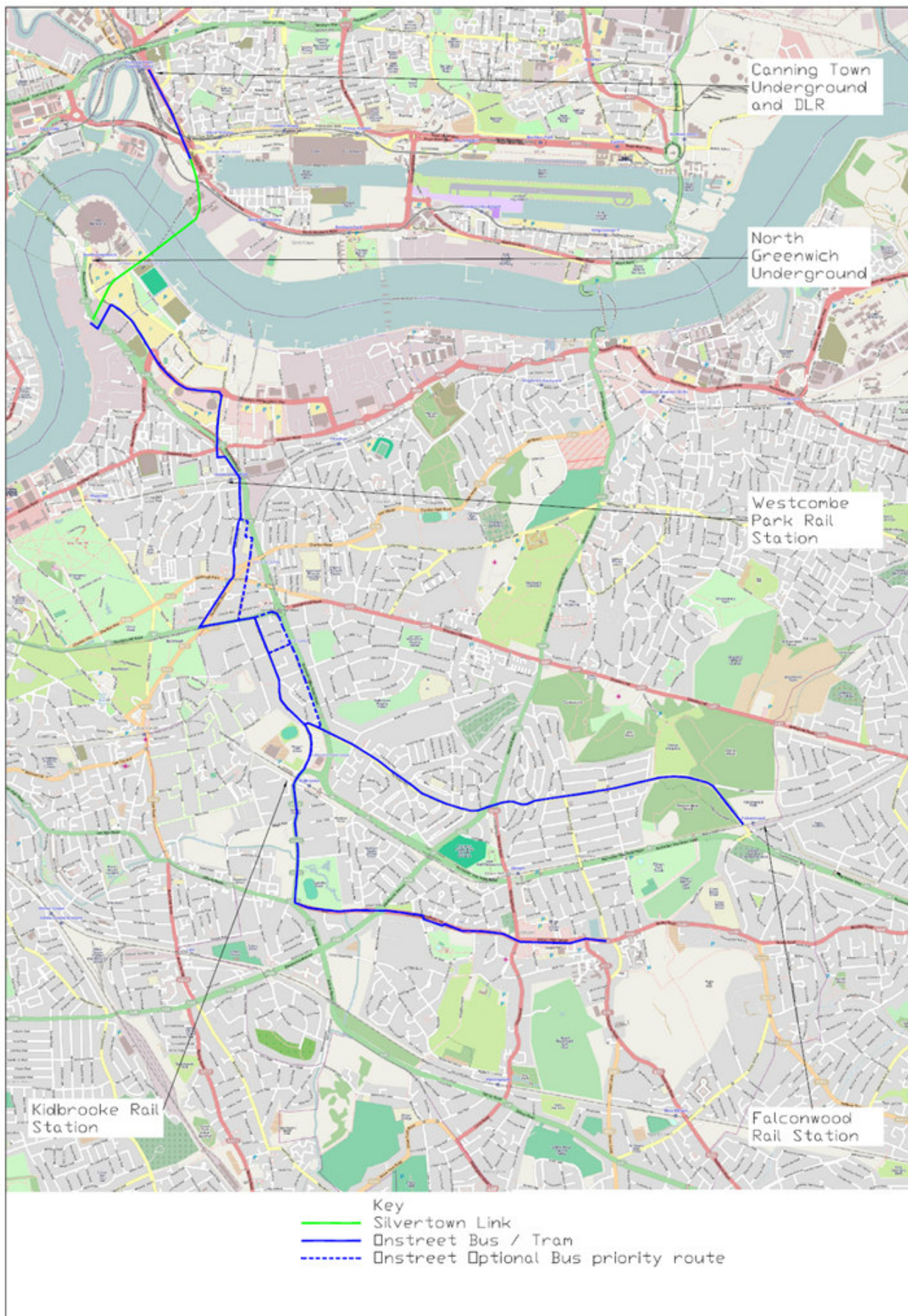


Figure 4.1: Illustrative Route for Options 1 and 2

4.3.4.4 Further consideration required:

- Identification of congestion hot spots and determination of bus priority
- New bus over rail route required at the north side of the Silvertown Tunnel
- Method to connect with the Silvertown Tunnel south side

Route length	11.125km
Run time	42 mins
Peak Vehicle Requirement	12 buses + 1 spare = 13 buses
Cost of new buses	13 x £150,000 = £1.95m
Other capital costs	£26m (ELT cost)
Additional O&M costs	£3.8/km x 686523kms/yr = £2.6m/yr

Table 4.1: Route Specification and cost - Option 1 HQB on street

4.4 Option 2: Tram System – On Street

4.4.1 Introduction

4.4.1.1 Modern tramways with street running capability and full alignment flexibility were established in London with the opening of Croydon Tramlink in May 2000. The latter demonstrates that street running and segregated alignments are entirely feasible and that trams and road traffic can be made to work reasonably well together.

4.4.1.2 In terms of quality, trams are likely to be perceived as a major improvement over bus services by users. Except where segregated, however, they remain vulnerable to traffic congestion and the consequent delays that can affect service schedules.

4.4.2 Description of service

4.4.2.1 This option considers the potential to run trams on street, along the route identified for High Quality Bus (Option 1) - see Figure 4.1. It is suggested that the Tramlink design standards supplied by TfL, which include a minimum horizontal curve radius of 25m and maximum gradient of 9%, would be appropriate, and achievable in the implementation of this route. The tram based solution could include the introduction of new tram bridges at appropriate locations rather than at grade priority measures when crossing local roads, such as Woolwich Road, to maximise public transport priority whilst minimising impact on the adjacent A102-A2 corridor.

4.4.2.2 This could offer significant journey time savings and journey time reliability benefits over the bus service. Trams are generally considered to be more attractive than buses and therefore have a wider catchment area. This point is reinforced by PTAL methodology which considers a tram service to be accessible to those located within 960m of the service as compared to buses which are only accessible at a maximum distance of 640m.

4.4.2.3 However, further detailed analysis would be required to establish the acceptability of the provision of on street trams on residential roads. It may also be challenging from a planning point of view to implement such infrastructure on residential roads.

- 4.4.2.4 Furthermore it is noted that if the tram was to utilise the proposed Silvertown Tunnel, additional width would need to be incorporated into the tunnel to accommodate the tracks.
- 4.4.2.5 The new Stadler trams being delivered to Tramlink in early 2012 could be employed on this route. These “Variobahn” cars are 32m long by 2.65m wide, five section articulated design with hub motors and low floors throughout. Originally constructed for Bergen, Norway, the six cars cost £16.3m (£2.7m each) and have a capacity of 72 seated plus 134 standing, a total of 206.
- 4.4.2.6 The cost of a street tramway was assessed using the average cost of construction of Croydon Tramlink which was £200m alignment cost for 28km of route, plus £25m for utilities diversions financed by TfL. At 2000 prices this is about £8m/route km. Updating this to 2012 prices assuming 3% inflation per year implies a multiplier of around 40% giving £8m x 1.4 = £11.2m/route km at 2012 prices. The original Tramlink cars cost about £1.4m each but the Variobahn cars cost £2.7m each.
- 4.4.2.7 The average speed of street trams with priority over other traffic, off vehicle ticketing, and boarding through several doors, is expected to be about 18kph. Tramlink achieves 26kph on the New Addington-Wimbledon line but mostly runs on reserved track.

4.4.3 Key features of the service

- 4.4.3.1 The tram service would offer similar advantages to the high quality bus service. It is suggested that the on street tram is likely to be more attractive than the bus service due to the greater reliability, comfort and speed which is likely to result in a higher uptake (PTAL 960m). This is likely to result in a greater easing of congestion on the existing road and public transport network.
- 4.4.3.2 With a wider catchment area, higher capacity and more attractive service, the tram is likely to improve access to jobs, shops and services for more people. It could also generate a greater modal shift towards more sustainable modes easing traffic and freight movement and generating less CO₂ per passenger mile. Furthermore the higher patronage of the service would allow it to provide greater support to regeneration.
- 4.4.3.3 The tram service would be able to offer similar benefits to walking and cycling as Option 1 by allowing these modes to make part of a multi-modal trip. However with a larger catchment area and with the ability to load folded cycles at all times, the tram would provide much more support for these modes. The provision of tram tracks on street would have to be carefully considered to minimise the impact on cycle movements.
- 4.4.3.4 It is noted that the priority measures to facilitate the tram service would not benefit the existing bus services and it is therefore unlikely to provide improvements to existing assets. In places it could even conflict with buses for road space.
- 4.4.3.5 The trams and platforms would be equipped with CCTV which would enhance the perception of security on street and on the service. The presence of regular trams would also activate the street scene making it safer. It would also offer additional accessibility benefits such as a smaller gap between platform and vehicle to assist boarding, electronic signs and audible announcements, and the fact that all tram stops are the same.
- 4.4.3.6 This appraisal is based on established urban tram technology. A tram system would be largely delivered within the public highway and is relatively simple to implement technically. However it is recognised that trams frequently are not welcomed by some residents immediately adjacent to the new service. Further detailed assessments and

extensive consultation with residents and other stakeholders would be required to deliver tramways on street.

4.4.4 Summary

4.4.4.1 This section provides a summary of the main advantages and disadvantages of the proposed Option 2: Tram System – On Street, when compared to the other options under consideration. It also provides a list of further considerations should this scheme be pursued further and an illustration of the costs relating to the scheme

4.4.4.2 Advantages:

- Reasonably low cost
- Accessible from 960m from the service (PTAL)
- Higher visibility
- Would provide a higher capacity and quality of service than the bus on street
- More attractive than bus service

4.4.4.3 Disadvantages:

- May not provide sufficient improvements over the existing PT network to meet the aims of the initiative
- Would interact with traffic impacting on journey times and reliability
- Planning process may be complex, seeking residents acceptance
- Silvertown Tunnel may need to be widened to accommodate the tram route

4.4.4.4 Further consideration required:

- Identification of congestion hotspots and determination of tram priority including bridges
- New tram over rail route required at the north side of the Silvertown Tunnel
- Method for incorporating the tram service into the Silvertown Tunnel
- Method to connect with the Silvertown Tunnel south side
- Extensive public consultation

Route length	11.125km
Run time	37mins
Peak Vehicle Requirement	11 cars +1 spare = 12 cars
Cost of new cars	£2.7m x 12cars = £32.4m
Other capital costs	£11.2m x 11.125 route kms = £124.6m
Additional O&M costs	£6.6/car km x 686523kms/yr =£4.53m/yr

Table 4.2: Route specification and cost - Option 2 Tram on street

4.5 Option 3: Bus Rapid Transit (BRT) & Guided Busway

4.5.1 Introduction

4.5.1.1 The next step up in quality considered is a Bus Rapid Transit (BRT) which can take the form of a conventional busway or a guided busway. This option would provide dedicated bus infrastructure on the core sections of the route.

4.5.1.2 The Runcorn busway, opened in 1971, was one of the UK's first busways. Since then a number of other schemes have been opened including; Fastrack in Kent Thameside Crawley Fastway, Edinburgh Fastline, Leeds Superbus, and the recently completed Cambridgeshire scheme linking Huntingdon/St Ives with Cambridge and Trumpington. Closer to this initiative, the West Parkside busway on the Greenwich peninsula provides segregated bus travel for most bus routes serving North Greenwich station. These Busways offer the benefit of segregating buses from general traffic thereby improving journey times and reliability.

4.5.1.3 There are currently no examples of whole bus routes in London which match the examples quoted above such as Fastrack and Fastway. The attempt to serve the Dome via the Millennium Transit busway did not live up to expectations and has caused road safety concerns in some locations. Everywhere else in London, bus reliability remains an issue. This is one reason why the image of buses remains poor. Greenwich Waterfront Transit was developed to achieve very high quality service but was dropped from the MTS. ELT is an attempt to achieve a step change but it faces several problems: it is very difficult to give a bus scheme the same "presence" as rail schemes. Buses are not seen as sufficiently permanent and reliable to give the confidence for residents and businesses to depend on them. To break this perception, bus schemes will need to provide:

- a fixed route not prone to diversion or alteration;
- very high reliability;
- higher than average journey speeds;
- better passenger information
- differential branding.

4.5.2 Description of service

4.5.2.1 As described in Option 1 the A102 / A2 corridor provides a direct north - south link which, due to the existing congestion and the need to retain traffic capacity, is unsuitable for conversion into a busway. The construction of a new busway over the critical section of this route between Woolwich Road and the Sun in the Sands would give a core segregated section for buses to operate on less congested roads linked to the existing Greenwich Peninsula bus way.

4.5.2.2 A partly elevated alignment, described in detail under the DLR option, could be used for the dedicated busway. The busway would commence via a ramp up at Pear Tree Way and run along the eastern side of the A102-A2 corridor as far as the Sun in the Sands. There would then be two main options to connect to Kidbrooke Station, the first would be to create a new flyover for buses to cross the A102 and ramp down on Rochester Way with two way bus operation on this road. However the delivery of this skew bridge over the A102 would be technically challenging and may require localised widening of the A102 at this location. The second option would be to continue the busway along the east side of the A102 and above the southbound approach ramp to Rochester Way and then cross the A102 to form a junction at the roundabout just north of Kidbrooke station.



Figure 4.2: Illustrative route for Option 3

- 4.5.2.3 This would be the preferred arrangement and would make the busway about 3km long - see Figure 4.3 Stops on street would have conventional infrastructure with step-free access and are likely to be designed to accommodate double bus length. Stops are envisaged at Dursley Road, Sun in the Sands, Charlton Road, Westcombe Park (rail interchange) Pear Tree Way, Bugsby's Way and then Silvertown Link approach and Canning Town. The main busway route would probably be lit but not signalled.
- 4.5.2.4 Assuming the bus services are similar to those specified for the HQB option, running times via a busway would be less than HQB on street. It was assumed that the Tramlink average speed of 26kph (scheduled on New Addington – Wimbledon) would be achievable over the busway section. Table 4.3 gives the key features of this option. Existing bus garages would be used and we assume that additional garage capacity is not required.
- 4.5.2.5 It is considered that the infrastructure described above could accommodate either a conventional busway or a guided busway. For future reference, the general arrangements and infrastructure requirements of each are described below.

4.5.3 Busways -v- Guided Busways

- 4.5.3.1 Busways are, in effect, conventional roads dedicated to buses. A typical 8.2 m cross section is shown in Figure 4.3. Guided busways are roads dedicated to buses which incorporate external means of steering the bus. Figure 4.5 below shows a typical section of an at-grade guided busway and Figure 4.4 shows a general arrangement of an elevated guided busway, which generally requires less space than a conventional busway.

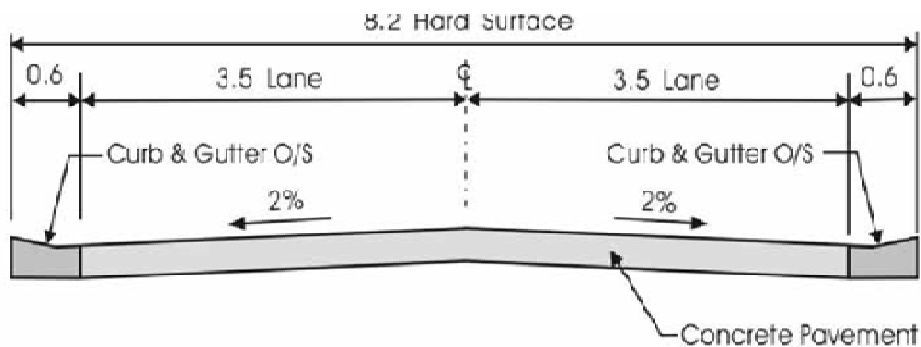


Figure 4.3 – Typical cross-section of a busway

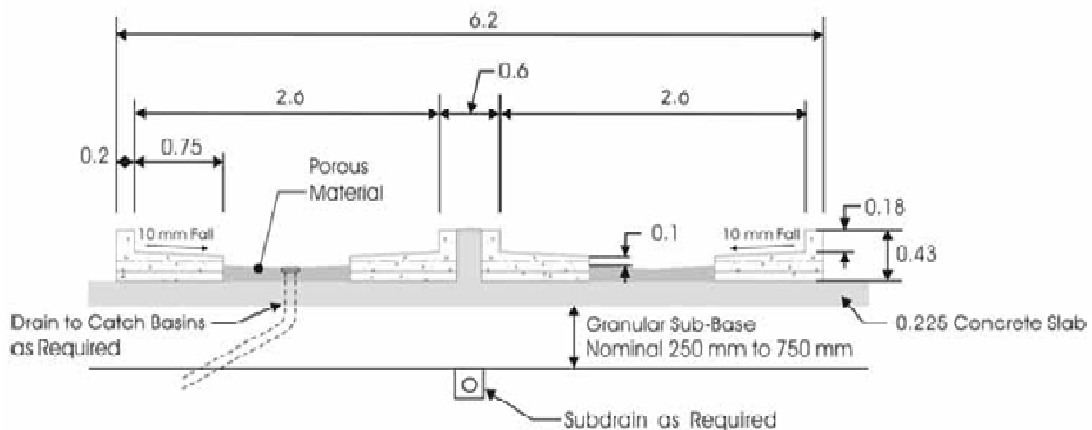


Figure 4.4 – Typical cross-section of an elevated guided busway

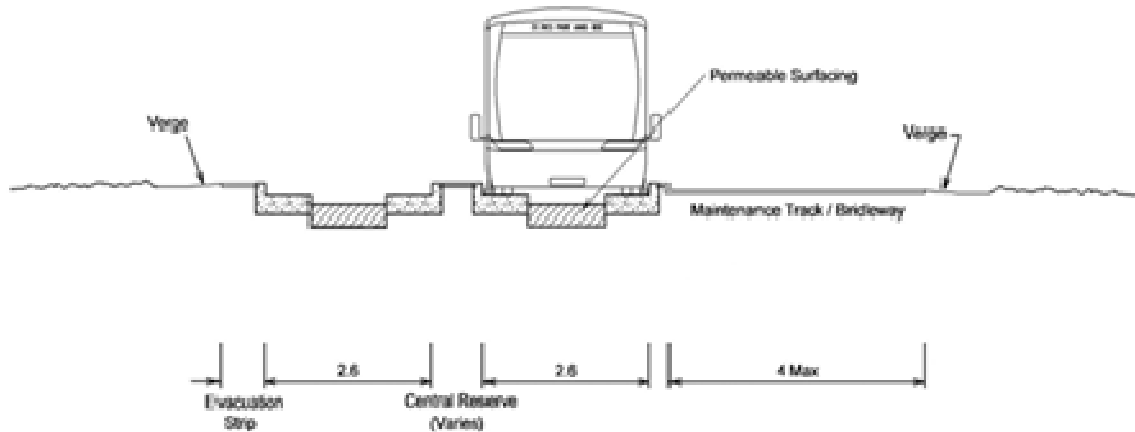


Figure 4.5 – Typical cross-section of an at-grade guided busway

- 4.5.3.2 The basic width of a double track kerb guided busway is 6.2m and on elevated sections it will probably be necessary to add emergency walkways, adding another 1m. The resulting width of 7.2m saves up to 1.4m compared with conventional busways. To operate on guided routes conventional buses need minor modification to add guide wheels linked to the steering. These bear on the kerbs and the bus wheels are steered automatically. Guideway design and operation is regulated by the Office of the Rail Regulator (ORR) which sets design and safety guidelines.
- 4.5.3.3 Use of a guided busway is recommended over a conventional busway as it would require less width minimising property impacts at pinch points such as; Woolwich Road junction, Westcombe Park railway bridge, Charlton Road, Old Dover Road and at the Sun in the Sands. It is anticipated that stops would have a similar arrangement to conventional busways.
- 4.5.3.4 It is assumed that the guided busway bus services would be the same as for the HQB option. It is assumed that additional bus garage capacity is not required for the guided bus routes.
- 4.5.3.5 A guided busway has many similar characteristics to conventional busway and is unlikely to involve significantly different costs in this corridor. There may be fewer impacts on property compared with conventional busway but this is a detailed matter that would require more detailed work. The Table 4.3 below therefore covers the general costs which would be incurred by either a conventional or guided busway.

4.5.4 Key features of the service

- 4.5.4.1 It is considered that a guided busway is likely to offer similar benefits to those generated by the on street tram. However considering it is not a tracked service its catchment area is likely to be limited to 640m based on PTAL assessment criteria ensuring a smaller patronage.
- 4.5.4.2 The guided bus way would not require significant bus priority on the general road network and it would remove some buses from the flow of general traffic as they would use the dedicated bus way. This should provide additional easing in congestion and improved network resilience. The guided bus way would significantly improve the reliability of bus journeys as buses would not be subject to impacts from congestion on the wider road network.

4.5.4.3 Although the bus way would provide more environmentally sustainable travel the environmental impact of its construction may not be offset by these improvements and further assessment would be required to establish the net environmental impact.

4.5.4.4 The guided bus way would involve established techniques but it would involve significant grade changes close to the strategic road network. The extents of the physical infrastructure changes are relatively complex. CPO may be required Residents adjacent to the route may object to construction impacts

4.5.5 Summary

4.5.5.1 This section provides a summary of the main advantages and disadvantages of the proposed Option 3: Bus Rapid Transit (BRT) – Guided Busway, when compared to the other options under consideration. It also provides a list of further considerations should this scheme be pursued further and an illustration of the costs relating to the scheme.

