Uxbridge Road Transit

Summary report

Transport *for* London

This report has been produced by
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Foreword

In 1997, following a series of strategic studies into the potential for intermediate modes in different parts of outer London, LT commenced a detailed joint assessment, under the title "Uxbridge Road Transit", of their potential in one of the most promising areas identified in previous studies – the Uxbridge Road corridor between Uxbridge town centre and Shepherd's Bush. In July 2000, many of LT's planning functions were incorporated into Transport for London (TfL).

A major factor in deciding to carry out a detailed feasibility study for Uxbridge Road Transit has been the commitment shown by the affected Local Authorities – Hammersmith & Fulham, Ealing and Hillingdon - to assist in the development of the project, and in particular their willingness to consider the principle of road space reallocation in favour of public transport. TfL acknowledge the support of these councils and recognises that their ongoing support will be crucial if the proposals are to proceed.

A major objective of this exercise has been to identify in detail, the traffic management measures that would be required to allow Uxbridge Road Transit to have a high level of priority over other traffic and which would be sufficient to shift modal choice substantially towards public transport, particularly from the private car.

It is our view that the securing of this priority would be the most important factor in determining the success of Uxbridge Road Transit. Although we recognise that the traffic management measures required to secure this priority are likely to generate considerable debate within the affected area, we believe that the impacts of these measures on other traffic could be managed in a way that would make the impacts acceptable.

We believe that the results of this study show that there could be a good case for investment in a high priority surface Transit network along the Uxbridge Road. Such a network could make a major contribution towards further improving the attractiveness of public transport within the corridor and provide an attractive alternative form of transport to the car. However this potential can only be realised if the local authorities combine to support the proposals, and we now invite them to respond to this challenge with vision.

Contents

Executive summary

One way of significantly improving the quality, safety, accessibility and efficiency of public transport is through intermediate mode schemes. Transport for London, working together with the local authorities, have recently completed comprehensive feasibility and evaluation studies of the potential for four intermediate mode schemes in London.

This report describes the development and evaluation of Uxbridge Road Transit to establish its economic and engineering feasibility and its environmental impact. The development of this 20 km scheme which is designed to serve all the town centres situated along the Uxbridge Road as well as key locations such as Ealing Hospital and Brunel University has been carried out in partnership with the London Boroughs of Hillingdon, Ealing and Hammersmith & Fulham.

Scheme development

The development of the scheme has tried to achieve maximum priority and hence system speed with good access to key locations such as the town centres while minimising the disbenefits to the other road users and any adverse environmental impacts. Given the severe limitations on the road space available in some sections of route and the assumption that substantial property acquisition would be unacceptable, the scheme development has necessarily needed to reach a quite difficult balance in the allocation of the road space between public and private transport, and pedestrians. Some of the evaluation results described below were found to be highly sensitive to this balance. A key aim of the design has been to provide an adequate level of priority for transit by restricting longer distance through traffic while maintaining local access for parking and servicing. Not only would the reduction in traffic provide priority for transit, but also increased space and an improved environment for pedestrians and cyclists.

Evaluation

The study included a comprehensive multi criteria evaluation framework which aimed to take account of a full range of views and aims of the different interest groups involved. The key results of these studies are:

Environmental

Overall the scheme would provide a large overall environmental benefit in terms of both noise and local air pollution. This would apply mainly to properties within the Uxbridge Rd and there would be some areas of localised disbenefit on alternative routes to the Uxbridge Rd.

Some carriageway realignments would be required and some limited property acquisition would be necessary. However, it is considered by TfL the extent of property acquisition could be reduced with further refinement of the scheme. During the construction work 4,500 properties along the alignment would be affected.

Safety

Overall there would be an overall reduction in the number of road accidents, which based on data used in highway improvement assessments would be equivalent to an estimated benefit of between £170,000 and £340,000 per year.

Economic

Forecast annual ridership on the transit scheme itself would be between around 50m pa for the tram and 34m for the diesel bus option. Overall the increases in total ridership on the public transport network (allowing for transfers from the bus network for instance) would be between 11m pa for tram option and 6m for the diesel bus option.