4.5.5.2 Advantages

- Improved bus journey times and reliability
- Higher profile service than conventional bus
- Lower impact on the flow of general traffic

4.5.5.3 Disadvantages

- High environmental impact relative to benefit
- Relatively complex planning process
- Limited catchment area (640m PTAL)
- May require CPO powers to deliver

4.5.5.4 Further consideration required:

- Preliminary design of busway
- Method to connect with the Silvertown Tunnel south side

Route length	10.62km (busway = 3km)
Run time	33mins
Peak Vehicle Requirement	10 + 2 spare = 12
Cost of new buses	£150,000 x 12 = £1.8m
Other capital costs	
Additional O&M costs	£3.8 x 655,360 kms/yr = £2.49m

Table 4.3: Route Specification and cost - Option 3 BRT Guided Busway

4.6 Option 4: Segregated Tram

4.6.1 Introduction

4.6.1 The next level of cost involves trams but with limited street running. The concept is to deliver high quality public transport largely insulated from road traffic. To do this, a tramway alignment could be defined along the line of the busway as identified for Option 3. The service would comprise a combination of segregated alignment alongside the A102, reserved track where possible elsewhere and some stretches of street running. The geometric requirements of each of these forms of provision are provided below.

4.6.2 Segregated Tracks

4.6.2.1 On fully segregated tracks, there must be safety clearances between passing trams and any trackside structures including traction poles. The minimum clearances are given by the Office of Rail Regulations (ORR) in its guidance on tramway construction and safety. Figure 4.6 is a copy of an illustration published by the ORR. It gives minimum clearances beside and between tram kinematic envelopes. These envelopes are to be determined for the scheme in question.

4.6.2.2 The width of trams varies across different networks; in London TfL have set the standard as 2.65m. With centre traction poles, a minimum gap of 200mm is needed between the Kinematic Envelope of the car and the pole (not shown). With a single side gantry, clearance of 500mm is needed. This applies to all structures beside the tramway. Also a minimum clearance of 600mm is required between the KEs of both tracks. This implies that the width of the tramway alignment is 6.9m plus the KE allowance, about 7.1m overall.

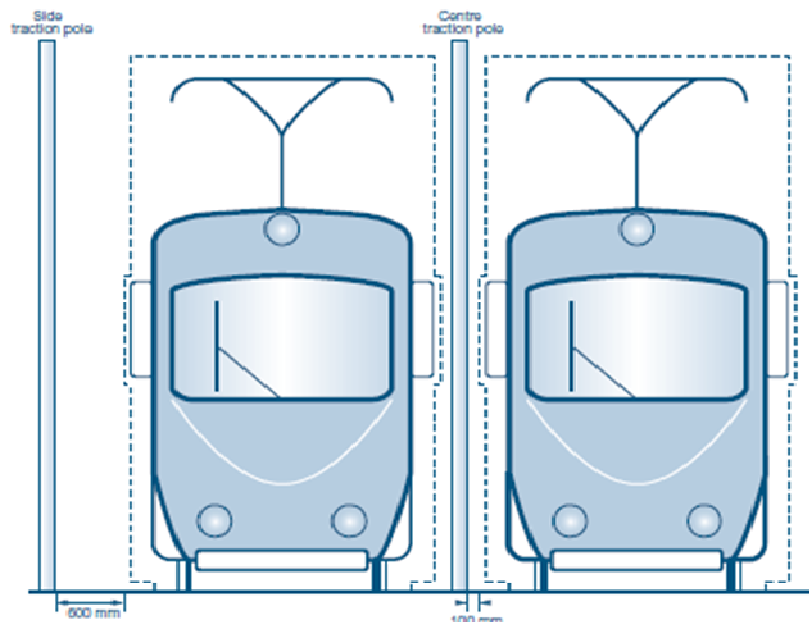
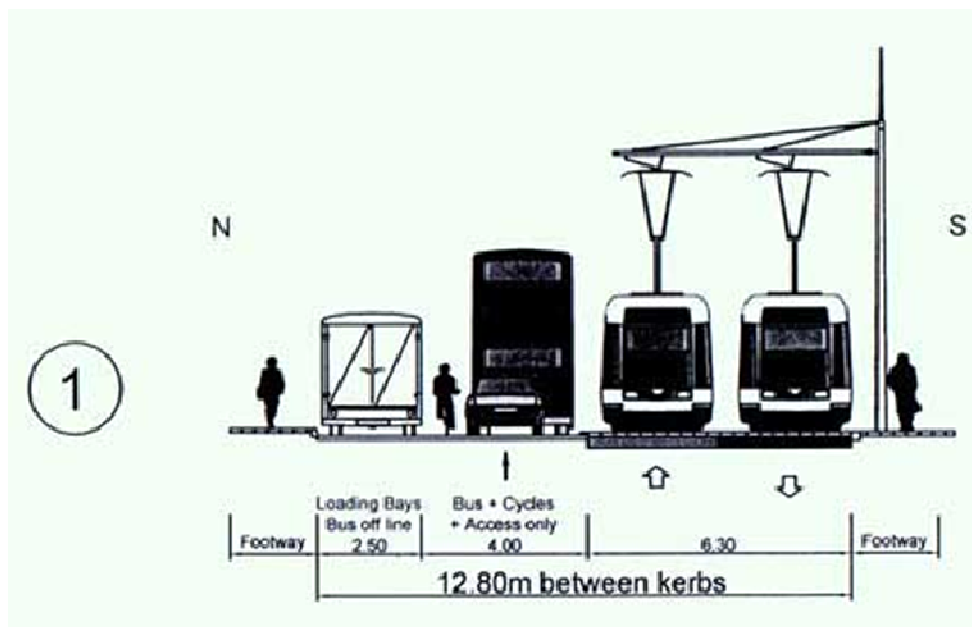


Figure 4.6 – Typical cross-section of segregated tram tracks. (Source: Guidance on Tramways, Railway Safety Publication No2, 2006, Office of Rail Regulation).

4.6.3 Reserved Tracks

- 4.6.3.1 Trams of 2.65m width used in London, can operate well on double track requiring a 6.3m wide reservation as long as there is a means of access in emergencies and locations for traction poles carrying the overhead line. See the cross section given in Figure 4.7. This arrangement is envisaged along Bugsby's Way and in the Kidbrooke area where space permits.



**Figure 4.7: Typical X-section of Reserved Track running
(Source: TfL West London Tram project)**

4.6.4 Street Running

- 4.6.4.1 It is suggested that the Tramlink design standards supplied by TfL, which include a minimum horizontal curve radius of 25m and maximum gradient of 9% would be appropriate for the street running sections of the Tramway

4.6.5 Route Description

- 4.6.5.1 The service would commence with a new interchange at Canning Town and then continue on through the new Silvertown Link Tunnel to north Greenwich; additional width would need to be incorporated into the tunnel to accommodate the tram route if a reserved track system is implemented in this location.
- 4.6.5.2 At this point the service would connect to Millennium Way to serve the business uses and public transport interchanges in this area. It is noted that the current proposals for connecting the A102 to the Silvertown Link in this location are complex in nature and so the addition of a further mode in this location would have to be carefully considered. The tram would then follow the route described for the busway in Option 3. It could use the reserved track arrangement until Pear Tree Way, at which point it would ramp up to a segregated arrangement. It could continue in this segregated arrangement until it reached Kidbrooke Station. At this point the service would ramp down and continue on to Eltham High Street via Kidbrooke Road and Eltham Road utilising either reserved track or on street running.

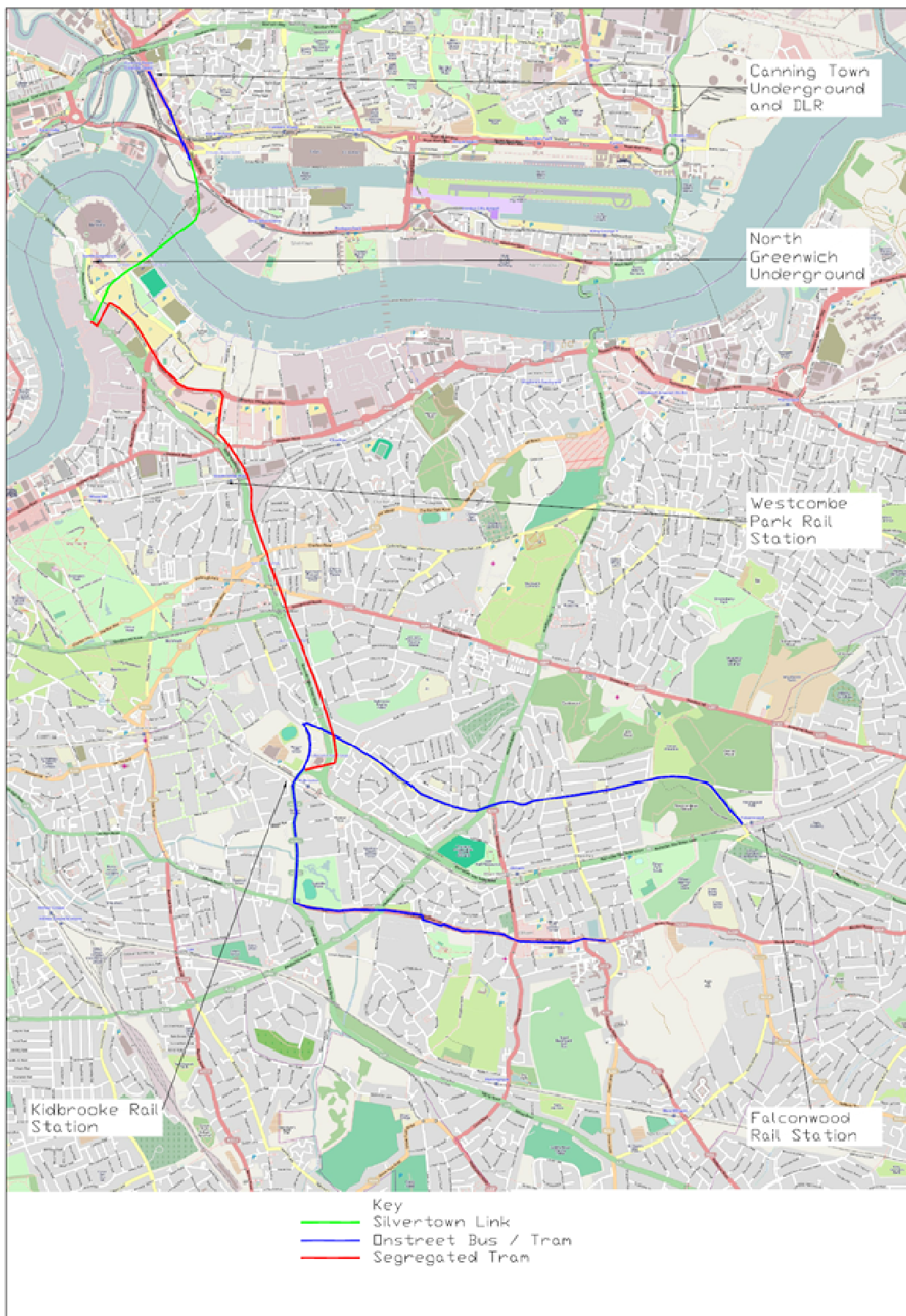


Figure 4.8: Illustrative route for Option 4

4.6.5.3 A segregated tramway with off-vehicle ticketing and boarding through several doors with Variobahn cars or similar is assumed to be capable of 30kph average speed on the section beside the A102, 26 kph through the Silvertown Link tunnel and 18 kph elsewhere.

4.6.6 Key features of the service

4.6.6.1 This option would provide a step change in the reliability and speed of the tram service over the on street arrangements providing; greater customer satisfaction, significant improvements in congestion, improving access to jobs for more residents, a higher level of relief to overcrowding to the Jubilee Line and rail service in RBG, and increasing the support for regeneration and integration.

4.6.6.2 The proposed tram route would have higher operating costs than the existing bus services but lower than the DLR service. However it is likely to be less attractive than the DLR service which would provide the highest level of service of the options considered.

4.6.6.3 The segregated tram would offer an additional tier of infrastructure adding to the resilience of the network. However the extents of the physical infrastructure changes are relatively complex and it is uncertain whether the sustainability benefits would outweigh the environmental impacts of construction. The delivery of the segregated route is likely to require CPO powers adding additional complexity to the delivery of this service.

4.6.7 Summary

4.6.7.1 This section provides a summary of the main advantages and disadvantages of the proposed Option 4: Segregated Tram, when compared to the other options under consideration. It also provides a list of further considerations should this scheme be pursued further and an illustration of the costs relating to the scheme.

4.6.7.2 Advantages

- Best journey time and reliability for bus and tram options
- Higher profile service other bus/tram options
- Would provide a higher capacity and quality of service than the bus options
- Larger catchment area (960m PTAL)

4.6.7.3 Disadvantages

- High environmental impact relative to benefits
- Relatively complex planning process
- Widening of Silvertown Link tunnel may be required if reserved track is used
- May require CPO powers to deliver

Further consideration required:

- Connection between Millennium Way and the south side of the Silvertown Link
- Impact on Silvertown Link
- Preliminary design of alignment
- Assessment of environmental impacts Vs benefit

Route length	10.62km
Run time	29 mins
Peak Vehicle Requirement	9 + 1 = 10
Cost of new cars	10 x £2.7 = £27m
Other capital costs	
Additional O&M costs	£6.6 x 655,360 kms/yr =£4.32m/yr

Table 4.4: Segregated Tramway Option: Eltham - Canning Town

4.7 Option 5: DLR Extension

4.7.1 Introduction

4.7.1.1 DLR currently serves the Royal Borough of Greenwich via the Lewisham line, and the Woolwich Arsenal extension. The Lewisham line connects Lewisham with Canary Wharf via Greenwich Town Centre, and the Woolwich Arsenal Extension connects Woolwich to Bank and Stratford international via Canning Town.

4.7.1.2 It is proposed that a new extension be provided to connect north and south Greenwich and link into the existing network south of Canning Town. The proposed River crossing and network connection options are discussed in Chapter 6. A fuller description of the possible alignment south of the River, and the infrastructure requirements as far as Falconwood, is provided in Chapter 7.

4.7.2 Route Description

4.7.2.2 It is proposed that the DLR extension would commence at the DLR Canning Town Station. From then it could continue on either via a new dedicated tunnel to the east of the proposed Silver Town Link tunnel, or via the Silvertown Tunnel which would require additional width to accommodate the DLR extension.

4.7.2.3 Upon exiting the River crossing tunnel the alignment would follow Millennium Way rising up on a viaduct to cross the roundabout at the junction with Blackwall Lane then dropping down to access the proposed Peninsula Park Station at grade. The alignment then crosses above Woolwich Road and follows the east side of the A102 generally at grade, passing beneath Shooters Hill Road, before rising on a viaduct to approach the existing rail station at Kidbrooke. It is feasible to fit the DLR tracks on the vacant land adjacent to the major road with minimal property impacts; however it is recognised there would be some. There would be a further three DLR stations provided on this section at Welcome Park, Charlton Road and the Sun in the Sands.

4.7.2.4 Close to Kidbrooke Station the DLR would cross the A102 via an 'S' shaped bridge, which can be achieved without reducing traffic capacity on the A2 as the structure would not encroach into the existing carriageway. Once across the A2 the alignment would drop down to access a station at Kidbrooke which would provide direct and convenient interchange with the rail services serving the existing Kidbrooke Rail Station.



Figure 4.9 – Illustrative route for Option 4

- 4.7.2.5 If considered necessary to go further, the alignment could continue east on railway land at grade with the existing tracks, which would require bridging several roads in a similar manner to the existing rail line. To access Eltham Rail station the DLR line would ramp up and cross the A2 via a new bridge. This section of the alignment is likely to be complex and costly requiring a high viaduct, while space at Eltham Station is very constrained.
- 4.7.2.6 From here the alignment would bridge back over the existing rail line, staying on railway land to a new DLR Station at Eltham Park. It could then continue on at grade through densely wooded side-long ground to Falconwood Rail Station, where it would terminate. Given that Falconwood and Eltham are already connected to Kidbrooke by a frequent rail service on the Bexleyheath line providing 10 trains per hour each way during peak periods, it is likely that a parallel DLR service between these stations could only be justified if this was essential to meet future passenger demands.

4.7.3 Key features of the service

- 4.7.3.1 The DLR is widely perceived as quick, clean, safe and reliable service. The proposed DLR extension would provide a new high quality and high capacity service which would significantly help to ease public transport capacity issues at North Greenwich Underground station by offering an alternative rail connection between Greenwich and London north of the Thames. A DLR extension would provide the highest capacity of all the options considered. It is also likely to attract the highest patronage being a well respected service with a reputation for reliable journey times and a higher satisfaction rating than other existing PT services on offer in Royal Greenwich.
- 4.7.3.2 The DLR has a greater potential than the other options to compete with car use on trip length and journey times. It would also provide a seamless interchange with other DLR and rail services. The service would significantly improve travel choices providing the highest level of support for regeneration and the greatest mode shift to more sustainable modes. As such it provides the greatest potential to significantly improve the movement of freight on the roads by relieving traffic from the local road network which in turn would improve the reliability of local bus services. By reducing congestion on the existing river crossing and avoiding early saturation of the proposed Silvertown Link road capacity, the proposal should improve customer satisfaction for road users.
- 4.7.3.3 The proposed DLR extension would have higher operating costs than the existing bus services, but this should be more than off-set by the value of the improved journey times for thousands of passengers daily and the local economic benefits afforded by access to new job opportunities that would otherwise be impractical.
- 4.7.3.4 It is noted that the some additional localised noise would be generated on elevated sections, but this should be partially off-set by reduced traffic noise and nuisance on other more sensitive parts of the local road network that should experience traffic relief as a result of general decongestion throughout the A2-A102 corridor.
- 4.7.3.5 The convenience of the DLR service is likely to attract significant patronage the majority of which will incorporate walking and cycling. Cycling would be further promoted by the provision of cycle parking at the new DLR stations and the fact that folded cycles are allowed on the DLR. The DLR is also fully accessible (DDA compliant) with lift or ramp access to platforms and small boarding gaps, etc.
- 4.7.3.6 The new DLR stations and trains would be equipped with CCTV, as are the existing, which are perceived as safer than buses and trams; while the new stations would help to activate the street scene. The fully automated, tracked and segregated nature of the DLR should make it the safest mode, avoiding all potential traffic conflicts. A significant number of passengers will mode shift from the car to the much safer DLR, so improving their safety and the safety of other road users such as pedestrians and cyclists.

- 4.7.3.7 The DLR extension can be implemented with little or no detrimental impact on the capacity and operation of the adjacent strategic road network and mainline rail services. It would provide a new and wholly separate tier of infrastructure which would not be affected by congestion on the road network. As well as improving road safety, this would greatly improve the resilience of the travel network without the need for measures that reduce traffic capacity, required by the other options. It can be built with full protection that would render it virtually invulnerable to damage/disruption from other transport modes.
- 4.7.3.8 The proposed DLR extension would be built on previous experience using tried-and-tested methods. The proposed A2-A102 alignment minimises the need to CPO land, which might otherwise add to its complexity.

4.7.4 Summary

4.7.4.1 This section provides a summary of the main advantages and disadvantages of the proposed Option 5: DLR Extension when compared to the other options under consideration. It also provides a list of further considerations should this scheme be pursued further and an illustration of the costs relating to the scheme.

4.7.4.2 Advantages

- Best and most reliable journey time of all the options considered
- Highest profile service likely to attract the largest patronage
- Highest capacity solution
- Safest solution – offering the most potential benefits in terms of reducing road traffic accidents and individuals' personal safety
- Larger catchment area (960m PTAL)
- Provides seamless interchange with several mainline rail services and the existing DLR network

4.7.4.3 Disadvantages

- Higher environmental impact than most of the other options
- Relatively complex planning process
- Widening of Silvertown Link tunnel or new tunnel required
- CPO required

4.7.4.4 Further consideration required:

- Use of Silvertown Link -v- new separate tunnel
- Extend DLR to Eltham / Falconwood or terminate at Kidbrooke

4.8 General consideration of the options

- 4.8.1 The on street bus and tram options offer the highest level of flexibility in terms of routeing, and if these systems shared existing road space the infrastructure costs could be reduced correspondingly. However, journey time benefits and modal transfer potential can be eroded significantly where buses/trams have to compete for space on an already congested local road network. This means fewer environmental benefits, compared with DLR and segregated bus and tram services, and higher CO2 emissions.
- 4.8.2 The segregated bus and tram options, following a similar segregated corridor as the proposed DLR extension, could possibly achieve comparable journey times but then the infrastructure costs would also be much the same; in which circumstances there is little to be gained from a bus/tram alternative but more to be lost. These alternatives could not link as seamlessly into the extensive DLR network north of the river to provide the highest possible quality connections to the wider Thames Gateway and Greater London. Also, unlike the totally segregated DLR, the segregated bus and tram options would have to cross existing roads in places with potential traffic interaction that carries associated collision risks (evidence the existing Greenwich Peninsula busway).
- 4.8.3 The proposed DLR Extension offers what potentially is the highest quality practicable public transport system for improving connections from the south of the Borough to Greenwich Peninsula and the Thames Gateway. It would also provide essential linkage to other important destinations north of the river. Southern parts of the Royal Borough where public transport accessibility is low at present but where substantial population growth is planned in the near future, such as Kidbrooke, have a particular need for a high quality transport facility of this nature. The DLR Extension, furthermore, would provide many more Royal Greenwich residents with quicker and easier access to new employment opportunities, and improved access to shopping centres, leisure facilities, healthcare and schools, etc.

4.9 SAF Conclusions

- 4.9.1 The high level illustration of the potential options to improve the north south connectivity within Greenwich and to London has been input into TfL's Strategic Assessment Framework, see Appendix 3. The illustrative nature of these options dictates that the data input for the SAF is limited in scope. However it is a useful framework to allow a comparison of the options. Figure 4.10 below shows how each of the options performs against the key transport challenges identified by the SAF.
- 4.9.1 It can be seen that the DLR extension provides a well rounded solution well outperforming the other options on all 16 transport challenges except in one instance - namely; supporting regeneration and tackling deprivation, which is only slightly bettered by the High Quality Bus Service. The next best performing option is the segregated Tram option. Although performing well, this option is not ahead of the other options in many of the challenges. The poorest performing options are the High Quality Bus route and the Busway options. From this assessment it is recommended that Option 5 the DLR Extension is taken forward for further detailed consideration and scheme development.
- 4.9.2 This analysis also clearly demonstrates that a DLR Extension would best fulfil the key objectives identified in 3.4.

Strategic fit - Challenges

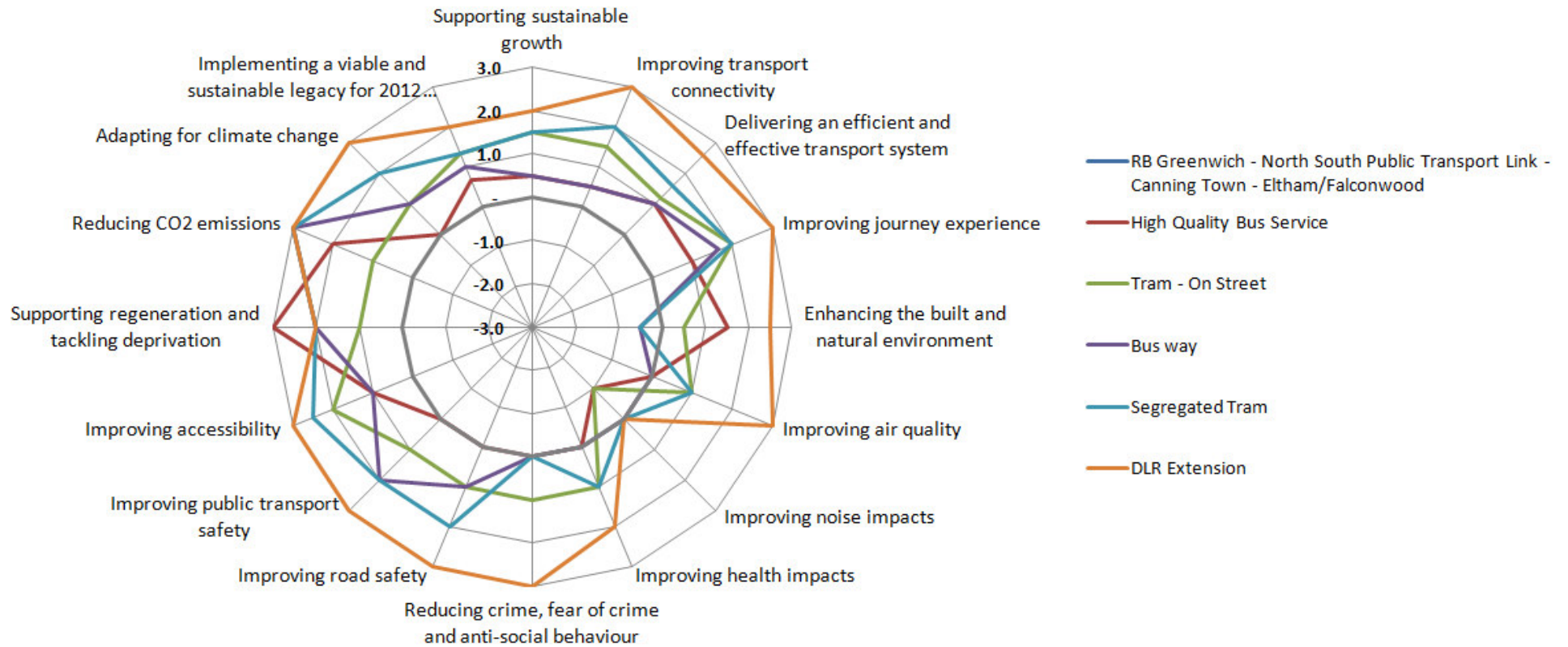


Figure 4.10: - Comparison of Options against SAF key transport challenges

5 THE EXISTING DLR NETWORK

5.1 The DLR Service Pattern

5.1.1 Hyder has engaged with TfL/DLR to gain a fuller understanding of the operational requirements and constraints of the DLR network, and its future development. The service pattern and level of service for the DLR network since the opening of Stratford International is summarised in Table 5.1. The DLR Network plan is reproduced overleaf for ease of reference.

a.m. Peak Service (06:30-10:00)	Frequency (trains/hour)	Train length (cars)
Bank – Lewisham	15	3
Bank – Woolwich Arsenal	7.5	3
Tower Gateway – Beckton	7.5	3
Lewisham – Stratford	5	3
Canary Wharf – Stratford	5	2
Stratford International – Beckton	Off peak only	3
Stratford International – Woolwich Arsenal	7.5	2

Table 5.1: DLR Services, March 2012

5.2 DLR Extensions

5.2.1 Several extensions are being considered including:

- a westward (tunnelled) extension from Bank via Fleet Street/City Thameslink towards Victoria or towards Euston and St Pancras (pre-feasibility complete);
- an extension south from Lewisham to Catford and to Bromley South or to Forest Hill (pre-feasibility work for Bromley South complete);
- Gallions Reach – Dagenham Dock (at TWA stage);
- Stratford International – Hackney Wick.

5.2.2 The Gallions Reach-Dagenham Dock extension has been planned in some detail but has been shelved. It was not a commitment in the TfL Business Plan 2009/10 announced by the Mayor in Nov 2009. Funding has not been allocated and it is not clear whether Barking Riverside housing, which the extension would serve, is a priority for government. Recent economic circumstances do not favour this new development at the present time.

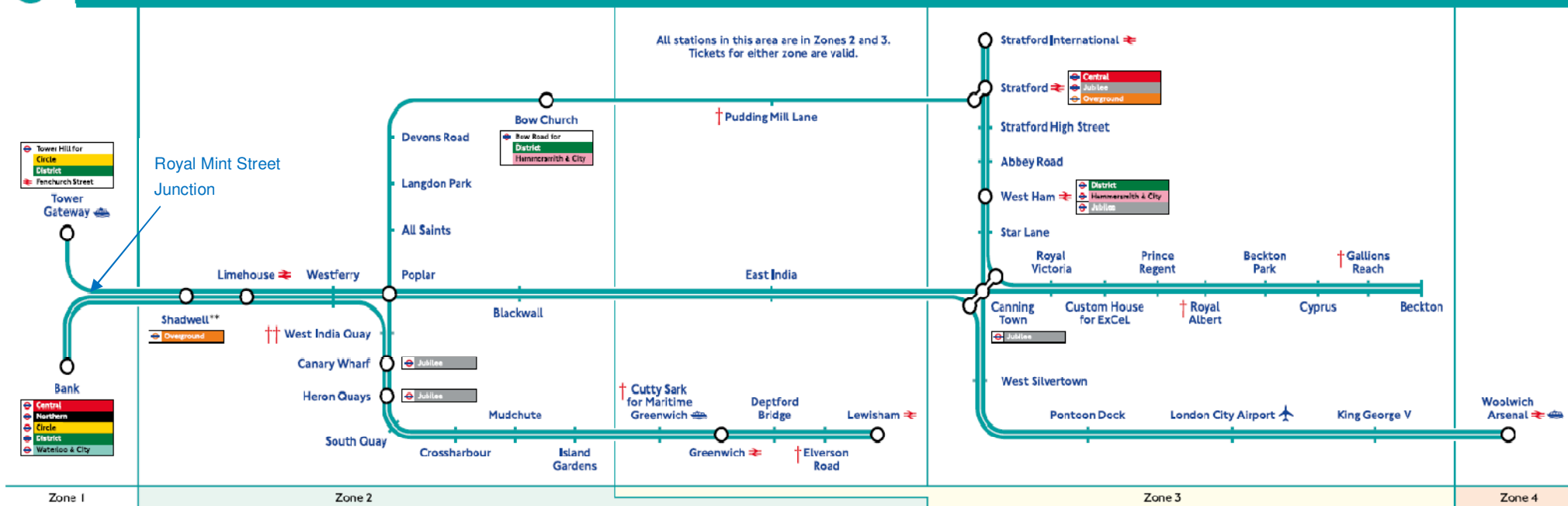
5.2.3 None of these proposals is likely to be funded in the near future. Therefore, the DLR network is likely to remain broadly unchanged for several years. There are lesser schemes for upgrading parts of the network and works triggered by other rail schemes particularly Crossrail. These include revision of the layout at Pudding Mill Lane.



For 24-hour travel information, telephone 084 3222 1234*. For DLR Customer Relations, telephone 020 7363 9700.



DLR stations have a lift or ramp access**



All stations in this area are in Zones 2 and 3. Tickets for either zone are valid.

- * You pay no more than 5p per minute if calling from a BT landline. There may be a connection charge. Charges from mobiles or other landline providers may vary.
- † The first two sets and last two sets of doors on a three-carriage train will not open at Cutty Sark for Maritime Greenwich, Pudding Mill Lane, Royal Albert, Gallions Reach or Elverson Road stations. Please use the centre of the train.
- †† At certain times trains from Bank towards Lewisham will not stop at West India Quay station.
- ** Lift access to/from DLR platforms at Shadwell station is unavailable until early 2012.

5.3 DLR Track Capacity

5.3.1 The SELTRAC ATO system permits 30 trains/hour (tph) or slightly more on double track lines. The main constraint is the usual one of the time taken to call at stations, which determines the absolute minimum headway (time between trains). The most heavily used section is Westferry - Royal Mint Street Junction which has three services comprising a total of 30 tph in the a.m. peak. The single track sections between Stratford and Bow Church limit the headway more severely on that line. Most services are now operated by three car trains. There are no plans to increase train length beyond three cars, which would prove extremely difficult.

Section	Peak TPH	Spare Capacity TPH
Westferry - Royal Mint Street Jcn	30	0
Poplar-Stratford	10	2
Canary Wharf - Lewisham	20	10
Westferry-Canning Town	15	15
Canning Town- Woolwich Arsenal	15	15
Stratford Int. – Canning Town	7.5	22.5
Canning Town- Beckton	7.5	22.5

Table 5.2: DLR Theoretical Spare Capacity (TPH)

5.3.2 Table 3.2 summarised DLR services on each main section of the network. This shows current peak trains per hour (tph) and the theoretical spare capacity assuming 30 tph is the practicable maximum level of service. This shows that there is spare capacity now on all sections except Westferry- Royal Mint Street Junction. There is very limited spare capacity on the Poplar-Stratford section because of long sections of single track.

5.4 Traffic Growth on DLR

5.4.1 The busiest sections of the DLR are the lines serving Canary Wharf, principally the Bank–Lewisham service. Trains are all three car and 30 trains per hour are operating at peak periods. There is no scope for additional trains or new services on the sections concerned. Traffic on the Beckton line is slowly building up but there is still plenty of spare capacity. Patronage on the City Airport/Woolwich Arsenal line continues to grow although there is scope for additional trains. The Stratford International line opened in 2011 and has plenty of spare capacity at present. However, development in the Star Lane area and elsewhere will require a strengthening of the level of service on this line. This could be largely provided by trains on the currently envisaged extension to south Greenwich

5.4.2 The Jubilee Line is crowded between Canada Water and North Greenwich with interchange movements at both stations feeding in to crowded trains. The TfL Rail Plan long run crowding plots forecast this as a critical link. TfL advise that new public transport schemes feeding this section of underground would not be welcome. One of the aims of the Lewisham–Forest Hill extension proposal is to relieve the Jubilee Line at Canada water by providing direct access to Canary Wharf from that part of the Overground Line.

6 THE RIVER CROSSING AND LINK TO EXISTING NETWORK

6.1 A Connection at Canning Town

- 6.1.1 **The Context:** To be a feasible proposition, the DLR Extension must cross the River Thames and effect connection to the existing tracks DLR in a manner that does not reduce the capacity of the network or limit the ability to serve growing markets. These issues, however, have to be considered in the context of TfL's current proposals for the Silvertown Link road tunnel which has now received mayoral endorsement and for which preliminary design work is underway (see 2.4.4).
- 6.1.2 **Sharing a Bored Tunnel:** TfL has expressed reservations about an integrated DLR and road tunnel. It is likely that the ground conditions would rule out the possibility of a bored tunnel large enough to accommodate both modes. The envelope of the road tunnel would be at least 9 m by 4.7 m for a two lane road, and the minimum envelope for a single track DLR in tunnel would be 3.4 m by 4 m (not including emergency access, walkways, fans or other services). Consequently if a bored tunnel under the River was the preferred option for the Silvertown Link, a separate tunnel would be needed for the DLR Extension.
- 6.1.3 **Safeguarded Land and Other Constraints:** The DLR Extension alignment north of the River is constrained by a number of factors. The straight track on the Woolwich Arsenal line just south of Lower Lea Crossing Bridge is the site of a possible station to serve the planned development of Thames Wharf. This and other planned infrastructure in the vicinity needs to be safeguarded, for which reason there could be no junction on this section of the tracks. Moreover the elevation of the DLR at this location, together with the alignment would make a junction difficult in this vicinity. The problems are compounded by the constraints of the Silvertown Link and the Emirates cable car, as well as the old lock basin.
- 6.1.4 **Connection Possibilities:** The possibilities for connecting the proposed DLR Extension to the existing network would necessitate either the new service routed north on to the Stratford International line or west towards Poplar. The feasibility of these two linking options and the alignment through Canning Town is constrained by existing DLR traffic on the Poplar line and the implications for the 'double junction' (at which the Woolwich Arsenal and Beckton lines interconnect) just south of Canning Town Station.
- 6.1.5 **Poplar Line Constraints:** At the present time there is no spare capacity through Westferry to accommodate a new service from Greenwich Peninsula. Projected traffic growth to the City Airport line via Poplar means that the existing peak levels of service will need strengthening in the foreseeable future, but any additional services on this line should be avoided. TfL/DLT also advises that the Canning Town double junction has little scope for modification and that any connection by the proposed Extension should avoid a flat crossing. Indeed any use of common track in this locality should be avoided as this would constrain track capacity more widely.
- 6.1.6 **Stratford Line:** By contrast the Stratford International line has a good deal of spare capacity at present, but planned development at Star Lane and elsewhere will require an upgraded service in the foreseeable future. This could partly be provided by Greenwich Peninsula trains. Moreover there would still be enough capacity for 10 trains per hour on a service from Stratford International on to the Greenwich Peninsula line

even if other development growth doubled demand for the existing services. This alignment, therefore, makes more sense than routing the proposed extension towards Poplar, also bearing in mind that access to Canary Wharf from Kidbrooke / Eltham / Falconwood is already possible via rail to Lewisham then DLR.

- 6.1.7 **Provisional Alignment:** The above considerations suggest that the DLR Extension should be routed on to the Stratford International line, so Hyder has prepared a provisional alignment for north of the River, which is shown on drawing number UA004230-0001 (Appendix 1). This routing assumes, for the present, that the Greenwich Peninsula line would join the Stratford Line on its east side immediately south of Canning Town Station, so avoiding a flat crossing of the double junction and the safeguarded Thames Wharf.
- 6.1.8 **Tunnel Approach:** To approach the proposed DLR tunnel north portal, our provisional alignment assumes a crossing of Lower Lea Crossing on a viaduct, before dropping down to pass beneath the City Airport DLR line between its existing piers. At this point it also crosses the Silvertown Link tunnel, narrowly avoiding the proposed ventilation/service building and an Emirates Airline tower, before entering the north portal.

6.2 Bored Tunnel or Immersed Tube?

- 6.2.1 **Bored Tunnel Depth:** If the DLR Extension was required to cross the river in a separate bored tunnel, the alignment would be constrained by the following considerations. We understand from TfL and information on hydrographical surveys from the Port of London Authority, that the river depth in the Bugsby's Reach area is about 10m under datum, and that the roof of the proposed Silvertown Link tunnel would be some 15-18m under the river bed to keep below the soft layers of mud and gravel. As the banks of the Thames are constructed to provide ground at about 6m above datum, a DLR ramp from ground level to pass under the Thames would need to drop about 38m.
- 6.2.2 **Gradients and Tunnel Length:** The DLR can accommodate gradients of 6%, which implies that the ramp from an elevated alignment, with track 6m above ground level, would need to be about 800m long (plus vertical curves) to pass under the Thames at 15m below datum. However, the Thames is about 350m wide and while some of the ramp could be under the Thames, the crossing would still require at least 1.6km of underground structure (tunnel or retained cutting) – a relatively expensive undertaking.
- 6.2.3 **Easing the Problems:** To access this tunnel the DLR would come into close proximity with other structures as described above, including the old lock entrance to the Royal docks. This is likely to cause additional difficulties with associated costs. This alignment is also problematic insofar as it impacts on the Waste Transfer Station, while the Thames Wharf access road and the Royal Victoria Dock main sewer would have to be realigned. These and other problems, however, could largely be avoided if TfL were to adopt an immersed tube solution for the Silvertown Link, rather than the proposed bored tunnel option, into which the DLR could also be routed. Figure 6.1 shows an example of such a structure.
- 6.2.4 **Immersed Tube Advantages:** Within the envelope of a submerged tube two segregated lines could be accommodated relatively economically. The advantages of this construction over a bored tunnel are broadly as follows:
- Unlike a bored tunnel the immersed tube does not become uneconomic when components are added laterally. The geometry of the Oresund Tunnel shown in Figure 6.1 illustrates the efficiency of an immersed tube compared to a bored tunnel.

The shape of the tube can be tailored to the minimum space requirements rather than be determined by the construction process. The DLR would require a smaller envelope to the Oresund Tunnel as both tracks could be placed inside a single cell.

- Being only 18 m to the crown and 24 m to the invert results in the approaches being significantly reduced in length which is of advantage in two respects. Firstly the links and alignments at both ends are eased and, secondly, the area sterilised for future development is reduced, more so by the crossings being combined.
- An immersed tube has other advantages in relation to current tunnel design and management legislation; it is relatively simple to provide a protected means of escape without any increase in the overall envelope. For bored tunnels it is necessary either to provide a dedicated escape tube within each bore or to provide cross passages between parallel tubes. In the case of an immersed tube the necessary provision is easily made by providing a single dedicated passageway between the two traffic tubes.
- The proximity of the Silvertown Link to the existing North Greenwich Station also results in the distance between the DLR and Jubilee Lines being significantly reduced for easier passenger interchange.

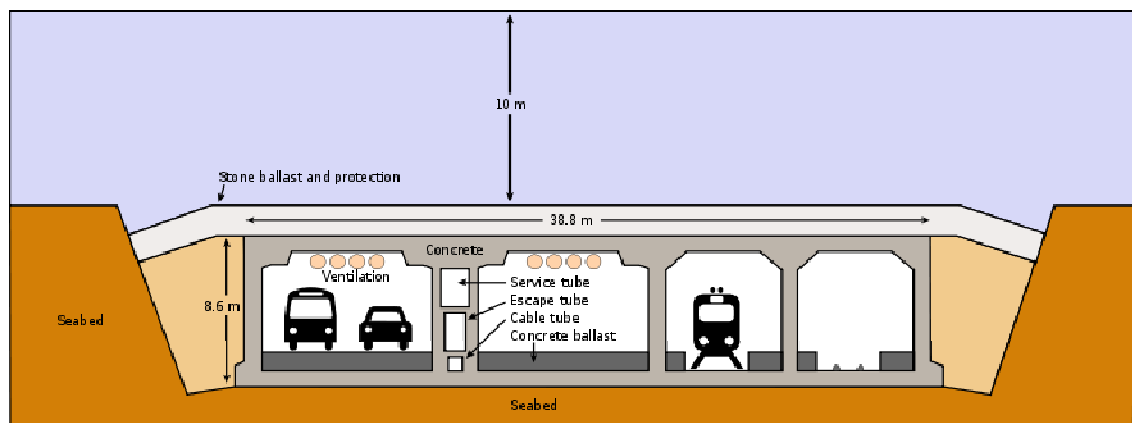


Figure 6.1: Oresund Immersed Tube Tunnel between Malmo and Copenhagen

6.2.5

Environmental Impact: TfL have suggested that an immersed tube would have more impact on the Thames environment than a bored tunnel, but this may not necessarily be true for the following reasons:

- TfL's principal concern would be the effects of dredging, but, as the Thames is very turbid, the impact should be small in terms of disturbing the silt.
- A greater concern could be the disturbance of the contaminated soils should the contamination beneath the old gasworks site have migrated down. If so, a much larger area of contamination would be disturbed by the bored tunnels with their long land based approaches through the area.
- Within the Thames the release of material during excavations for the tube would be reduced by the use of cutter suction dredgers. With a bore it would be necessary to handle the contaminants, including high levels of phenols, through the tunnel workings with all the attendant health and safety risks.

Therefore while the *initial* impact on the River Thames ecology is likely to be higher than a bored tunnel, a comprehensive EIA could demonstrate that an immersed tube is the right option for both modes, given that a combined structure would show significant savings over separate tunnel crossings in terms of cost and environmental impact. The river ecology would recover in a relatively short time following completion of the works.

- 6.2.6 **TfL Views:** The views of TfL on these matters are articulated in an email exchange between Tony Wilson (TfL) and Colin Ferguson (Hyder) included as Appendix 2 to this report. With regard to the synergies of a combined scheme, there would need to be a very strong case to deflect from delivering the existing Silvertown Link proposals (in a bored tunnel). It should be recognised, however, that an immersed tube proved to be an economic and efficient solution for the Medway Tunnel, which also lies within the Thames basin.
- 6.2.7 In response to Tony Wilson's remarks, this report attempts to articulate the specific problems (key issues and objectives) which we are seeking to address (Section 3.5), how the DLR Extension would address them and what other ways of addressing them have been considered (Chapter 4).
- 6.2.8 Further considerations of bored and immersed tube tunnels for crossing the River Thames are discussed in Section 7.12.2.