Transit would give rise to a reduction in trips made by car of between 4000 (diesel bus) and 5000 (tram) in the am peak period.

Despite the fact that the total number of public transport journeys would increase, public transport users would experience a net reduction in travel times of between 2.3 and 7.2 million passenger hours per annum, and there would be an increase in transport use of between 5 and 11 million passenger kilometres per year.

The public transport priority measures would result in private car users experiencing a net increase in travel times of between 2.9 and 3.2 million vehicle hours per annum.

Capital costs (at 1998 prices) would range from £116m for the bus option up to around £195m for the tram option.

The benefit to cost ratio was estimated to range between 3.48 for the tram to 2.58 for the trolley bus. In the case of the diesel bus option, the benefits were negative because the highway impacts more than offset the public transport benefits.

Accessibility

Improved public transport services would bring between 96,000 and 320,000 extra people within 30 minutes of local centres. These benefits are not evenly distributed between centres however and those centres which are currently relatively inaccessible such as Hanwell and Southall are forecast to benefit the most. At Hanwell for example the tram option would increase the population within a 30 minute catchment area by 30 percent.

Overall, there would be a small reduction in pedestrian severance measured in terms of delays in being able to cross the road, with more roads(75%) experiencing a reduction in severance than an increase(25%).

New stopping restrictions would impose an overall moderate disbenefit in terms of parking and servicing affecting approximately 500 properties. However the needs of legitimate parking and servicing functions have been taken into account in the traffic management measures which while restraining through traffic have aimed to provide routes for local access.

Integration

By improving accessibility to local town centres and development areas, transit would assist with economic development and regeneration as well as reducing social exclusion in deprived areas.

Conclusion

The study has demonstrated that the scheme would be feasible both in terms of the engineering design and its economics while meeting many environmental and planning objectives incorporated within the evaluation framework. However, this feasibility would depend upon some key assumptions concerning the re-allocation of road space and the difficult compromises involved. Uxbridge Road Transit would provide significant benefits in assisting regeneration, improving public transport accessibility and improving the environment. The main factor in determining these benefits is the introduction of traffic priority measures as these ensure that public transport services, including bus feeder services, can operate without delays due to traffic congestion and parked vehicles. However it is also vital that public transport services are adapted and improved to take full advantage of these measures. It is also a critical aspect that adequate mitigation measures are developed to ensure the impact of any diverted traffic is acceptable. The evaluation suggests that, while the tram option has the highest cost, the significantly higher benefits lead to a better benefit cost ratio overall. The evaluation also demonstrates the sensitivity of this result to assumptions about the balance between traffic restraint and transit priority which give rise to the relative benefits between public and private transport. Given its higher cost, the case for the tram option would be most at risk in terms of achieving the necessary level of priority over other road users.

Way forward

TfL and the local authorities have decided to proceed to the next phase on the development of Uxbridge Road Transit – preliminary public consultation. The purpose of the consultation is to establish what level of support exists for the Transit in principle from the public as well as potential private sector partners. It will also be used to inform the formal decision to be taken by the Mayor, TfL and the Boroughs as to whether to proceed with the development and implementation of the scheme and the priority to be placed on early progress.

1 Introduction

The Project Definition stage of the Uxbridge Road intermediate mode project (known as Uxbridge Road Transit) has now been completed and its main conclusions are summarised in this report. Following this introduction, the remainder of this report is divided into ten sections (see below).

In 1997, London Transport (LT) commenced, in partnership with the London Boroughs of Ealing, Hammersmith & Fulham and Hillingdon, a detailed assessment of the potential for an intermediate mode route along the A4020 Uxbridge Road between Uxbridge town centre and Shepherds Bush.

This assessment followed on from a number of previous studies that had reduced a list of nearly fifty potential corridors and areas suitable for intermediate modes in outer London down to the most promising four, including the Uxbridge Road. A major factor influencing the decision to carry out a detailed evaluation of the Uxbridge Road intermediate mode route was the support offered by the relevant Local Authorities, in particular their willingness to consider the re-allocation of highway capacity along this corridor in favour of the mode.

The aim of this engineering and economic feasibility stage – known as the Project Definition stage – was to produce an assessment of the costs and benefits of providing an intermediate mode route along the Uxbridge Road, in order to help LT's successor – Transport for London (TfL), the local authorities and other stakeholders to decide whether or not this project should proceed to the next stage of development. A further aim has been to define in more detail, the types of traffic management measures that would be required to provide the intermediate mode with a significant level of priority over private road vehicles and to help the local authorities understand the impacts of introducing these measures.

- An introduction to intermediate modes
- A summary of the work carried out to date on intermediate modes in London
- A description of the objectives of the Uxbridge Road Transit project
- A description of the development of the project
- A description of the public transport and highway impacts of the project
- A description of the construction and operating cost impacts of the project
- A summary of the results of the evaluation of the project
- Conclusions and recommendations
- A discussion on the proposed way forward for the project

2 What are intermediate modes?

London's public transport network is largely made up of heavy rail systems (Underground and Railtrack), bus services and taxis. However, throughout the world, a number of alternative transport modes, known as intermediate modes, are being introduced in a variety of situations, in a bid to improve the image and performance of public transport and to attract private vehicle users on to public transport. Intermediate public transport modes are those with costs and capacities lying between heavy rail and bus. They include light rail systems, tramways, busways (with and without vehicle guidance), trolley buses and unconventional bus technologies such as dual mode electric/diesel vehicles (duobuses).

Within London, the Docklands Light Railway (DLR - a fully segregated automatic light railway) and Croydon Tramlink (light rail with street running) are examples of intermediate modes. Outside London, new light rail systems have been constructed in Manchester, Sheffield and Birmingham, while guided buses run in Leeds and Ipswich. Recently, the Manchester light rail system (Metrolink) was extended and construction of a new light rail system serving Nottingham has commenced. Following the successful introduction of sections of guided busways in Leeds, plans are now being developed to extend this system to other parts of the city.

Although intermediate modes have a wide range of characteristics, there are no hard and fast rules in assessing which is the most appropriate in any given situation and as a result, in every case, individual site characteristics, local policy objectives and priorities need to be taken into account in selecting the preferred type. For example, with levels of emissions, diesel vehicles produce particulates at source, while electric vehicles are emission-free at the point of operation. However many electric vehicles impose environmental intrusion by requiring overhead electrification equipment in the streets while the construction-related impacts of some fixed track systems are very high.

Light rail – Croydon Tramlink

Guided light transit – Paris

Guided bus – Rotterdam

3 Background to intermediate mode studies

There is now widespread support for the improvement of public transport in London and the provision of an attractive alternative to the car, within the context of improved accessibility and sustainable economic development.

Within this policy context, the importance of the bus, both in terms of the number of passengers carried and its inherent flexibility in meeting a wide range of transport roles, has been firmly acknowledged in recent key policy documents. The development of the Priority (Red) Route network, on trunk and main roads, and the London Bus Priority Network (LBPN), on main and secondary roads, has formed the basis of a London-wide strategy to protect buses from the worst effects of congestion.

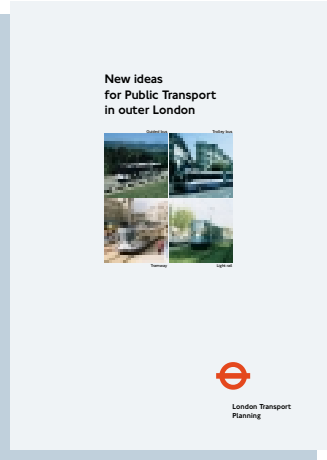
Whilst the Priority (Red) Routes and LBPN programmes are already delivering significant benefits to passengers, these programmes have been limited by the degree to which it has been deemed acceptable to restrain other road users. Local authorities however, are now required to prepare statements on how they will reduce traffic and improve air quality in their areas and are now developing measures to achieve this.

These measures will allow road space to be re-allocated in favour of public transport and permit the introduction of more radical forms of priority. Although this approach is often portrayed as being an attempt to 'punish' car drivers, in reality it reflects the fact that the level of priority given to surface more space efficient public transport primarily determines its performance and therefore its attractiveness as an alternative to the private car. As a result, although road space re-allocation may cause some delays to car users, it should also lead to an overall improvement in both the efficiency of the transport network and the environment.