7 BUILDABILITY OF DLR EXTENSION

7.1 The Route in Principle

- 7.1.1 The Royal Borough of Greenwich is served by the DLR Lewisham line and the Woolwich Arsenal extension. The Lewisham line, opened in 1999, connects Lewisham with Canary Wharf via Greenwich Town Centre. In 2009 the DLR City Airport line, (which previously terminated at King George V), was extended under the River to a new terminus at Woolwich Arsenal. This provides valuable interchange with rail and buses services at Woolwich but makes only limited contribution to accommodating north-south travel needs in the Royal Borough.
- 7.1.2 Having explored a number of other options, R B Greenwich asked Hyder to focus on the opportunities for a DLR Extension via the Greenwich Peninsula and the A2-A102 (BTSA) corridor extending to Kidbrooke, Eltham Station or Falconwood. In principle the aim is to provide a high quality north-south public transport facility that, as far as possible, would avoid property impacts and be deliverable at a cost commensurate with other comparable sections of the DLR.
- 7.1.3 The proposed alignment, described below, follows an existing transport corridor occupied by a major arterial road (A2-A102) as far south as Kidbrooke, from where it is joined by a mainline railway (the Bexleyheath line). For most of the route as far south as Kidbrooke it is feasible to fit the DLR tracks on to vacant land adjacent to the major road with minimal property impacts, (although there would be some).
- 7.1.4 Southeast of Kidbrooke, however, the alignment logistics would become more complex as a consequence of construction on the railway embankment, with correspondingly higher costs. A high viaduct would be needed to access Eltham Station where space is very constrained, while the only possible surface alignment to Falconwood is on densely wooded side-long ground. This may be largely unstructured vegetation but is likely to be viewed as a 'natural extension' of Oxleas Wood and Eltham Park North by conservation / biodiversity interests.
- 7.1.5 Notwithstanding the above, our plans provisionally show a concept DLR alignment extending all the way to Falconwood, the further ramifications of which are discussed below. Our subsequent costings (Chapter 8) assess the Canning Town-Kidbrooke, Kidbrooke-Eltham and Eltham-Falconwood sections separately, so the various extension options can each be costed.

7.2 Connections to Existing Transport Services

- 7.2.1 The proposed DLR Extension would provide essential north-south access across Royal Greenwich, linking the residential south of the borough with new jobs and services on the Peninsula. It would also provide valuable connections with other existing public transport services in several locations, affording vastly improved connectivity from most parts of Royal Greenwich to much of Greater London and beyond.
- 7.2.2. Possibly the most valuable benefits would be derived from the direct connections with the existing DLR network north of the River, which would afford faster access to a large part of the Thames Gateway, Canary Wharf, and Stratford etc. Given that several DLR stations also interface almost seamlessly with London Underground services (e.g. Canning Town, West Ham, Stratford), Royal Greenwich would also enjoy much better connectivity to the City of London and the West End, etc.
- 7.2.3 Whichever option was adopted, the DLR Extension, moreover, would interface with existing mainline rail services at Kidbrooke and Westcombe Park, affording increased connectivity for existing rail users to reach all parts of Northeast London served by the

DLR. This would provide additional travel opportunities from origins deep into Kent and Southeast London, and contribute to the transport infrastructure required to facilitate regeneration throughout the Thames Gateway and beyond.

- 7.2.4 Further to the above dialogue relating to the Canning Town connection and River Crossing options (Chapter 4), the following paragraphs discuss the constraints and other considerations that have shaped the recommended alignment of a possible DLR Extension through the Royal Borough. These describe the proposals with reference to drawings UA004230-0001 to 0005, included at a 1:5000 scale (at A3) in Appendix 1 of this report.

7.3 Routeing on Greenwich Peninsula

- 7.3.1 If constructed in a bored tunnel to the alignment shown on drawing number UA004230-0001, the tracks would emerge from the south portal immediately south of West Parkside. From this location the “North Greenwich” DLR station does not easily interface with the Jubilee Line. A pedestrian link would be needed, which could possibly take the form of an airport-style conveyor for easier and quicker interchange. The DLR, however should not conflict with the Emirates Airline that would terminate some distance to the north of the south portal of the River Crossing.
- 7.3.2 If constructed in an immersed tube with the Silvertown Link, the North Greenwich DLR Station would likely be situated (underground) on the north side of Edmund Haley Way directly opposite the Emirates Air Line South Station. This would be closer to the Jubilee Line making for easier connections. These favourable interchange considerations together with others outlined in 6.2 above make a compelling case in favour of a combined road/DLR immersed tube river crossing.
- 7.3.3 In line with the Greenwich Peninsula Masterplan, this area has been extensively redeveloped over the last decade with the Jubilee Line extension and the construction of the O₂ centre. Much of the eastern side of the Peninsula was brown field land which has now been reclaimed, and major residential and retail development has been undertaken. There are several vacant sites where much further development is proposed.
- 7.3.4 As far as possible, therefore, the DLR Extension will need to avoid safeguarded development land when crossing the Peninsula. We propose an alignment along the west side of Millennium Way, rising on a viaduct to cross the Pear Tree Way roundabout and access a “Peninsula Park” DLR Station just south of Blackwall Lane. The tracks would drop to run parallel to A102 viaduct, before rising again to cross the Sainsbury’s Car park and filling station on a separate viaduct. This alignment would improve access to this commercial area with minimal property impact and little required alteration to existing road layouts, etc. (see drawing number UA004230 0001).
- 7.3.6 The construction would need to take account of the poor ground conditions on the Peninsula that comprise deep deposits of alluvium and peat to depths of up to 20 m. Such weak soils can only be crossed by piling and the construction of ground slabs. While these ground conditions are not untypical of other parts of the Thames basin where the existing DLR is constructed, the Peninsula in the past has been subjected to abnormal levels of industrial contamination including phenols and other products from coal distillation.
- 7.3.7 Blackwall Point, for example, was home to one of the largest gasworks in Europe, which generated contamination to a depth of up to 30 m. Other industries in this area included the undersea cable manufacture, Delta Metals, amongst other polluting works. Whilst a great deal of remediation has already been done, the DLR Extension could

necessitate some further decontamination measures where it intrudes into the underlying ground, particularly around the proposed station box at North Greenwich.

- 7.3.8 In recognition of these issues it is envisaged that the DLR across the Peninsula would be constructed on piled structures throughout, isolated from the surrounding ground. At ground level, this might take the form of a continuous piled raft track bed with piled crossheads at 15-20m supporting precast pre-stressed concrete beams carrying the rail bed. (Note: much of the A102 Blackwall Tunnel Southern Approach (BTSA) is on a piled raft constructed in the late 1960's.)
- 7.3.9 Tunnelling in this zone is not a practical or economic proposition until some depth is reached. Hence, North Greenwich Station on the Jubilee Line is constructed in a box which acts to isolate the station both from the weak ground and the contamination. It follows that the new DLR stations would require the application of similar principles, while the tunnel approach would need to be constructed using cut-and-cover techniques for some depth, until relatively sound ground was reached, at which boring could commence (assuming a bored tunnel was the required River crossing solution).
- 7.3.10 The approaches to the station would be cut-and-cover for the same reason, formed between secant piled walls, following well established principles and procedures for the construction of the DLR, Crossrail and other infrastructure along the Thames basin. Historically the shallow sections of the Old Blackwall Tunnel were also formed in cut and cover, again for the same reason.

7.4 Woolwich Road Crossing

- 7.4.1 Crossing Woolwich Road will have some impact on a number of private dwellings. The alignment illustrated – a viaduct immediately to the east of the A102 BTSA viaduct – could be constructed to fly directly over several houses, whence a number of others in the Fearon Street / Farmdale Road area would fall within its shadow. Depending on the placement of the abutments, it may not be necessary to demolish any of these properties, but compensation would be payable to those householders whose amenities are significantly impacted by the new structure and its construction requirements. In the final analysis it may be preferable to acquire all the properties within the area bounded by Fearon Street Aldeburgh Street, Farmdale Road and the DLR to effect a comprehensive redevelopment of these sites, whence the DLR may not need to be constructed quite so high.
- 7.4.2 An earlier concept – to cross Woolwich Road by constructing the DLR along the centre line of the A102 BTSA (to avoid the above property impacts) has been reviewed. The implications for traffic flow on the A102, combined with the required reconstruction of the existing structure, would make this option prohibitively expensive and generally not feasible. Because of weak and complex ground conditions, tunnelling is also not possible, so taking the Woolwich Road crossing underground would require cut-and-cover techniques, which could have more extensive property impacts than the proposed viaduct.

7.5 Woolwich Road – Shooters Hill Road (Sun-in-the-Sands)

- 7.5.1 Having crossed Woolwich Road, the DLR would stay on viaduct to access a new “Westcombe Park” DLR station, which would interface with the existing mainline rail station via the existing footbridge over the A102 BTSA. From here it would drop down to pass beneath the North Kent line then snake around a recently constructed industrial building north of Bramshot Avenue. From here the DLR would run along what is

currently a section of Bramshot Avenue that serves as an access to the adjacent industrial site. Ancillary works would be needed to reconfigure the access to this site, but it should be possible to avoid any demolition/reconstruction of the existing buildings.

- 7.5.2 The alignment would follow the vertical alignment of the A102 to access a new “Charlton Road” DLR station on the A102 BTSA embankment to the rear of properties fronting Eastcombe Avenue. It would then stay in cutting to pass under Charlton Road and Old Dover approximately at grade with the A102 BTSA. This section will require a 4-6m high retaining wall adjacent to Banchory Road. South of Charlton Road the DLR would enter a shallow ‘cut-and-cover’ tunnel to pass under the Shooters Hill Road roundabout, emerging south of Hervey Road to access a new “Sun in the Sands” DLR station in cutting. These arrangements would require a new footbridge at the site of the existing roundabout owing to the loss of the two existing subways and the pedestrian approaches to the Sun in the Sands station.
- 7.5.3 The ground conditions from Woolwich Road to Shooters Hill Road are dominated by the “Harwich Series” beds, which are a mixed group of soils varying from silty sands to laminated clays. These soils are highly variable and can cause significant engineering problems, but working in them has become common practice in the Thames Basin. Subject to adequate geotechnical investigations, established and proven construction techniques are available for the building of foundations and retaining walls in these soils. The Harwich beds continue to Kidbrooke where the earthworks for the A102 have historically cut through them. Thus with the hindsight provided by the building of the A102 most of the construction issues arising can be readily addressed.
- 7.5.4 Crossing Shooters Hill Road with a cut-and-cover tunnel would require the construction of temporary bridges to maintain traffic flow. It is anticipated that the roundabout would remain in service throughout the construction period with the aid of other temporary works, but some traffic disruption is inevitable. The bridge works needed for the Charlton Road and Old Dover Road crossings should be possible without traffic significant disruption, as should the A102/A2 embankment excavation and retaining wall works. None of the works on this section would require the demolition of adjacent property, although some residents and businesses living at close quarters would be disturbed during construction.

7.6 Shooters Hill Road – Kidbrooke

- 7.6.1 South of Shooters Hill Road, the alignment illustrated on UA004230-0003 runs along the A2 embankment (on side-long ground) to the rear of properties fronting Woolacombe Road, before rising on a viaduct. We envisage that the viaduct would become a steel curved box girder as it crosses over the A2 and A2213. To minimise the time that the A2 is disrupted, this could be fabricated at the side of the road and moved into position across the A2 on a wheeled heavy load transporter overnight. If TfL/DLR preferred to construct this using their familiar R-C box section construction, an intermediate pier would likely be required in the A2 central reserve. This would necessitate some localised carriageway realignment and more traffic disruption.
- 7.6.2 The illustrated alignment on this section has property impacts for the nearest houses adjacent to the A2. Compensation may be payable to several householders on Rochester Way and possibly to some in Woolacombe Road whose rear gardens would also be overlooked. But as a high retaining structure already separates the A2 from the DLR affected land, it should be possible to construct this section of the route without significant disruption to traffic, apart from the aforementioned A2 crossing.
- 7.6.3 The compensation issues could possibly be avoided by tunnelling under Rochester Way, but then the tunnel would have to extend under Dursley Road and the A2, as

there is insufficient space between the crossings to rise and fall with acceptable track gradients. Even assuming it was geotechnically feasible, it seems unlikely that the tunnelling option would be cheaper than the viaduct plus compensation payments. (A cut-and-cover technique would require extended temporary closure of the A2 which would not be acceptable).

7.7 Kidbrooke - Eltham

- 7.7.1 From Kidbrook Station, the DLR could continue southeast along the Bexleyheath line embankment between the railway and the A2. A rail bed structure would be needed for the DLR to be constructed at grade with the railway, possibly piled depending on the condition and strength of the existing embankment. New bridges for the DLR would be needed alongside the existing rail bridges to cross Eltham Green Road, Shawbrook Road, Westhorne Avenue and Foxhole Road.
- 7.7.2 From Foxhole Road the alignment illustrated on drawing number UA004230-0004 shows the DLR rising on a high viaduct to cross the railway before crossing the A2 and Wellhall Road to access Eltham Station. The DLR would be grade separated from the mainline station and sit directly over the bus station which would have to be extensively redeveloped to accommodate it. We envisage a viaduct comprising a simple plate girder construction as it rises, before becoming a box girder to cross the railway, the A2 and Well Hall Road. A combination of techniques would be needed, including skidding and cantilever construction, to minimise disruption to the road beneath.
- 7.7.3 The high level railway/A2 crossings and the Eltham Station arrangements would be technically challenging and correspondingly expensive to implement. They would have property impacts for a number of householders in Pullman Place overshadowed by the viaduct. These works would also necessitate extensive clearance of dense vegetation on the railway embankment that provides some screen planting in places, the loss of which may raise some conservation / biodiversity issues.
- 7.7.4 This alignment should not require any structural changes to the existing Eltham Tunnel, but the works associated with this section of the route would necessitate working on railway land with additional costs associated with imposed speed restrictions and extra constraints on the work environment. An alternative to this elevated alignment would be to drop down into a tunnel east of Foxhole Road to enter Eltham Station below the level of the existing railway. Assuming a bored tunnel under Eltham Station was geotechnically feasible the costs would still be appreciable.

7.8 Eltham – Falconwood

- 7.8.1 Continuing with the elevated alignment as illustrated on drawings UA004230-0004 and 0005, the DLR crosses back to the north side of the Bexleyheath line before dropping down to rail level with a retaining wall to the north side. It crosses under Westmount Road to access a new “Eltham Park” DLR station. The retained cutting then continues eastwards under Glenesk Road and Rochester Way to access Falconwood Station where the DLR would terminate.
- 7.8.2 The alignment on this section of the route should not have appreciable impact on the adjacent properties that front Dunvegan Road or Eltham Park Gardens. It would, however, necessitate extensive clearance of the dense vegetation along the railway embankment that has grown up since changes in rail management policy led to reductions in rail-side land maintenance. However the loss of this vegetation adjacent to Oxleas Wood, including many mature trees, may now raise some conservation / biodiversity issues.

7.8.3 The works associated with this section of the route would necessitate working on railway land with additional costs associated with imposed speed restrictions and extra constraints on the work environment. A possible alternative to the illustrated alignment may be to tunnel the entire section from Eltham to Falconwood, but this would likely cost appreciably more assuming it was geotechnically feasible.

7.9 Eltham High Street Option

7.9.1 If tunnelling to Falconwood was felt to be a desirable course of action, consideration should also be given to tunnelling from Eltham Station to Eltham High Street. Arguably the benefits associated with this routing are appreciably more than those of the Falconwood option.

7.9.2 Running the DLR to Eltham High Street would bring many more homes into direct contact with fixed rail transport services (given that Falconwood is already served by the Bexleyheath line), and would assist the regeneration of Eltham Town Centre.

7.10 Construction on Side-long Ground

7.10.1 In several locations, the alignment as illustrated would require the construction of track on side-long (sloping) embankments. The DLR would then require a secant wall retaining structure in front of which the embankment would be excavated to construct the track bed at grade. Depending on ground conditions, piling may be required but in most places, this may only be needed at intervals along the length. The structure would then comprise a crosshead (pile cap) with beams, so would be quite compact.

7.10.2 Figure 7.1 (piled foundations) and Figure 7.2 (R-C raft) show typical cross-sections that could be used depending on the sub-soil bearing capacity.

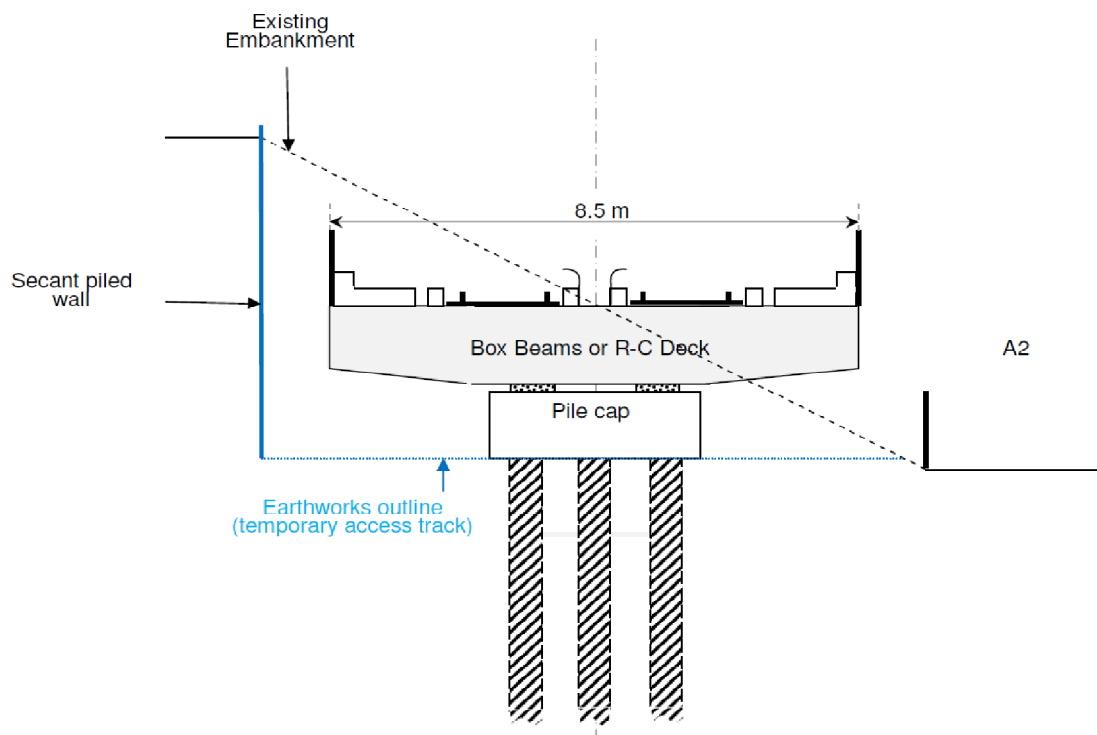


Figure 7.1: Piled foundations – “Ground level viaduct”

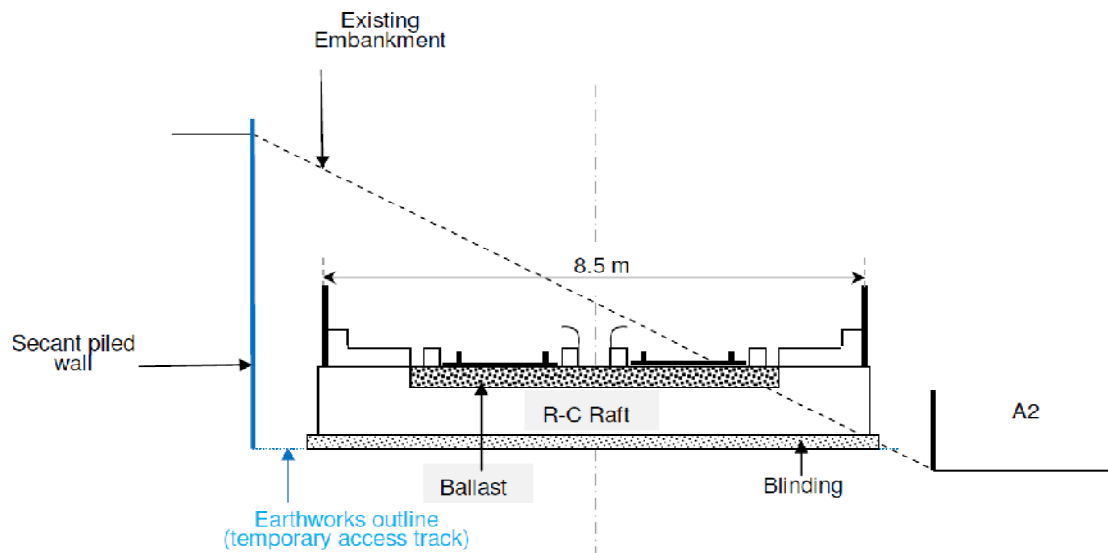


Figure 7.2: R-C Raft Construction

7.11 Stations

7.11.1 DLR stations with side platforms have an overall width of about 16 metres (assuming the platforms are not staggered). An alternative design would be to use an island platform to reduce the overall footprint. The overall width of the station with a single, island platform would be about 13 metres. For elevated stations, this would permit a single stairway/escalator tower and a single lift tower. To conclude this buildability chapter, Table 7.1 is a summary of the stations on the illustrated DLR Extension with brief details of their construction and accessibility. For illustrative purposes, Figure 7.3 shows a typical example of an elevated DLR station.



Figure 7.3: West Silvertown Elevated DLR Station

- 7.11.2 TfL/DLR current forecasts of DLR patronage on the current network by 2017 is for some 118 million passengers per year (ppy). This will drop slightly for several years following the opening of Crosrail, but will quickly recover to approach 120 million by the middle of the century. (Source: DLR website – “*DLR Current & forecast Patronage*”).
- 7.11.3 Using a pro-rata assessment based on the number of DLR stations, the envisaged extension to Falconwood could be expected to generate an estimated (118million / 45 x 8) = 21.0 million additional passengers to the network, Based on a preliminary assessment of the local urban environment and land uses, it is estimated that these might distribute between the envisaged stations as shown in Table 7.1.
- 7.11.4 Naturally these provisional figures would be reviewed in the light of more robust passenger modelling needed to validate the full business case. Thereafter they would form the basis of pedestrian modelling for detailed station design. A further provisional assessment of network passenger potential is offered in Section 8.6.