Tram only street – Strasbourg

Bus priority – Shepherd's Bush, London

New ideas for Public Transport in outer London

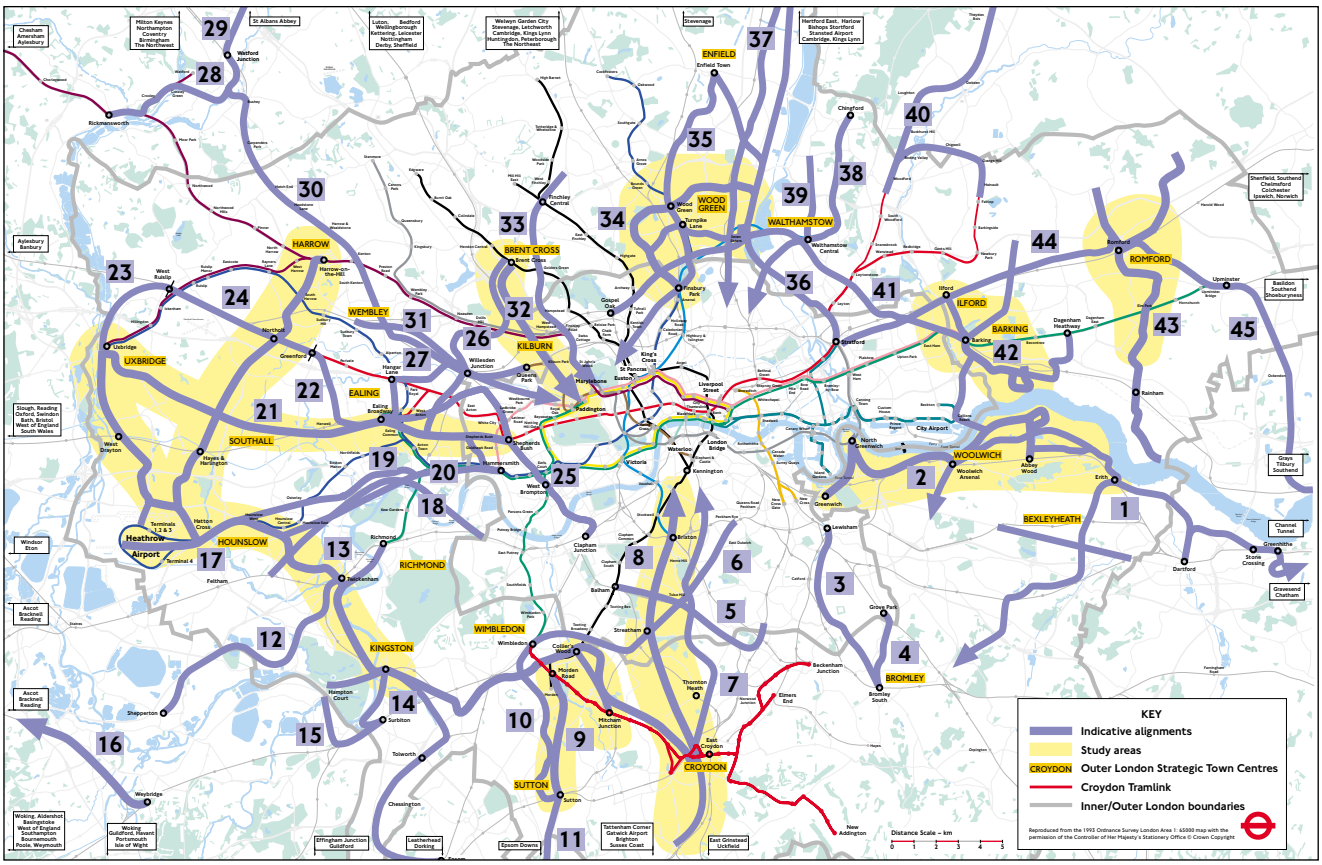


In 1994, faced with a growing willingness from both national and local politicians to consider in principle the issue of road space re-allocation, along with the successful implementation of the Docklands Light Railway (DLR) and the development of the Croydon Tramlink project, LT commenced a strategic review of possible areas and transport corridors in outer London that might benefit from the introduction of intermediate modes. Outer London is currently the area of London of greatest challenge to public transport – residential densities are low, car ownership and use are high and growing, trip patterns are diverse and the public transport market share is the lowest in London.