Station Name	Construction	Accessibility	Estimated passengers/year
North Greenwich	Shallow box 6-7 m deep Side platforms	Pedestrian links to Jubilee Line, Emirates Airline and Millennium Way	6.0 million
Peninsula Park	Elevated - See Figure 7.3 Side platforms	Pedestrian links to Blackwall Lane and commercial area	4.0 million
Westcombe Park	Elevated Side platforms	Pedestrian links to Farmdale Road and footbridge to mainline rail	2.5 million
Charlton Road	Ground level Island platform	Pedestrian link to Charlton Road	1.0 million
Sun in the Sands (or Shooters Hill Road)	In cutting Island platform	Pedestrian underground links to Hervey Road, New footbridge over Shooters Hill Road	1.0 million
Kidbrooke	Ground level Side platforms	Pedestrian links to mainline rail, Station Approach and Tudway Road	2.5 million
Eltham	Elevated Side platforms	Pedestrian links to bus station, mainline rail and Well Hall Road	2.0 million
Eltham Park	In cutting Island platform	Pedestrian links to Westmount Road	1.0 million
Falconwood	Ground level Side platforms	Pedestrian links to mainline rail and Rochester Way	1.0 million

Table 7.1: Summary of Stations

7.12 Bridges and Other Structures

7.12.1 Structures Inventory

7.12.1.1 Along the length of the proposed line of the extension there are a significant number of bridges and structures. These comprise structures of several forms as follows:

1. Thames crossing in either bored tunnel or immersed tube;
2. Elevated sections of the DLR on viaducts;
3. Under bridges carrying the DLR over discrete obstacles;
4. Over bridges carrying the obstacles over the DLR;
5. Footbridges;
6. Cut and cover tunnel carrying the DLR beneath more extensive obstacles;
7. Piled rafts carrying the DLR over poor, weak and sensitive ground;
8. Retaining walls supporting properties and roads adjacent to the DLR.

7.12.1.2 The proposed locations of most of these structures are shown on the alignment plans in Appendix 1 of this report. The viaducts raise the DLR above the surrounding ground and form the approaches to under bridges commencing from Canning Town and running south the viaducts are as follows:

1. Canning Town to Dock Road crossing the Beckton branch of the DLR, the Lower Lea Crossing and a local road to Thames Wharf, including the DLR, Lower Lea Crossing and Thames Wharf under bridges;
2. Millennium Way to Peninsular Park, including the Millennium Way and Bugsby's Way Roundabout under bridge;
3. Horn Lane to Westcombe Park, including Pear Tree Way and Woolwich Road Underbridges;
4. Dursley Road to Kidbrooke Station, including A2 and A2213 under bridges;
5. Foxhole Road to Eltham Station, including Network rail, A2 and Well Hall Road under bridges;
6. Eltham Station to Westmount Road, including Network Rail under bridge.

7.12.1.3 In addition to the under bridges included above, there are five under bridges as follows:

1. Network Rail loop line;
2. Eltham Green Road;
3. Shawbrooke Road;
4. Westhorne Avenue;
5. Foxhole Road.

7.12.1.4 Over bridges are located as follows:

1. Network Rail Westcombe Park extension;
2. Charlton Road extension;
3. Old Dover Road extension;
4. Westmount Road extension;
5. Glenesk Road extension;
6. Warren Golf Course;
7. Rochester Way extension.

7.12.1.5 Footbridges will be required at several locations and may be identified additionally at other locations as a consequence of detailed design. At this time footbridges as either new or modified existing structures have been identified as follows;

1. Westcombe Park Station;
2. Bramshott Avenue;
3. Sun in the Sands, replacing two existing subways.

- 7.12.1.6 A cut and cover tunnel will be constructed at Sun in the Sands extending from Delacourt Road to Hervey Road.
- 7.12.1.7 From the point where the extension emerges from North Greenwich Station to north of Woolwich Road at ground level between the viaducts the DLR will be carried on a piled raft owing to poor and weak ground conditions and from Kidbrooke Station to Foxhole Road a raft will also be required where the extension runs above the existing Network Rail embankment.
- 7.12.1.8 As the extension begins to rise at Westcombe Park to Dursley Road the land to the east of the extension will be supported by retaining walls. Following more detailed development of the alignment and the development of the engineering of the route some additional minor retaining walls will be required and will be associated with bridges, stations and other obstacles next to the alignment. Retaining walls also form an intrinsic part of other types of structure as discussed below.

7.12.2 Thames Crossing

- 7.12.2.1 Two options are available for the crossing of the Thames. In many ways an immersed tube is the preferred option where the DLR extension would form part of the proposed New Thames Crossing. This gives both a better alignment and a shorter crossing owing to the shallower depth of the tunnel structure.
- 7.12.2.2 The alternative is a cast iron lined bored tunnel, which for the Thames basin would be the more traditional approach. Bored tunnels of this type have been constructed beneath the Thames for over a century and have become relatively common practice, carrying several of LU's lines and the DLR. A bored tunnel would be very similar in design and construction to the existing DLR crossing between King George V and Woolwich Arsenal.
- 7.12.2.3 The bored tunnel would require a site at each end, with one used to launch the tunnel boring machine and the other receive the TBM. If one TBM is used, then the receiving site also acts as the launching site for the second bore and the original launching site receives the returning TBM.
- 7.12.2.4 Immersed tube tunnels are not common in the United Kingdom, but have been built below the Medway at Rochester and carry the A55 North Wales Coast Road beneath the Conwy Estuary. The Medway and Conwy tunnels are both dedicated to road traffic, but internationally there are numerous examples of combined tunnels, the most notable being the Oresund, linking Denmark and Sweden beneath the Baltic. An immersed tube is simply a series of reinforced concrete units provided with cells for each of the units. Conwy and Medway both have two cells, whereas Oresund has a total of 6. It is envisaged that the Thames crossing would require no more than 4 cells, which would comprise two road tunnel cells, a single rail tunnel cell for the twin track and possibly an emergency access and service tunnel, the latter being determined by the tunnel committee, which is established to take an overview on safety and operation and is required by current legislation. Generally the advantages of this approach have been discussed previously.
- 7.12.2.5 The construction of the immersed tube units takes place in a dry dock that is normally located nearby and, as in the case of Medway, can be within the approach structure. Having once built the units, they are floated out and sunk into a prepared dredged channel within which bedding material has been placed. Seals between the units make the tunnel watertight and after placing the interior is fitted out. The method of construction leads to an efficient use of space and avoids the lost spaces inherent in bored tunnels.

7.12.2.6 The relative merits of a bored and immersed tube tunnel are further discussed in Section 6.2. For both methods of construction, the approaches would be of structurally similar cut and cover construction, which is discussed in greater detail below.

7.12.3 Viaducts

7.12.3.1 The viaducts are to be relatively simple structures for speed and ease of construction. The advantage of viaducts over embankments is the much smaller footprint and the avoidance of settlement problems inherent in the soils across the site. There are two possible solutions that are buildable in this situation either the use of steel plate girders as used on the DLR at South Quay and the other is precast post tensioned segmental construction as adopted on later sections of the DLR. The latter is heavy and has significantly greater structural depth, requiring heavy and dedicated launching equipment, as well as a complex site set up.

7.12.3.2 The advantages of steel plate girders are the speed and simplicity of erection with all fabrication taking place off site. The spans except on the approaches to the longer span over bridges will be 20 m and will comprise two parallel girders. This span allows bridge components to be transported by road and lifted into place using a normal crane. The speed of erection significantly reduces the impact on the environment as also does the much reduced structural depth. The track bed is then carried on a series of transverse precast concrete units, which are again capable of being lifted into place using normal cranes.

7.12.3.4 Although durability is often cited as an advantage for concrete over steel, there are still long term maintenance issues with concrete and there are also issues over the durability of the tendons used to provide the pre-stress, as has been demonstrated recently by the problems besetting the Hammersmith Flyover. Steel is assumed to have problems of corrosion, but modern corrosion systems have a life before first over coating of 25 years or more. For example Forth Bridge repainting has recently been completed and is expected not to require any further attention for 25 to 30 years and Britannia Bridge is currently planned to be repainted after a period of 30 years and shows little visible evidence of corrosion.

7.12.3.5 The foundations and substructure of the viaducts will be executed in reinforced concrete and will be carried on piled foundations, as will other bridges. Longer spans can be accommodated using a similar system of two parallel plate girders, which remain structurally and economically efficient up to spans well in excess of those expected on this project.

7.12.3.6 Plate girders are less efficient on curved spans and at the crossings of the A2 approaching Kidbrooke, of Network Rail and the A2 at Eltham and of Network Rail to the east of Eltham a different solution is required. The longer spans and the curvature are readily accommodated by the use of steel box girders. These would be constructed off line and finally rolled into place using heavy lift vehicles, requiring the roads to be closed for the few hours necessary for the transit.

7.12.4 Under bridges

7.12.4.1 In the main the under bridges are described above. There are several discrete under bridges on the alignment and these would also generally be constructed using plate girders for speed and simplicity of construction.

7.12.4.2 Over the Network Rail loop the bridge would be constructed off line and rolled in. The substructure and foundations would be piled.

7.12.5 Over bridges

- 7.12.5.1 Where bridges are to be lengthened, as at Old Dover Road, they would be executed using precast pre-stressed beams onto the modified abutments and new abutments. The foundations would be piled.
- 7.12.5.2 The exception would be the extension of the existing rail bridge at Westcombe Park where the extension would be constructed off line and rolled in. To reduce the structural weight a standard network rail twin box through girder would be adopted.

7.12.6 Sun in the Sands cut and cover tunnel

- 7.12.6.1 At Sun in the Sands the DLR extension must pass beneath the eastern section of the roundabout and the A102 southbound off slip and the A2 southbound on slip. There are two obstructions on this alignment, which will need to be removed, these are the two subways linking the central area of the roundabout with Shooters Hill Road north and south. The presence of these obstructions, together with other infrastructure and combined with the shallow depth of the tunnel mitigates against either thrust boring or traditional tunnelling. The tunnel is estimated to have a length of 210 m.
- 7.12.6.2 Following demolition of the two subways, the construction will comprise the sinking of two parallel lines of secant piles to form the tunnel walls. The base of the tunnel will be formed by an insitu reinforced concrete slab, that will carry the track bed and the roof will be formed using precast pre-stressed concrete beams with an insitu reinforced concrete top slab. The base slab will form the track bed and the top slab will carry the reinstated highway.
- 7.12.6.3 Although there will be some disruption during construction and for short periods Shooters Hill Road will be closed and access and egress at the junction will be prevented, the design and installation of the tunnel will be planned to reduce these to a minimum. The works will not affect the west side of the roundabout, which will provide several traffic management options. These options combined with temporary bridging across the work site will reduce the disturbance to short periods. The precise details of the cut and cover tunnel will be developed following the site investigation.
- 7.12.6.4 As discussed above the approaches to the Thames crossing will also be constructed in cut and cover, for which a similar technique will be adopted.

7.12.7 Piled rafts

- 7.12.7.1 The Greenwich Peninsular comprises areas of peat and alluvium extending to a depth of some 20 m over much its area creating weak and poor ground conditions. A significant part of the A102 Blackwall Tunnel South Approach was, as a result of these conditions, was constructed on a piled raft and is therefore a continuous structure rather than being a road built in the traditional way. Traditional construction for either a road or railway would necessitate the excavation and removal of significant volumes of soil and the import of an equivalent amount of suitable material. Given the heavy burden of such operations and the added problem that much of the site is heavily contaminated with the residue of coal distillates, a piled solution is far less intrusive and has a much lower environmental impact as well as being much more economic.
- 7.12.7.2 To construct a piled raft, piles are sunk in discrete groups at regular intervals along the line of the track, pile caps are then constructed to form crossheads and finally precast pre-stressed beams are placed to span between the crossheads, upon which the track bed is completed and the permanent way installed. Groups of 4 to 6 piles at about 15 m spacing would be sunk to a depth of about 30 m to gain sufficient capacity in the

underlying soil and following the completion of the pile caps up to 14 beams each about 0.5 m wide would be installed. An insitu reinforced concrete slab is then cast to form the track bed.

7.12.8 Retaining walls

- 7.12.8.1 The retaining wall structures form a key part of several sections of the proposed DLR extension. In addition to forming simple retaining walls between Westcombe Park and Dursley Road, they are an intrinsic part of other structures, notably the approaches to the Thames Crossing and the station box at North Greenwich. The combination of limitations of space and poor ground conditions at several locations require a solution that is buildable, efficient and compact. Such a solution is provided by secant pile walls.
- 7.12.8.2 Secant piling comprises a series of bored piles that are formed by first sinking a line of piles spaced less than a diameter apart and then sinking piles between the first line that cut into and overlap the first line. This arrangement is shown in the sketch below. The system produces an interlocked line of piles that can either act as cantilevers with no additional support, other than that provided by the ground, or can be propped either with a base or top slab. This latter solution would be adopted in the approaches to the Thames crossing, North Greenwich Station and the Sun in the Sands cut and cover tunnel as discussed above.
- 7.12.8.3 To mobilise sufficient capacity the secant piles are generally taken to a depth of between two and three times the exposed retained height. Where secant piles are used on the Greenwich Peninsular, it is envisaged that these would extend to a depth of about 30 m and where the structures are in the Harwich Formation the piles will have an overall length of circa 20 m. These depths will need to be verified following the completion of the geotechnical investigation and detailed design.

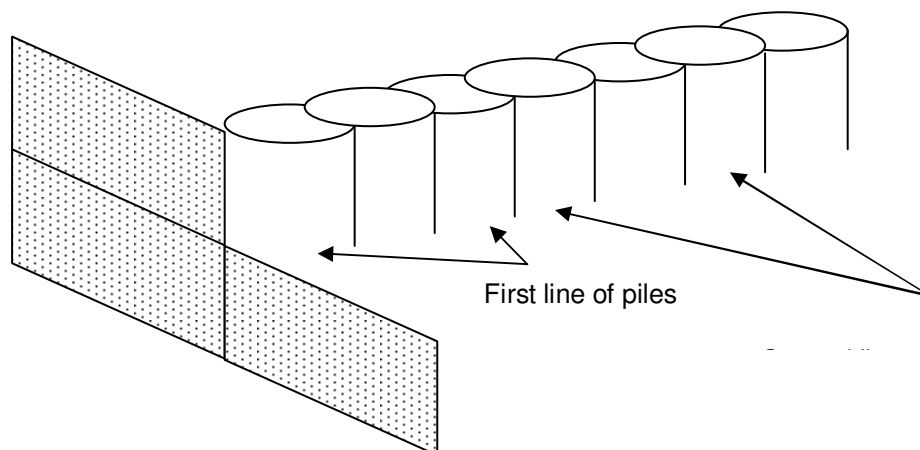


Figure 7.4: Schematic detail of secant piling.

8 ECONOMIC CONSIDERATIONS

8.1 Costs Categorisation

- 8.1.1 The cost of delivering a DLR extension is difficult to forecast at the feasibility stage. So much depends on factors for which information would only become available much later following further survey and research work. At this time it possible only to provide indicative unit costs based on previous experience and various assumptions with regard to ground conditions, envisaged property impacts and likely ancillary works, etc.
- 8.1.2 The costs should be considered in three categories, viz:
- Capital Construction
 - Rolling Stock
 - Operation and Maintenance

8.2 Capital Construction Costs

- 8.2.1 An itemised summary of the estimated capital construction costs is provided in Table 8.1. This shows the various unit costs broken down across the sections of the route as follows:
- Canning Town to North Greenwich - Immersed tube combined with Silvertown Link (not including station)
 - Canning Town to North Greenwich - Independent bored tunnel (not including station)
 - North Greenwich to Kidbrooke (including all stations)
 - Kidbrooke to Eltham (including Eltham Station)
 - Eltham to Falconwood (including Eltham Park & Falconwood Station)
- 8.2.2 The various unit costs for each section of the route are summarised to provide a basic Total Structure Cost (TSC), on to which is added professional fees and a number of other 'contingencies', viz:
- Design & Supervision (10% of TSC)
 - Preliminaries (8% of TSC)
 - Allowance for Ancillaries and/or property impacts (6% of TSC)
 - London Weighting (60% of TSC)
 - Rail Environment Working (140% of TSC)
 - Optimism biases (44% of total costs including all of the above)
- 8.2.3 Rail environment working carries a particularly heavy premium owing to the general restrictions imposed by Network Rail and restricted working times. The total costs for each section of the route have thus been calculated as shown in Table 8.2. From this it is possible to calculate the estimated costs for different DLR Extension Options, as shown in Table 8.3.
- 8.2.4 It will be seen that the Canning Town – Kidbrooke Option could be constructed for as little as £455 million if the DLR could share an immersed tube River crossing with the Silvertown Link. A separate bored tunnel would likely add an estimated £66 million to all extension options (allowing for contingencies). Also it can be seen that the construction costs per metre for the Kidbrooke-Eltham and Eltham-Falconwood sections are appreciably more than those for North Greenwich-Kidbrooke, so the costs for these 'additions' would be disproportionately higher.

Feature	Canning Town to North Greenwich, Immersed tube combined with Silvertown Link (not including station)				Canning Town to North Greenwich, Independent bored tunnel (not including station)				North Greenwich to Kidbrooke (including all stations)				Kidbrooke to Eltham (including Eltham Station)				Eltham to Falconwood (including Eltham Park & Falconwood Station)			
	Quantity	Unit	Rate (£'000)	Cost (£'000)	Quantity	Unit	Rate (£'000)	Cost (£'000)	Quantity	Unit	Rate (£'000)	Cost (£'000)	Quantity	Unit	Rate (£'000)	Cost (£'000)	Quantity	Unit	Rate (£'000)	Cost (£'000)
Secant pile walling	600	m	14	8400	600	m	14	8400	2230	m	3.2	7136	0	m		0	0	m		0
Piled foundations	68	no.	120	8160	68	no.	120	8160	51	no.	120	6160	72.5	no.	64	4640	0	no.		0
Viaducts (R-C Segmented Box or Steel box girders)	560	m	13.5	7560	560	m	13.5	7560	270	m	17.5	4725	50	m	18	900		m		0
Ground slab	600	m	7	4200	600	m	7	4200	770	m	7	5390	1050	m	7	7350	0	m	7	0
DLR Tunnel (marginal on Immersed Tube)	1100	m	24	26400	1600	m	32	51200	0	m		0	0	m		0	0	m		0
Station box (included in secant piling)		no.		0	1	no.		0	0	no.		0	0	no.		0	0	no.		0
Stations	0	no.		0	0	no.		0	6	no.	3200	19200	1	no.	3200	3200	2	no.	3200	6400
Permanent Way and Associated Costs	2150	m	11	23650	2150	m	11	23650	4600	m	11	50600	1770	m	11	19470	2010	m	11	22110
Total Structure Cost (TSC)				78370				103170				93211				35560				28510
Fees and Contingencies																				
Design & Supervision (10% of TSC)				7837				10317				9321				3556				2851
Preliminaries (8% of TSC)				6270				8254				7457				2845				2281
Allowance for Ancillaries and/or property impacts (6% of TSC)				4702				6190				5593				2134				1711
London Weighting (60% of TSC)				47022				61902				55927				21336				17106
Rail Environment Working (140% of TSC)																51206				41054
Optimism (44% of TSC + London Weighting)				63448				83526				75464				51320				41146
Net Cost				207649				273359				246972				167957				134658
Cost per m				97				127				54				95				67

Table 8.1: Itemised Summary of Capital Construction Costs -

Section of Route	Cost (x £ million)	Cost per m (x £'000)
Canning Town – North Greenwich via an immersed tube tunnel shared with the Silvertown Link (cost reflects the ' <i>marginal cost</i> ' of a lateral extension of the immersed tube to accommodate DLR) – not including station	207.6	97
Canning Town – North Greenwich via an independent deep bored tunnel – not including station	273.4	127
North Greenwich to Kidbrooke, including all stations	247.0	54
Kidbrooke – Eltham including Eltham Station	168.0	95
Eltham – Falconwood including Eltham Park & Falconwood Station	134.7	67

Table 8.2: Route Sections Construction Costs

Extension Options - Totals	Cost (x £ million)
Canning Town - Falconwood (bored tunnel)	822.9
Canning Town - Falconwood (immersed tube combined with S. Link)	757.2
Canning Town - Eltham (bored tunnel)	688.3
Canning Town - Eltham (immersed tube combined with S. Link)	622.6
Canning Town - Kidbrooke (bored tunnel)	520.3
Canning Town -Kidbrooke (immersed tube combined with S. Link)	454.6

Table 8.3: Extension Options Construction Costs

8.3 Rolling Stock Costs

- 8.3.1 The amount of rolling stock required for any DLR line depends on the run time between the termini, the minimum headway (time between trains) and the total layover time. The following describes the calculation for the cost of cars on a notional service running between Stratford International and Falconwood.
- 8.3.2 The run time from Stratford International to Falconwood is assessed at 29 minutes. This is a combination of 10mins for Stratford International to Canning Town (5.5 km) - the existing DLR timing, plus the run time between Canning Town and Falconwood - 19.1 minutes assuming 33kph for the 10.5 km (33 kph being the average speed of DLR trains between Canning Town - Woolwich Arsenal and Canning Town -Beckton).
- 8.3.3 Assuming a total layover time of 12 minutes, the round trip time would be just over 70 minutes, so a headway of 10 minutes would require 7 trains in service. All trains are assumed to have 3 cars so a total of 21 cars would be needed, plus a nominal 10% spare cars (2), giving a total new car requirement of 23 cars.