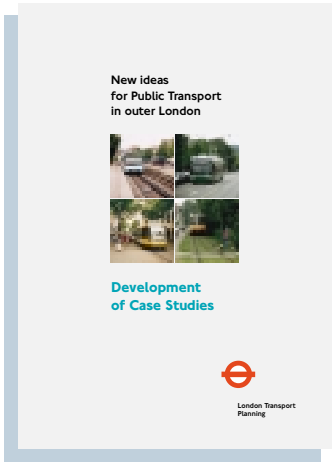
Through consultation with the outer London Boroughs and analysis of present-day demand on the bus and rail networks, around 60 ideas were generated which were then grouped into 45 areas for review. These 45 areas were then assessed for their potential for intermediate modes, using a largely qualitative method and comparative framework, against indicators agreed with the local authorities.

In June 1995, LT published the report *New ideas for Public Transport in outer London* which identified the nine most promising areas for intermediate modes in outer London and recommended that these should be assessed in further detail.

Intermediate Modes in London: initial corridors for review



New ideas for Public Transport in outer London – Development of Case Studies



The nine case studies identified in the 1995 report were developed to a greater level of detail by LT in 1996. For each of the areas, outline engineering design and cost estimation work was carried out and demand forecasts and preliminary environmental impact assessments produced. As in the previous study, the various schemes were assessed on a consistent basis against agreed objectives, which were developed in consultation with the relevant local authorities and from current policy objectives.

The results of the studies into the nine case studies were published by LT in September 1996 in *New ideas for Public Transport in outer London – Development of Case Studies*. This study concluded that overall there appeared to be a strong case for investment in intermediate modes in a number of these study areas:

Study area	Conclusion
Thamesmead/ Greenwich	High potential for segregation in development areas, consider bus-based system
A23 corridor	Consider track-based system, but major roadspace re-allocation problems. Consider Underground extension.
Edgware Road	Consider track-based system, but roadspace re-allocation problems
Wood Green	Consider bus-based system
Barking	High potential for segregation in development areas, consider bus-based system
Tramlink extensions	Consider track-based extensions to Purley Way and Sutton
Heathrow Orbital	Consider bus-based system
Uxbridge Road	Consider track-based system
Romford	Consider bus-based system

"The general performance of the (Uxbridge Road) options in meeting the identified objectives is relatively positive, with the maximum priority option performing well. This would attract high levels of demand and could potentially justify investment in a track-based system, assuming a significant level of priority is achieved. A future strategy should seek to improve conditions for existing and potential public transport users and pedestrians. It should build on the significant bus priority works in place and those planned".

Source: Conclusions on Uxbridge Road intermediate mode schemes: New Ideas for Public Transport in outer London – Development of Case Studies LT 1996

Following the publication of *New ideas for Public Transport in outer London – Development of Case Studies*, LT carried out a consultation exercise with the affected local authorities to gauge their reaction to the report and decide how to proceed further.

It was recognised that it would be impossible to proceed further with all these schemes at the same time and that their success depended upon local authorities agreeing to consider seriously the issue of road space re-allocation from private to public transport. As a result, it was stipulated that schemes would only proceed further if local authorities would give this commitment towards roadspace re-allocation as well as contributing to the financial cost of further planning work on the projects.

At the end of this consultation process, four of the study areas were identified for further development work – Barking, Romford, Uxbridge Road and Thamesmead/Greenwich. This further development stage, the 'Project Definition' stage, commenced in late 1997 under the joint control of LT and the relevant local authorities. The aim of this stage in the project was to identify the detailed traffic management issues required to secure the priority for the intermediate mode and to produce a detailed

assessment of the likely costs and benefits of constructing the intermediate mode.