8.3.4 In 2007 an order of 55 cars last procured by DLR cost an average of £2.1 m each. This cost has been increased by 10% to meet the growing costs of materials and the reduced economies of a smaller order. The total cost for 23 cars is therefore assessed as $23 \times 2.1 \times 1.1 = \text{£}53.1\text{m}$.

8.3.5. A fewer number of cars is required for other route options as these are appreciably shorter than the extension to Falconwood. Summary calculations for the three route options under consideration are shown in Table 8.4.

Extension Option	Route Length (km)	DLR Extension Run Time (min)	Stratford Int - Canning Town run time (min)	Total Layover (min)	Round trip time (min)	Number of trains	Headway (min)	No of Cars (inc spares)	Cost of Cars (£ m)
Canning Town - Falconwood	10.5	19.1	10.0	12.0	70.2	7	10.0	23	53.1
Canning Town - Eltham	8.5	15.5	10.0	9.0	59.9	6	10.0	20	46.2
Canning Town - Kidbrooke	6.8	12.4	10.0	15.0	59.7	6	10.0	20	46.2

Table 8.4: Extension Options Rolling Stock Costs

8.3.6 It will be seen that the Canning Town - Kidbrooke option could operate a 10 minutes headway with just six trains (20 cars) costing £46.2 million with a total layover of 15 minutes. The Canning Town – Eltham option could also operate a 10 minutes headway with just 6 trains if the layover was reduced to 9 minutes.

8.4 Operation and Maintenance Costs

8.4.1 Most of the annual operation and maintenance (O&M) costs have been assessed using average costs supplied by DLR at 2007 prices, but updated to third quarter 2010 prices using average seasonally adjusted earnings data from the Office of National Statistics. The Maintenance of Way costs are taken as 0.50% of the total route construction costs per annum.

8.4.1 An O&M cost model was constructed for all three route options, which calculations are shown in Table 8.5 (colour coded for clarity). It will be seen that the total O&M costs for the Canning Town – Kidbrooke option amount to some £6.21 million per annum. Those for extending the DLR to Eltham, and to Falconwood are appreciably more.

DLR OPERATIONS AND MAINTENANCE COSTS PER YEAR FOR EACH ROUTE OPTION				
Item	Unit	Unit Costs	Quantities	Cost/Year
Train Km Costs	cost/km	£1.17		
Canning Town - Falconwood	Annual train kms		1,014,390	£1,186,836
Canning Town - Eltham	Annual train kms		887,591	£1,038,482
Canning Town - Kidbrooke	Annual train kms		779,812	£912,380
Train Captains				
Canning Town - Falconwood	cost/yr trains in service persons/shift	£54,180.40	7 3.5	£1,327,420
Canning Town - Eltham	cost/yr trains in service persons/shift	£54,180.40	6 3.5	£1,137,788
Canning Town - Kidbrooke	cost/yr trains in service persons/shift	£54,180.40	6 3.5	£1,137,788
Maintenance of Way	cost/yr %	0.50%		
Canning Town - Falconwood	Construction Cost		£817,939,824	£4,089,699
Canning Town - Eltham	Construction Cost		£683,281,392	£3,416,407
Canning Town - Kidbrooke	Construction Cost		£520,330,992	£2,601,655
Station Maintenance				
Canning Town - Falconwood	cost/stn/yr No of Stns	£74,365.30	10	£743,653
Canning Town - Eltham	cost/stn/yr No of Stns	£74,365.30	8	£594,922
Canning Town - Kidbrooke	cost/stn/yr No of Stns	£74,365.30	7	£520,557
Lift Maintenance				
Canning Town - Falconwood	cost/lift/yr No of Stns Lifts/stn	£72,665.50	10 1.8	£1,307,979
Canning Town - Eltham	cost/lift/yr No of Stns Lifts/stn	£72,665.50	8 1.8	£1,046,383
Canning Town - Kidbrooke	cost/lift/yr No of Stns Lifts/stn	£72,665.50	7 1.8	£915,585
Ticket machines maintenance				
Canning Town - Falconwood	cost/machine/yr No of Stns TMs/stn	£3,718.26	10 3.3	£122,703
Canning Town - Eltham	cost/machine/yr No of Stns TMs/stn	£3,718.26	10 3.3	£122,703
Canning Town - Kidbrooke	cost/machine/yr No of Stns TMs/stn	£3,718.26	10 3.3	£122,703
TOTAL O&M COSTS/YEAR				
Canning Town - Falconwood				£8,778,290
Canning Town - Eltham				£7,356,685
Canning Town - Kidbrooke				£6,210,669

Table 8.5: Route Options Operation and Maintenance Costs

8.5 Basic Financial Model

- 8.5.1 Using discounted cash flow techniques, a basic financial model has been constructed to assess the revenues/costs ratios for a 30 years operation based on various assumptions for passenger numbers and fare income. This could be used to support the DLR extension business case once accurate passenger modelling data is available. In the meantime the model permits an indicative comparison between the various DLR extension options based on common assumptions for passenger/fare data sets.
- 8.5.2 For the present, the basic model incorporates the following general assumptions:
- a three years construction period with one third of the capital costs expended in each year
 - a subsequent 30 year operation period (scheme life) to assess return on investment
 - annual discount factor of 4% to determine the present value of future cash flows
 - all rolling stock is replaced after 20 years
 - the average fare paid per trip is £3.00
 - in addition to fare revenue, an income of £1 million/annum is available from advertising and/or sponsorship opportunities.
- 8.5.3 Assuming a 'bored tunnel' River crossing, summary outturns from the model are shown in Table 8.6. Based on the preliminary estimates of the numbers of passengers likely to be generated by each of the Extension Options (see Table 7.1), it will be seen that all three Options would achieve revenues/costs parity over 30 years. Naturally these figures would look better with lower construction costs afforded by a 'shared tube' tunnel on the River crossing.

Extension Option	Estimated passengers/year (million)	Assumed average fare	30 Year Costs (£m)	30 Year Revenues	Revenues/ Costs Ratio
Canning Town - Falconwood	21.00	£3.00	£995	£1,021	1.03
Canning Town - Eltham	19.00	£3.00	£835	£925	1.11
Canning Town - Kidbrooke	17.00	£3.00	£656	£829	1.26

8.6: Estimated Revenues/Costs ratios for the Extension Options

- 8.5.4 The longer extensions, of course, could be expected to attract more passengers than the Canning Town – Kidbrooke option, but at most these could be expected to be in the order of an extra 2.0 million and 4.0 million for the Eltham and Falconwood extensions respectively, the revenues from which would not cover all the costs of the additional construction; hence the lower revenues /costs ratios. It follows that it would be more difficult to establish a business case for the longer options than for the Canning Town – Kidbrooke option.
- 8.5.5 Given that Falconwood and Eltham are already connected to Kidbrooke by frequent trains on the Bexleyheath line (10 trains/hour each way during peak periods), it is likely that a parallel DLR service between these stations could only be justified if this was essential to meet future passenger demands. In the medium term, terminating the DLR Extension at Kidbrooke could fulfil most of the key objectives for improving north-south links with considerably reduced costs, so affording a stronger business case for the DLR Extension project as a whole.

8.6 Assessment of Passenger Potential

- 8.6.1 Figure 8.1 shows the areas within 1.0 km of the proposed Stations on the DLR Extension as far as Kidbrooke. Collectively these areas cover some 10 square kilometres, or about 20% of the Royal Borough. Extending the DLR to Kidbrooke would, therefore, bring an estimated 50,000 residents within 20 minutes walk of DLR services, while at least a further 100,000 would be no more than 20 minutes away via a single bus, train or cycle trip.
- 8.6.2 Assuming 67% of residents are in employment (see 2.1.4) and that only 33% of those within 20 minutes walking distance make use the DLR Extension, this equates to some 22,000 new trips per day using the DLR network for just employment purposes by Royal Greenwich residents. About as many daily trips again by Royal Greenwich residents could be added for other purposes. But in addition to trips originating in Royal Greenwich, there would also be a lesser, but appreciable, number of trips originating in other boroughs with destinations in Royal Greenwich that would make use of this DLR Extension.
- 8.6.3 On this assessment, therefore, it seems entirely realistic that the DLR Extension to Kidbrooke could attract at least an extra 47,000 passengers/day to the DLR Network (>17 million/year), sufficient to cover its construction and operational cost over a 30 year period. These figures are broadly consistent with the assessment shown in Table 7.1 based on TfL/DRL's forecast network patronage. This DLR extension, moreover, would give Royal Greenwich residents comparable access to new jobs and services in the Thames Gateway to that already enjoyed in other boroughs north of the River.

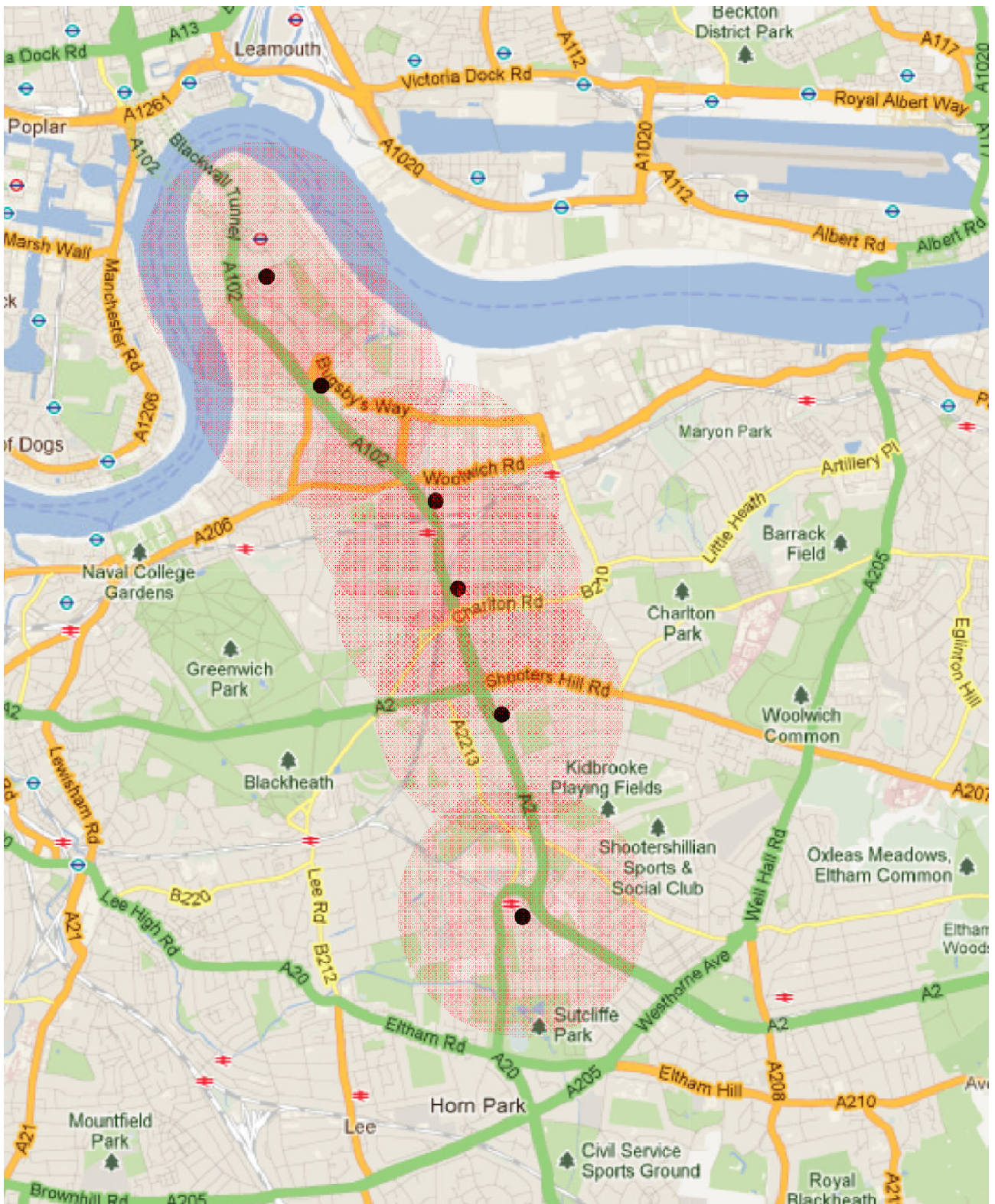


Figure 8.1: Areas within 1.0 km of DLR Stations, North Greenwich - Kidbrooke

9 CONCLUSIONS

9.1 Connection to Existing Links

- 9.1.1 A study of the existing DLR Network shows that, at the present time there is no spare capacity through Westferry - Poplar to accommodate a new service from Greenwich Peninsula. Any connection by the proposed Extension should also avoid a flat crossing of the Canning Town 'double junction' where there is little scope for modification. Use of common track in this locality should be avoided as this would constrain track capacity more widely. A track connection near Thames Wharf is not possible as land in this locality is safeguarded for development, including a new station.
- 9.1.2 By contrast the Stratford International line has a good deal of spare capacity and will require an upgraded service in the future, which could partly be provided by North Greenwich trains. It is proposed, therefore that the line from Greenwich Peninsula should join the Stratford Line on its east side just south of Canning Town Station, so avoiding a flat crossing of the double junction and the safeguarded Thames Wharf.
- 9.1.3 Tunnelling options comprise a bored tunnel independent of the Silvertown Link or a shared immersed tube tunnel. An independent bore would involve longer and more substantial approach structures. A number of other constraints make this a difficult alignment and one that would be relatively expensive to construct.
- 9.1.4 These problems, however, could largely be avoided by a shared immersed tube that would likely show considerable savings over separate tunnels in terms of cost and environmental impact. The DLR would cross the river at a shallower depth affording significant reductions in the approach structures and simplifying the DLR alignment north of the River, with corresponding reductions in cost and property impacts.

9.2 Demonstration of Need

- 9.2.1 The north-south links study, outlined in 3.1 has demonstrated a clear need for a high quality public transport system to provide essential connections across the Royal Borough. From an assessment of the existing and proposed transport provisions in RBG, the key north – south travel issues are identified as follows:
- a) The main focus of the existing rail routes is to serve the City and the West End, essentially east - west movements. North-south links are mostly bus-based services which do not offer the more favourable trip speeds or journey time reliability of fixed track (rail) services.
 - b) Many Royal Greenwich residents experience a general inability to make rapid and relatively seamless journeys to other parts of Greater London by public transport. The lack of satisfactory connections to employment opportunities in Greenwich Peninsula, East London and the Thames Gateway is an impediment to growth and investment in the Royal Borough.
 - c) Current river crossing proposals (the Silvertown Link) show an over dependency on road based travel which, unless demand-managed, could have adverse consequences for traffic growth, sustainability and the local environment.
- 9.2.2 The key issues point to an urgent need for the highest possible quality public transport system that will deliver the following key objectives:
- i. support RBG's strategy for sustainable growth by giving its residents levels of access to new jobs in the Thames Gateway major business centres (including

Greenwich Peninsula) comparable to those already enjoyed in most boroughs north of the River,

- ii. ease traffic congestion on the River crossings and local road network by extending travel choices that will deliver modal transfer and accommodate most new development related travel demands *sustainably*, with significant environmental benefits,
- iii. improve access for RBG residents to the Greater London public transport system, making it easier to reach all parts of the capital, so helping to deliver the Convergence Agenda supported by the Mayor of London.

9.2.3 Extending the DLR to Kidbrooke will bring an estimated 50,000 residents within 20 minutes walk of DLR services. A further ~100,000 would be no more than 20 minutes away via a single bus, train or cycle trip. It is apparent, therefore, that the Canning Town – Kidbrooke Extension would attract levels of patronage comparable to other existing DLR branch lines.

9.3 Options Appraisal

9.3.1 Five rapid transit options have been considered using TfL’s Strategic Assessment Framework (SAF) tool that assesses the systems against 16 key “transport challenges”. Our findings from this analysis can be summarised as follows.

9.3.2 Option 1: High Quality Bus Service – On Street: a low cost, low impact and flexible option that could utilise the proposed Silvertown Tunnel to interchange at Canning Town. But this offers the longest and least reliable journey times of the options considered, so is not likely to provide the step change in service required to meet the key objectives.

9.3.3 Option 2: Tram System – On Street: a reasonably low cost, high visibility system that would provide a higher capacity and quality of service than the bus on street. But it would interact with traffic, impacting on journey times and reliability so may not provide sufficient improvements to meet the key objectives. The Silvertown Tunnel may need to be widened to accommodate the tram track, while the planning/delivery process is likely to be complex.

9.3.4 Option 3: Bus Rapid Transit – Guided Busway: a higher profile service than a conventional bus that should improved bus journey times and reliability, but carrying higher costs and a high environmental impact relative to the likely benefits. It would require a relatively complex planning process and significant land acquisition (CPO).

9.3.5 Option 4: Segregated Tram: a higher profile service than other bus/tram options with better journey times and reliability, a higher capacity, and better quality of service than the bus options. But this too carries a high environmental impact relative to benefits and would require a complex planning process and land acquisition. Widening of the Silvertown Link tunnel would also be required for reserved track was used.

9.3.6 Option 5: DLR Extension: the highest profile service likely to attract the largest patronage and offering the best and most reliable journey time of all the options considered. Also the highest capacity and safest solution, providing seamless interchange with several mainline rail services and the existing DLR network. It carries higher environmental impact than most of the other options, and will require a relatively complex planning process and land acquisition. It would require a widening of the Silvertown Link or a separate tunnel. The DLR out performs all other options on the 16 SAF transport challenges and best meets RBG’s key objectives for improving north - south links.

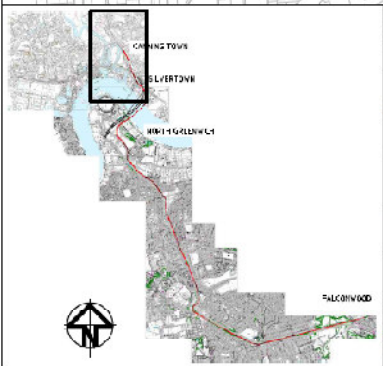
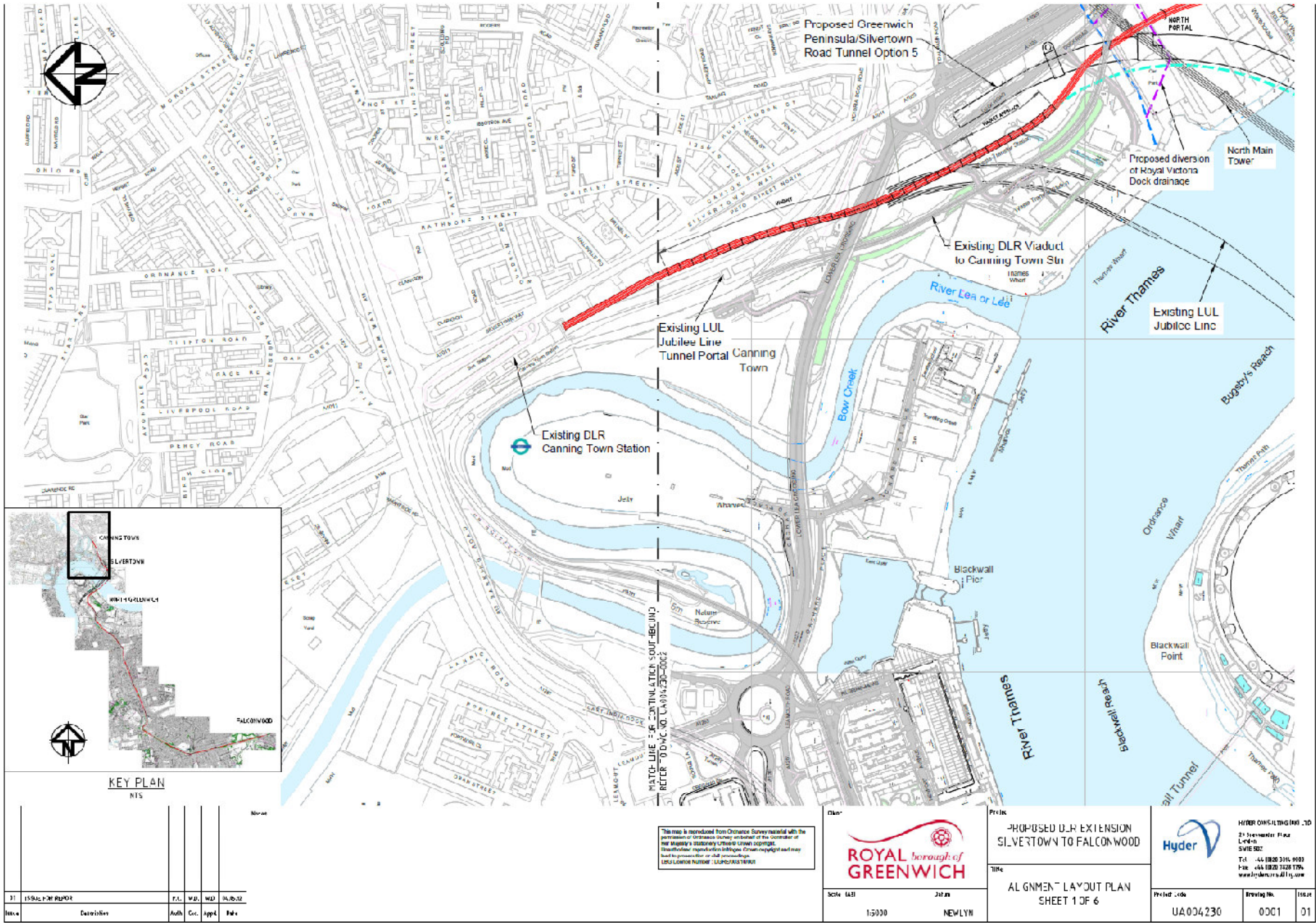
9.4 Buildability and Costs

- 9.3.1 From the Chapter 7 it is clear that the proposed DLR Extension presents many challenges, but the entire route under consideration appears to be buildable using tried-and-tested technical solutions, with relatively low property impacts. For every section, the construction methodology will depend on the outcome of detailed surveys relating to grounds conditions, topography and environmental constraints, etc.
- 9.3.2 Notwithstanding the River crossing issues, we see no reason why the costs of a Canning Town – Kidbrooke Extension should be disproportionately higher than equivalent existing sections of the DLR network on which our unit costs have been based. A full business case has yet to be made but residential densities and likely passenger demands also appear comparable with other existing branch lines, so there is every reason to be confident that the proposals can be justified in revenue terms. A Canning Town – Kidbrooke extension should also meet other business case criteria when future regeneration benefits have been taken fully into consideration.
- 9.3.3 Further extensions between Kidbrooke - Eltham and Eltham - Falconwood, would be less easy to build with disproportionately higher costs and without comparable revenues. It is less likely, therefore, that a business case could be made for either of these additions at the present time given the existing connections between these stations on the Bexleyheath mainline railway. By terminating at Kidbrooke, however, the DLR Extension should largely fulfil the key objectives for improving north-south links at appreciably less cost.

10 RECOMMENDATIONS

- 10.1 Hyder has assessed the social, economic and geographic context of the Royal Borough of Greenwich and the land-use/transportation issues pertinent to regeneration. In our assessment the existing transport provisions between the north and south of the borough, and into the Thames Gateway, are incompatible with the Royal Borough's aspirations for sustainable growth. There is a mismatch between the future location of new homes in south Greenwich and new jobs in other boroughs, mostly to the north, which can only be remedied sustainably with new high quality public transport links.
- 10.2 It is recommended that R B Greenwich endorses the findings of this study and requests TfL and the Mayor of London to:
- 1) note the social and geographic context of Royal Greenwich and the findings of previous studies that confirm a need for a high quality north-south public transport network to serve the Royal Borough,
 - 2) endorse Hyder's preliminary findings that a DLR Extension, between Canning Town – Kidbrooke for the present, offers the most appropriate solution at for improving north-south transport links and connecting Royal Greenwich most sustainably with the wider Thames Gateway and Greater London,
 - 3) approve in principle the connection of the proposed DLR Extension to the Stratford International Line immediately to the South of Canning Town Station,
 - 4) instruct the designers of the currently proposed Silvertown Link River crossing to consider in full the benefits of an "immersed tube" that could also accommodate a DLR crossing at less cost than two independent bored tunnels,
 - 5) provide funding to R B Greenwich, and technical assistance with passenger demand modelling, in order to expedite a full business case assessment of the proposed DLR Extension
 - 6) subject to a positive business case, provide further funding to complete the requisite geotechnical and topographic surveys, an Environmental Impact Assessment and preliminary design of the preferred route for full public consultation.

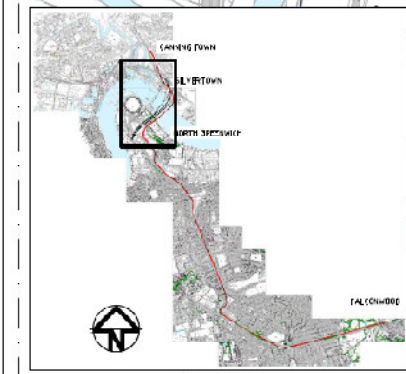
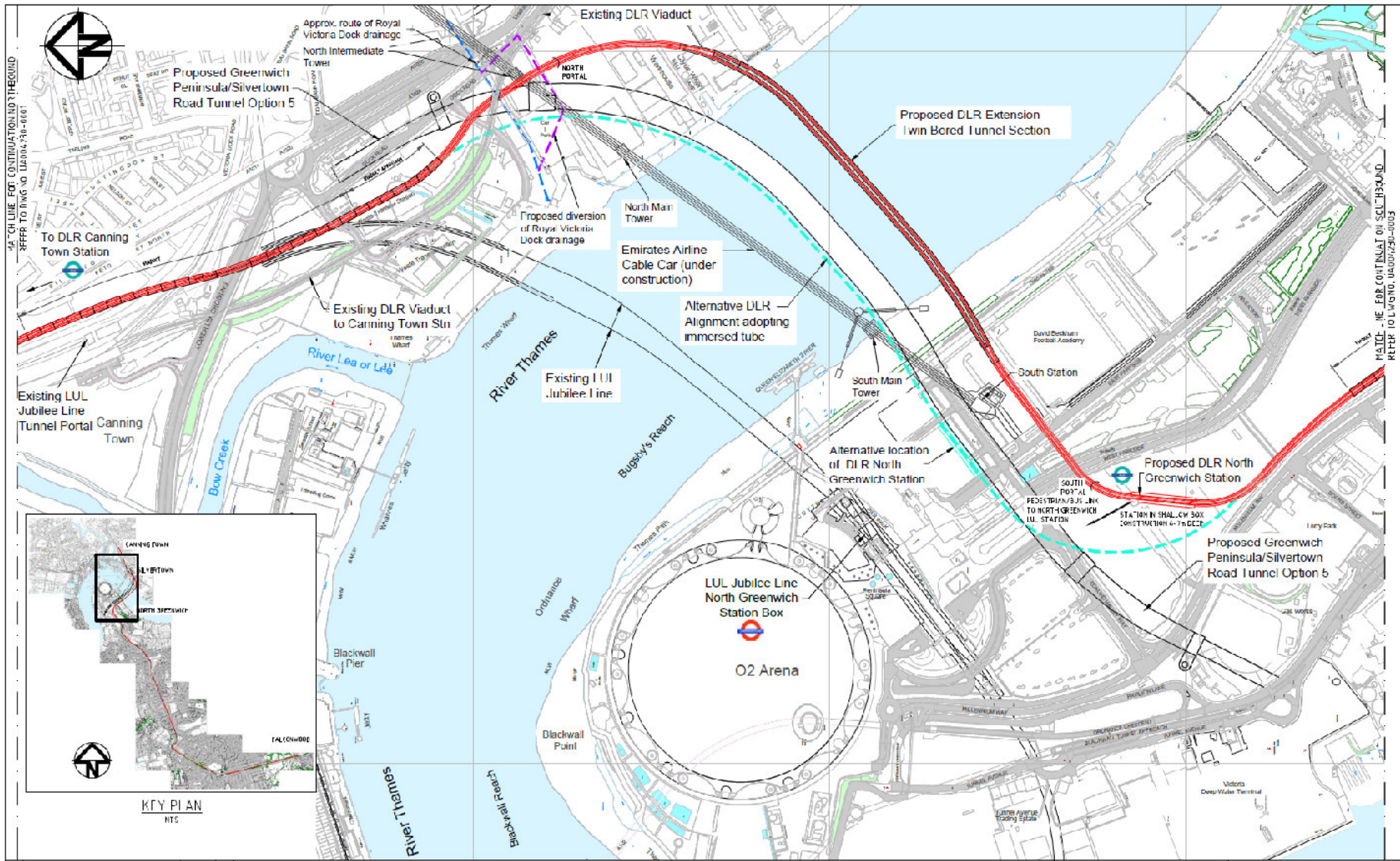
Appendix 1: DLR Extension – Provisional Alignment Plans



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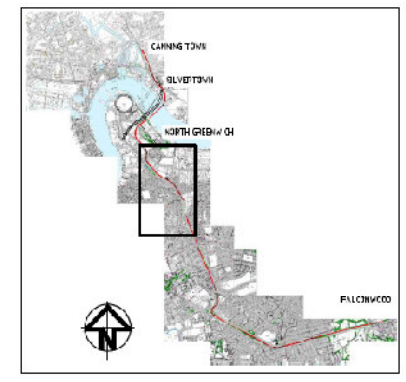
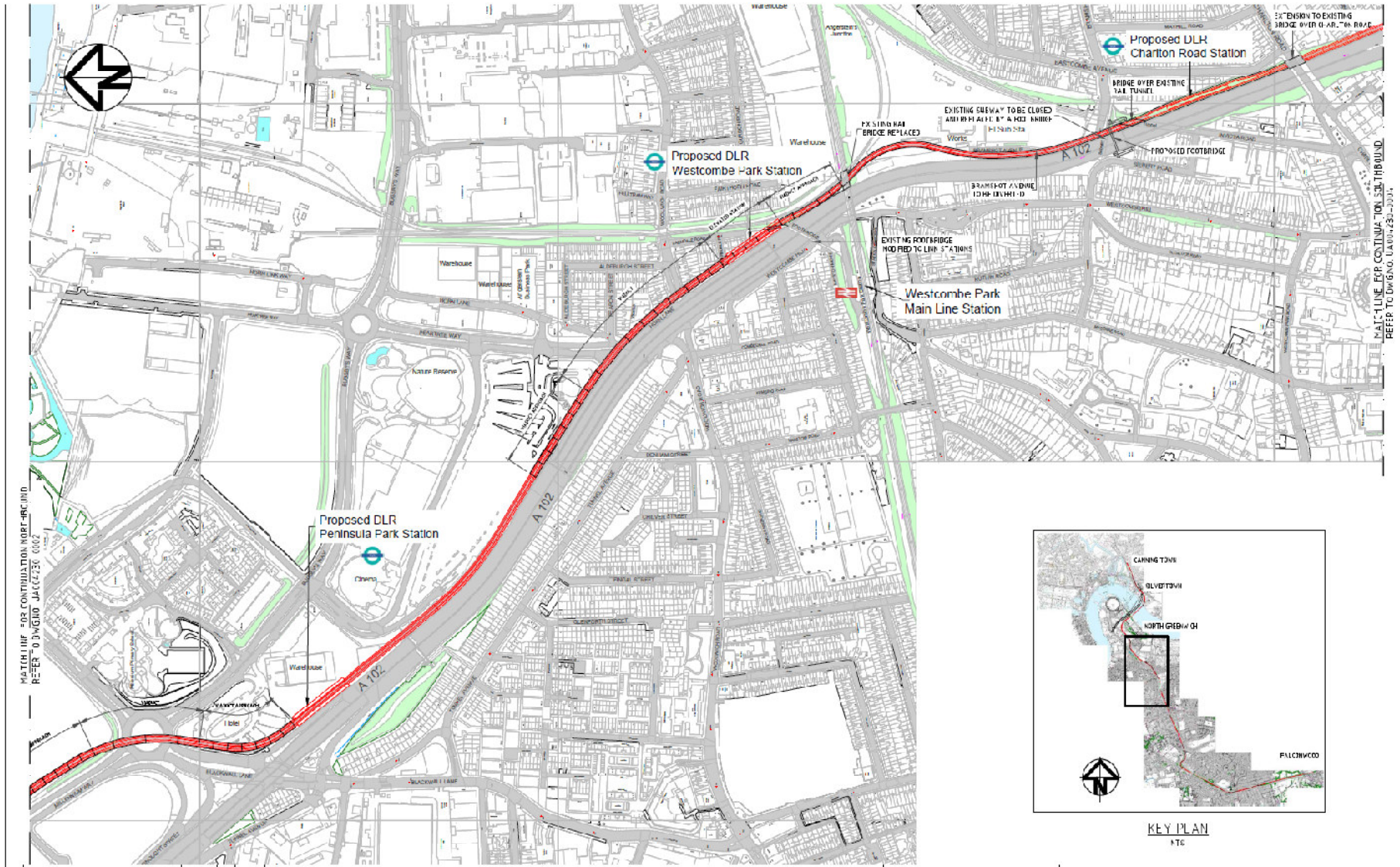
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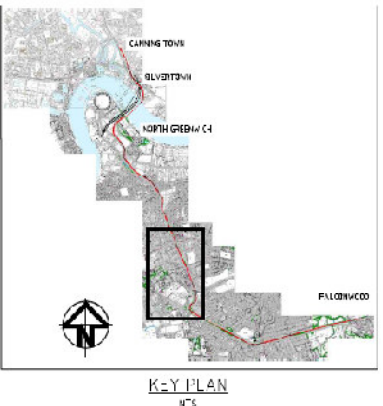
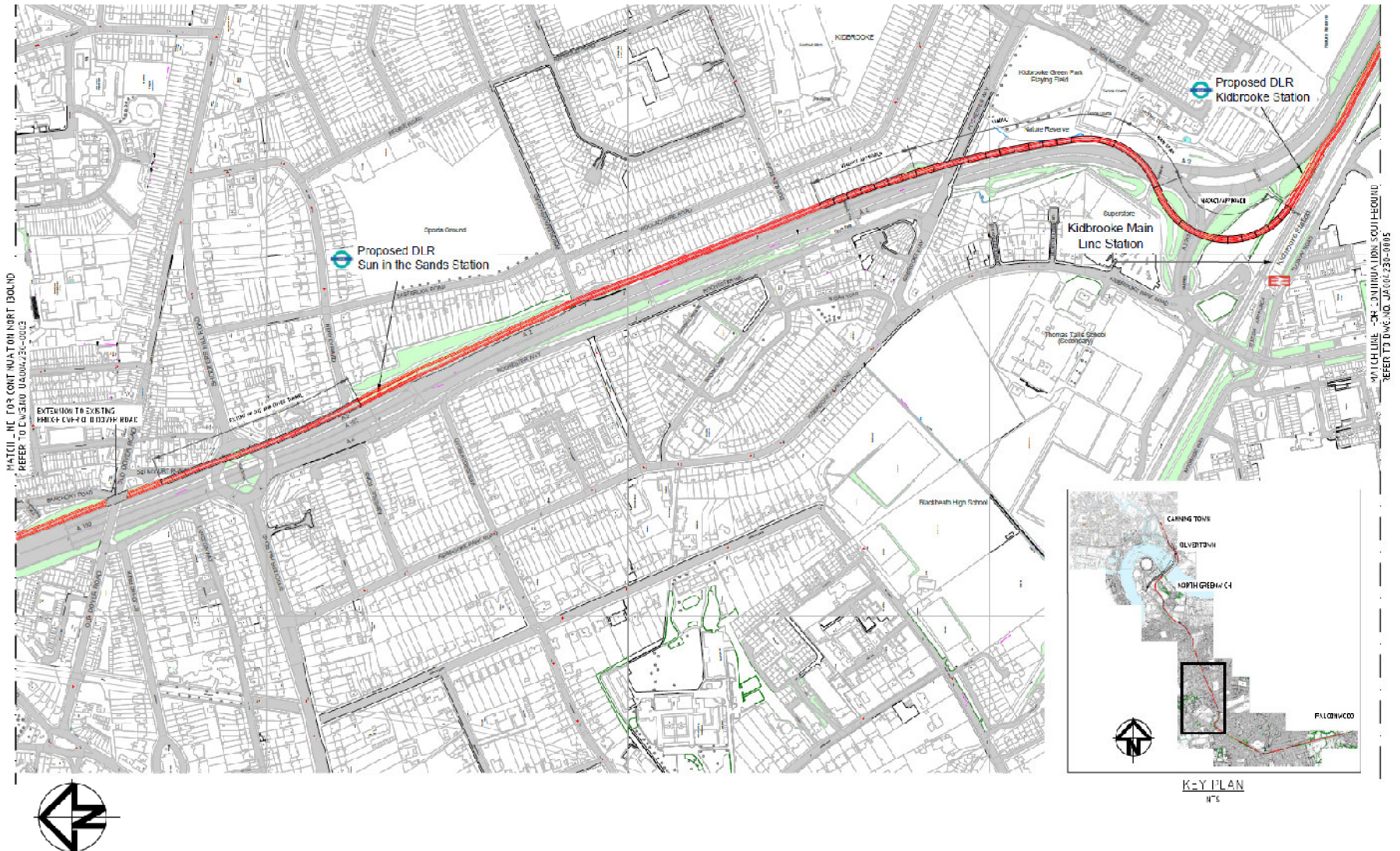
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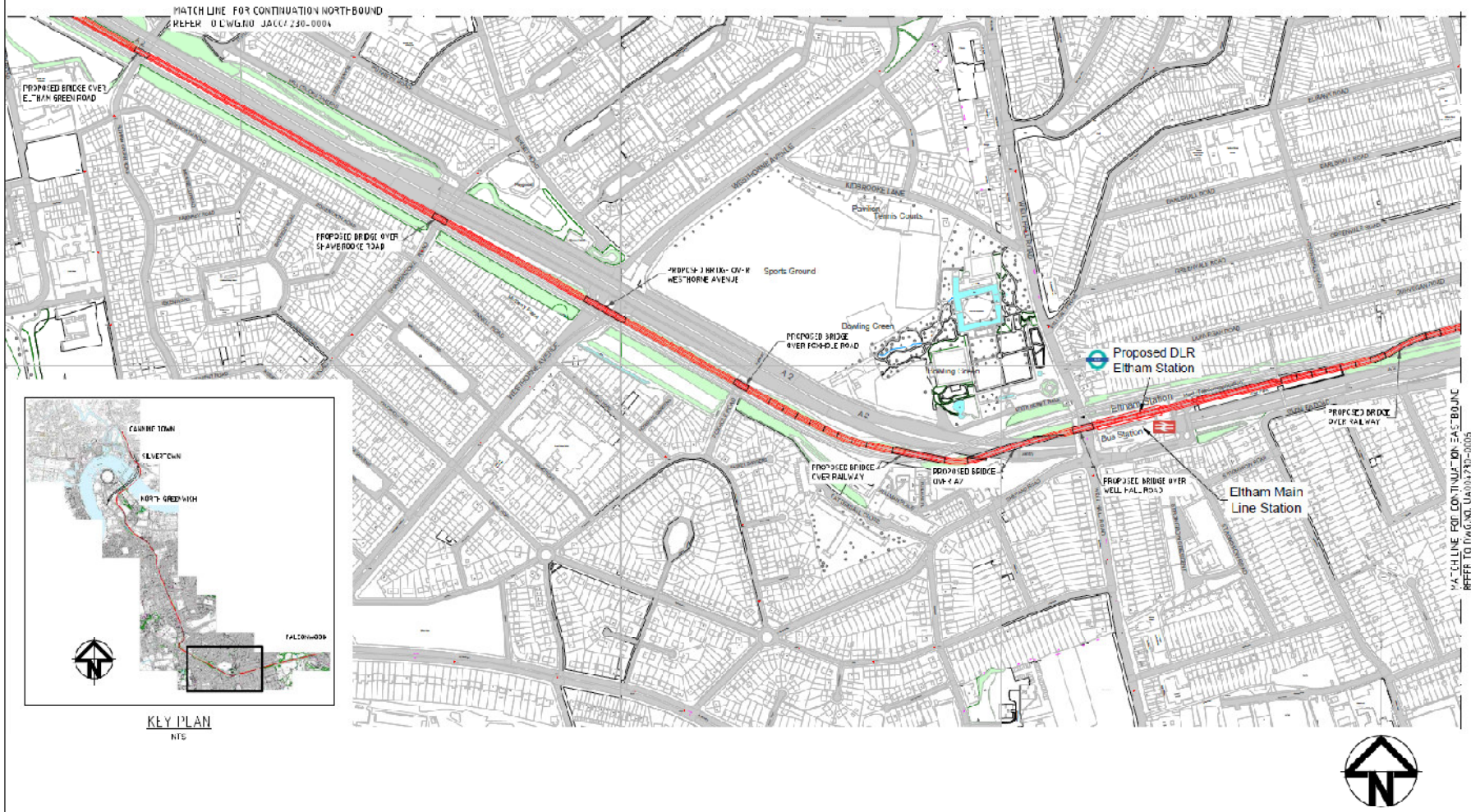
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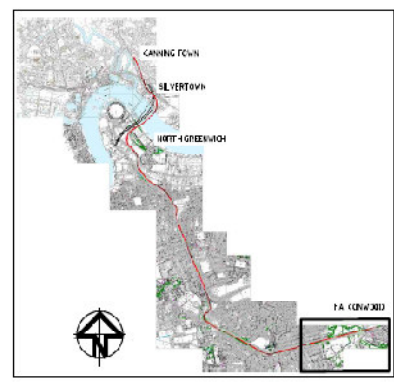
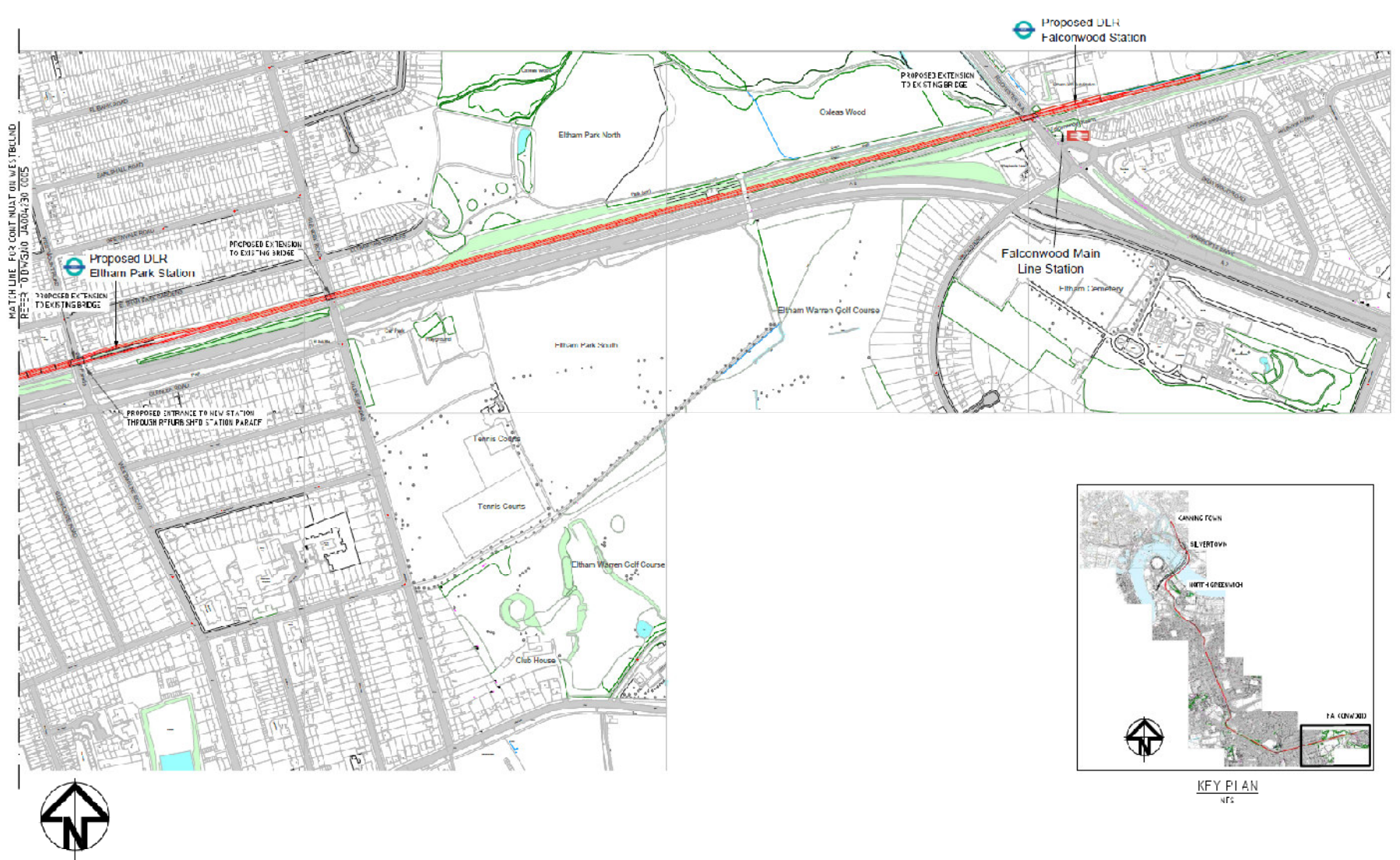
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 Issue: C1

Appendix 2: Email Communication with Tony Wilson (TfL)

From: Wilson Tony (Planning) [mailto:TonyWilson@tfl.gov.uk]
Sent: 11 April 2012 09:58
To: Colin Ferguson
Cc: Brian Hanson
Subject: RE: Proposed DLR Extension, Silvertown to Falconwood

Colin,

Thanks for sending this through.

I think I should correct one point in your email; I don't recall an immersed tunnel being preferred, and the minutes support this (see the third paragraph under point 3).

With respect to the immersed tunnel option, I think it's important to bear in mind that the chief benefit of this which you quote is that the tunnel would be inherently shallower and therefore the tunnel approach would be significantly shorter. I think this probably underestimates the amount of capital (both financial and political) which has been invested in the Greenwich Peninsula masterplan, which would require that any tunnel stayed below ground until west of Millennium Way. While it would be physically possible to have a shorter immersed tube tunnel, an open cut or ramp, used by large volumes of heavy traffic, would not be compatible with the large new commercial and residential district approved for this side of the peninsula, which is a priority for both the borough and the Mayor and is under construction.

The work on tunnel methodologies is not yet complete but the initial findings suggest that an immersed tunnel in this location would cost considerably more than a bored tunnel, as well as bringing greater environmental and planning risks, so a bored tunnel remains the most likely outcome.

With regard to the synergies of a combined scheme, there would need to be a very strong case to deflect from delivering the Silvertown tunnel, which is supported by national, Londonwide and local policies, and for which we currently have a mandate from the Mayor to progress. Changing tack to include consideration of adding a DLR extension to the project scope would probably set us back a couple of years at least.

As yet, the need for a second railway linking North Greenwich to Canning Town and Stratford is not clear; there is spare capacity on this section of the existing Jubilee line. If the desire is to bring more passengers to North Greenwich to access the westbound Jubilee line, it is not clear whether this is desirable from a crowding perspective or attractive from a customer perspective, given that all Eltham line trains call at Lewisham, which has a frequent DLR service to Canary Wharf less crowded than the Jubilee line, and all Westcombe Park trains call at Greenwich. The existing interchanges at Lewisham and Greenwich are better than could be achieved at North Greenwich. There are also a number of land impacts to be considered on both sides of the river, and a difficult connection to the DLR around Canning Town.

With sight of the case for such an extension it may be easier to judge the key issues, but at the moment it is unclear what the proposed line is trying to achieve and what alternatives means of achieving this have been considered. That's not to say that I can't see any merits in it, but they appear to be fairly minor given the available capacity on the existing DLR options via Lewisham and Greenwich, while it would carry a very high price tag, and would be competing for funding against a great many other capital projects which have established cases grounded in an established transport or economic challenge. This includes the double tracking of the DLR between Bow Church and Stratford, which would allow a more frequent service between Lewisham/Greenwich and Stratford.

If your work is able to articulate the specific problem which you are seeking to address, how this scheme would address it, and what other ways of addressing it have been considered, it would be very helpful.

I hope the above points are helpful.

Regards

Tony

Tony Wilson | Transport Planning Manager

Transport for London | Strategy & Planning

10th Floor Windsor House | 42-50 Victoria Street | London SW1H 0TL

tonywilson@tfl.gov.uk | Ext: 64393 | Tel: (020) 7126 4393

From: Colin Ferguson [mailto:Colin.Ferguson@hyderconsulting.com]
Sent: 10 April 2012 11:29
To: Wilson Tony (Planning)
Cc: Brian Hanson
Subject: Proposed DLR Extension, Silvertown to Falconwood

Tony,

Some time has passed since we met to discuss the work we are doing for Royal Borough of Greenwich to consider a possible extension of the DLR from Silvertown to Falconwood (end of financial year has made us rather busy since then), but many thanks for taking the time to meet us and many thanks for sending us the follow-up information. Our notes of the meeting are attached.

You will recall we said that our preferred option for the DLR river crossing would be a sharing of an immersed tube tunnel with the proposed Silvertown Crossing. Although TfL's current leaning for the Silvertown Crossing was toward a twin-bored tunnel, the immersed tube tunnel option had not been ruled out.

We have since looked at the two alignments that the proposed DLR extension would have to make to connect into Canning Town Station: i) via a separate twin bored tunnel (shown red on the attached plan); and ii) via a sharing of the proposed alignment of the Silvertown Crossing (shown blue on the attached plan). Although our study concludes that both alignments are buildable, the immersed tube option is the better solution in terms of value engineering as it would be inherently shallower than a traditional bored tunnel and so the approach works would be significantly shorter and less complex.

The general section through the immersed tube tunnel would look similar to the Oresund Crossing (below), except the DLR would require a smaller envelope and both lines could be placed in a single cell.

[<image001.png>](#)

We are therefore of the view that if the proposed DLR extension between Canning Town and Falconwood is to be progressed, for each crossing scheme to be considered individually would not make sense and a combined scheme would make a great deal of sense in terms of economy and reduced impact.

We are currently compiling our report to Royal Borough of Greenwich on the findings of the feasibility study of the proposed extension of the DLR and a comment from TfL on the above (even if a very guarded one), that we could incorporate into the report, would be welcomed.

Many thanks,

Colin

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Appendix 3: Strategic Assessment Framework Pro-forma

TO BE ADDED

Appendix 4: DLR Extension Photomontages



Millennium Way – Blackwall Lane Crossing



Woolwich Road Crossing



Charlton Road – Shooters Hill Road at-grade Alignment



Rochester Way Crossing



A2 Kidbrooke Crossing

Appendix 5: Notes of Meetings with TfL/DLR

First Meeting with Rob Niven – 13/1/12

Mike Hows (RBG) advised that the Cabinet had asked for a feasibility study of the DLR Extension to be progressed. New high-quality transport infrastructure of this kind was considered a high priority to improve north-south links across Greenwich and connect the Royal Borough into the Thames Gateway. The current mismatch between the proposed locations of new homes (5,000 units in Kidbrooke) and new jobs on the Peninsula and wider Thames Gateway was a key driver.

Rob Niven (DLR) advised that TfL (Richard de Cania and Tony Wilson) had looked at alignments across the River Thames. They had concluded that running DLR above or below a road crossing at Silvertown would be problematic. Also the tie-in with DLR on the north side of the River would be difficult. To assist with determining feasibility, TfL/DLR has data which may prove useful to RBG. The following DLR schemes are currently being considered:

- Western Extension to Bank/Euston/St Pancras (to tie in with HS2)
- Northern Extension from Stratford International to the Olympic Park and particularly improvements to connectivity to the north side of the Olympic Park in Legacy
- In the South: Lewisham extension to Bromley
- In the East: extension to Dagenham Dock (updating needed)
-

RN mentioned that whilst an A2-A102 alignment appeared natural, he queried the suggested station locations and connectivity and whether the residential densities may be too low to support DLR. It was suggested that where the alignment was parallel to existing rail lines (Falconwood – Kidbrooke), improvements to rail services should be considered if necessary. It was accepted, however, that there is a rail services gap between Kidbrooke and Westcombe Park, and that the densities on this sections of the scheme at least were reasonable.

RN highlighted the following priorities at this stage:

- 1) demonstrate the need for a new light rapid transit system,
- 2) consider the various LRT alternatives (options appraisal)
- 3) clarify the feasibility of the river crossing and connection to existing network,
- 4) determine whether a DLR extension is buildable within sensible costs.

The options appraisal needed to be addressed using TfL's Strategic Assessment Framework (SAF) for feasibility work - the most appropriate tool. RN advised that post-SAF, TfL/DLR could then get involved in assisting with demand/patronage modelling. RN confirmed that he would be happy to help in providing information to make the DLR case more robust. Any requests for information should be made to RN, in the first instance.

MH asked whether TfL/DLR had undertaken any feasibility work on extensions to the DLR at Woolwich. RN confirmed that whilst it lives on as a plan, this had not been looked at in detail.

Meeting with Tony Wilson – 16/2/12

Hyder met with Tony Wilson of TfL to seek an early briefing on the Silvertown Link and other relevant work. Hyder summarised the pre-feasibility work done for Royal Greenwich and concern about the inadequate north-south public transport links, particularly cross-river, for the southern part of the borough.

River Crossing: TW described the 2 x 12.1m bored tunnel alignment developed by Motts. The tunnel alignment passes under the former access lock to Victoria Dock, between DLR viaduct piers under the Airport line and avoids the foundations of the Airline cable car piers. It also takes account of planned buildings on Greenwich Peninsula. TfL are also considering an immersed tube and are awaiting a report on this proposal. The likely cost of the bored tunnels and approach roads is about £400m. TW's view was that an integrated DLR/road immersed tube tunnel was not desirable - the

main concern being the environmental impact of dredging in the tideway, but it is not ruled out at this stage.

DLR Connection Issues: (Track layout diagrams supplied by TW). TW advised that that Canning Town junction has little scope for modification. He warned that traffic growth on the Poplar - City Airport line means that peak service levels will probably need strengthening, so it may not be possible to route additional trains from North Greenwich towards Poplar. Also there is passive provision for a station at Thames Wharf - on hold at present (dependent on development finance), and other safeguarded land which precludes any North Greenwich connections in this locality.

DLR Extensions Planning: TfL are keen on a westward extension from Bank, to Euston and/or St Pancras. TfL are also looking at Lewisham-Catford-Forest Hill in tunnel. These are seen as high priority at present. The Forest Hill extension would relieve crowding on the overground service, which is also becoming urgent.

Crossrail Southern Branch: This will be in tunnel beneath Canning Town Junction and will serve a station box under West India Dock, north of Canary Wharf.

Tramlink Extensions and Tram Options: Hyder asked who is responsible for extensions planning and what schemes were being considered. TW confirmed that Policy and Strategy were working on extensions and that Crystal Palace, Bromley, Sutton and Tooting extensions were being considered. TW will forward Tramlink design standards. Train and station lengths are not fixed.

Jubilee Line Crowding: TW said that crowding on the Jubilee line (North Greenwich - Canada Water) is a key issue and that a new mode feeding North Greenwich might add to the problem. Hyder should consider the implications. TW could supply crowding plots to assist.

Canada Water Option: This lead to the consideration of a possible DLR link from south Greenwich turning west to provide a connection to South Quay and Canada Water where the link would be in tunnel. It was noted that this would provide no direct connection with DLR, albeit there would be an interchange, so this proposal would not necessarily be a "DLR extension". (*Note: consideration of this option forms no part of RBG's brief to Hyder*).

Second Meeting with Rob Niven – 8/3/12

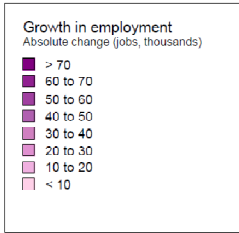
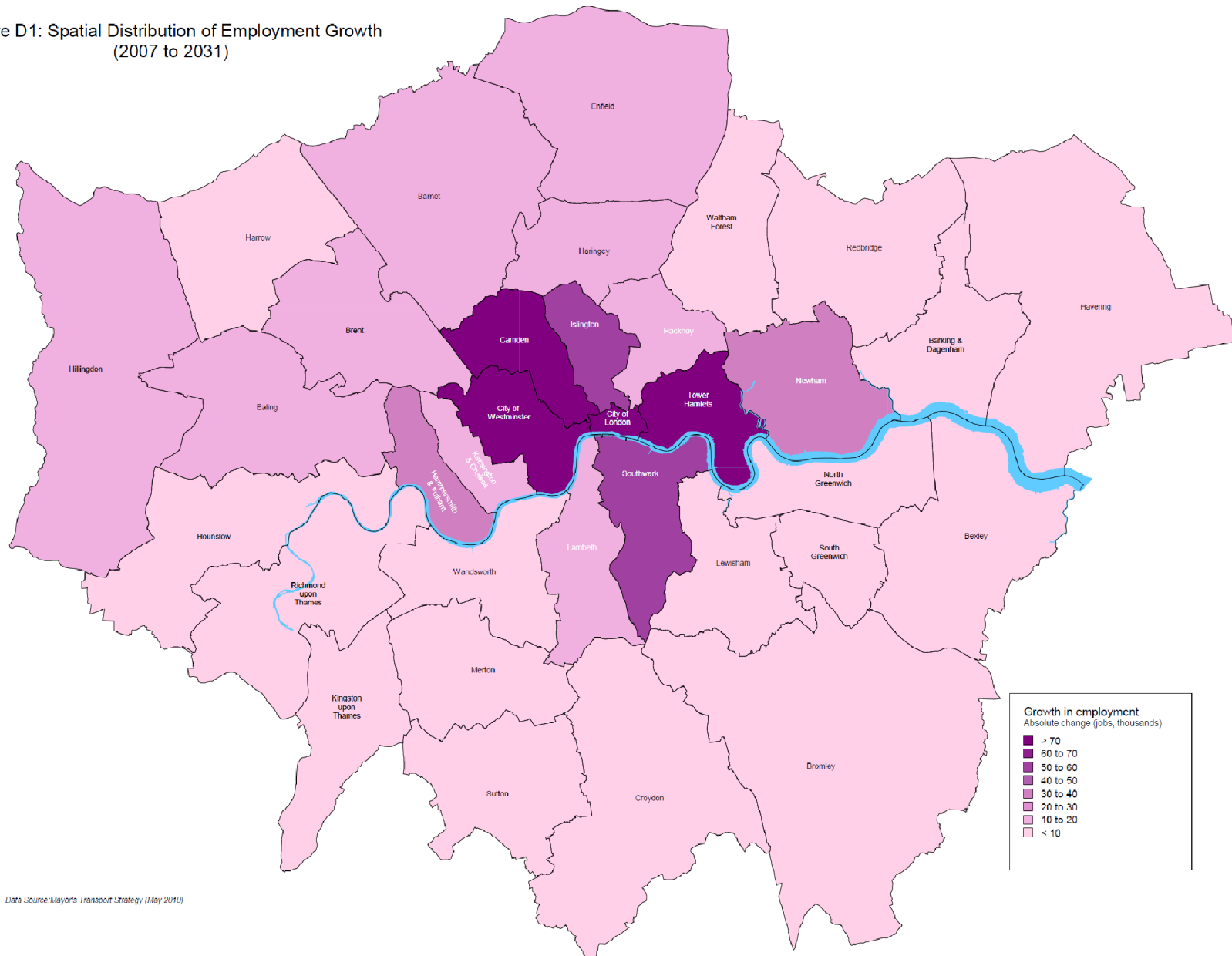
Rob Niven provided Hyder with more information on passenger forecasts and DLR extensions work. He was asked to comment on Hyder's alignment for the proposed DLR extension and a connection at Canning Town Junction. His advice was:

- DLR would not accept a new flat junction at Canning Town, i.e. an additional diamond crossing, so we would need to plan the connection to avoid this.
- There is a national grid pylon beside the Woolwich Arsenal line that must not be disturbed.
- The straight track on the Woolwich Arsenal line just south of Lower Lea Crossing Bridge is the site of a possible station at Thames Wharf and needs to be safeguarded - there can be no junction on this section.
- The Woolwich line passes under the Lower Lea Crossing. This road drops down to the roundabout underneath Silvertown Way and would force a new line into cutting to pass beneath. However, the existing bridge over the DLR is 3 or 4 tracks wide so 3 tracks with walkways could pass under. This permits several layout options.

The idea of connecting to the Stratford International line was raised. This line has plenty of spare capacity now, but there is development planned at Star Lane and elsewhere that will require an upgraded service, which could partly be provided by trains from Greenwich Peninsula.

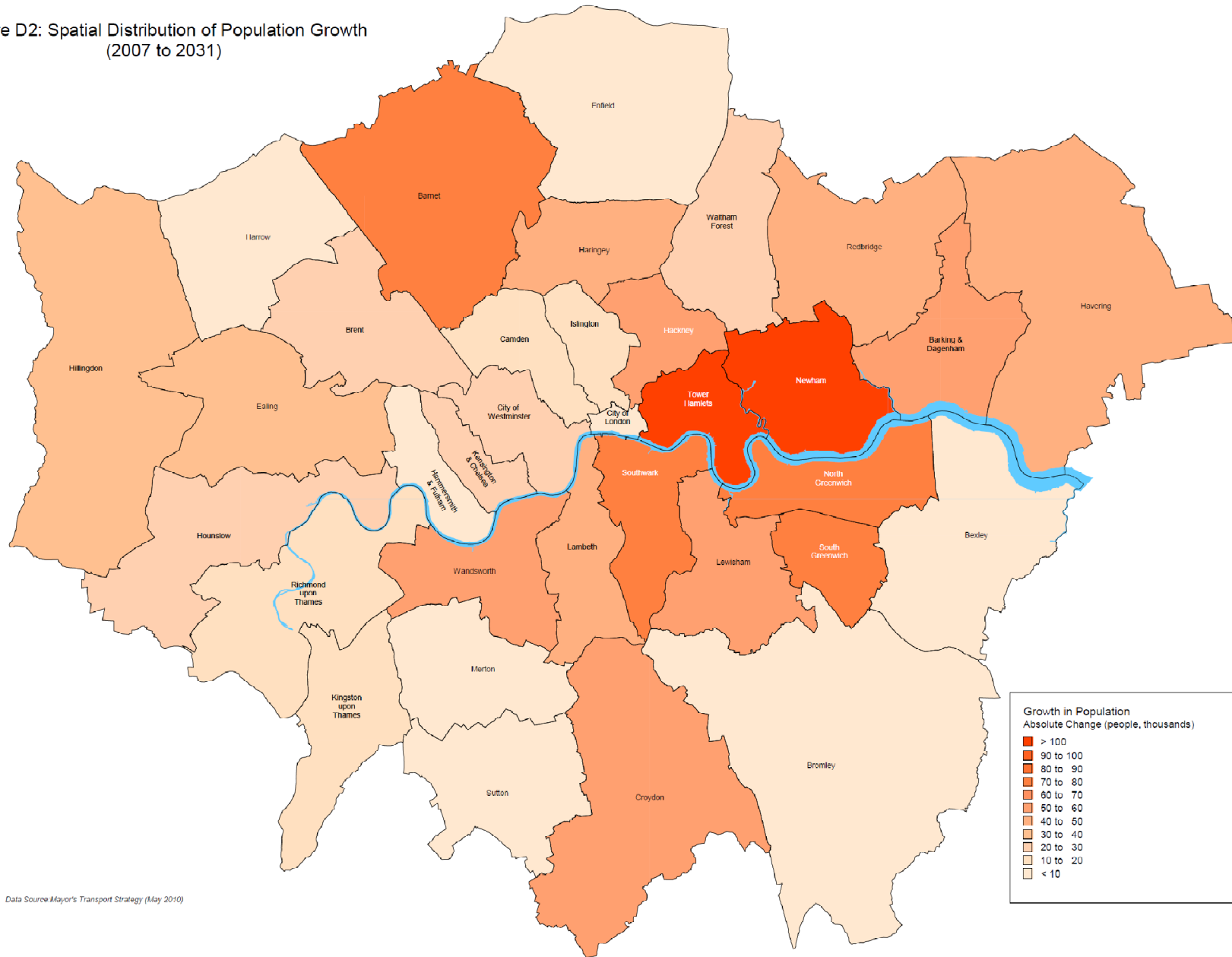
Appendix 6: Figures of Employment and Population Growth

Figure D1: Spatial Distribution of Employment Growth
(2007 to 2031)



Data Source: Mayor's Transport Strategy (May 2010)

Figure D2: Spatial Distribution of Population Growth
(2007 to 2031)



Data Source: Mayor's Transport Strategy (May 2010)