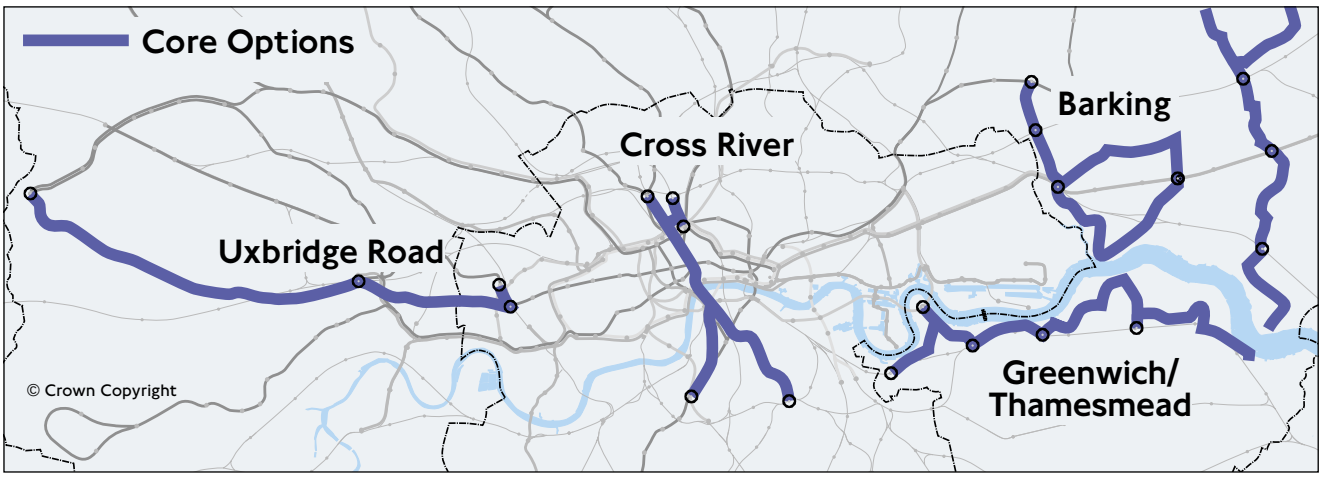
Barking and Romford schemes were merged to form a combined network called "East London Transit." Along with these three outer London projects, TfL has also developed the central London Cross River Transit project. This intermediate mode project would run between Waterloo and Euston, with two extensions on the southern end to Peckham and Stockwell and two extensions at the northern end to Camden Town and King's Cross. This project has been developed to the same level of detail as the four outer London studies and is the subject of its own report.

In January 2001, all four intermediate mode projects were included within the Mayor's draft transport strategy for London. This document expressed support for the principle of these projects as well as recognising that their implementation would require further detailed planning and consultation.

London Bus Initiative

Apart from the intermediate mode studies discussed here, other projects are under way to enhance the attractiveness of bus travel in different parts of London. The most significant of these projects is the London Bus Initiative (LBI) which aims to improve the quality of bus travel on 27 strategically important bus routes, collectively called BusPlus routes. In the Uxbridge Rd, route 207 has been identified as a "Quality Whole Route" for which enhanced priority measures are being developed. Under this project, each of these routes will have a combination of measures applied which as well as bus priority measures may include the introduction of higher quality bus vehicles and bus stops as well as improved driver training. A number of these BusPlus routes serve corridors such as the Edgware Road and between Harrow and Heathrow Airport which were examined as part of the earlier strategic intermediate mode corridor studies and identified as having significant potential.

Intermediate Modes in London: schemes identified for Project Definition stage in 1997



4 Objectives

At each stage of the study of the potential for intermediate modes in outer London, an objective led evaluation framework was used to test the performance of the different possible schemes against the planning and transport objectives for the area.

In the case of Uxbridge Road Transit, the objectives for the project were developed in consultation with the London Boroughs of Ealing, Hammersmith & Fulham and Hillingdon and from current policy documents such as Unitary Development Plans (UDPs). Although they are interrelated, these objectives can be broadly divided into planning and transport related areas.

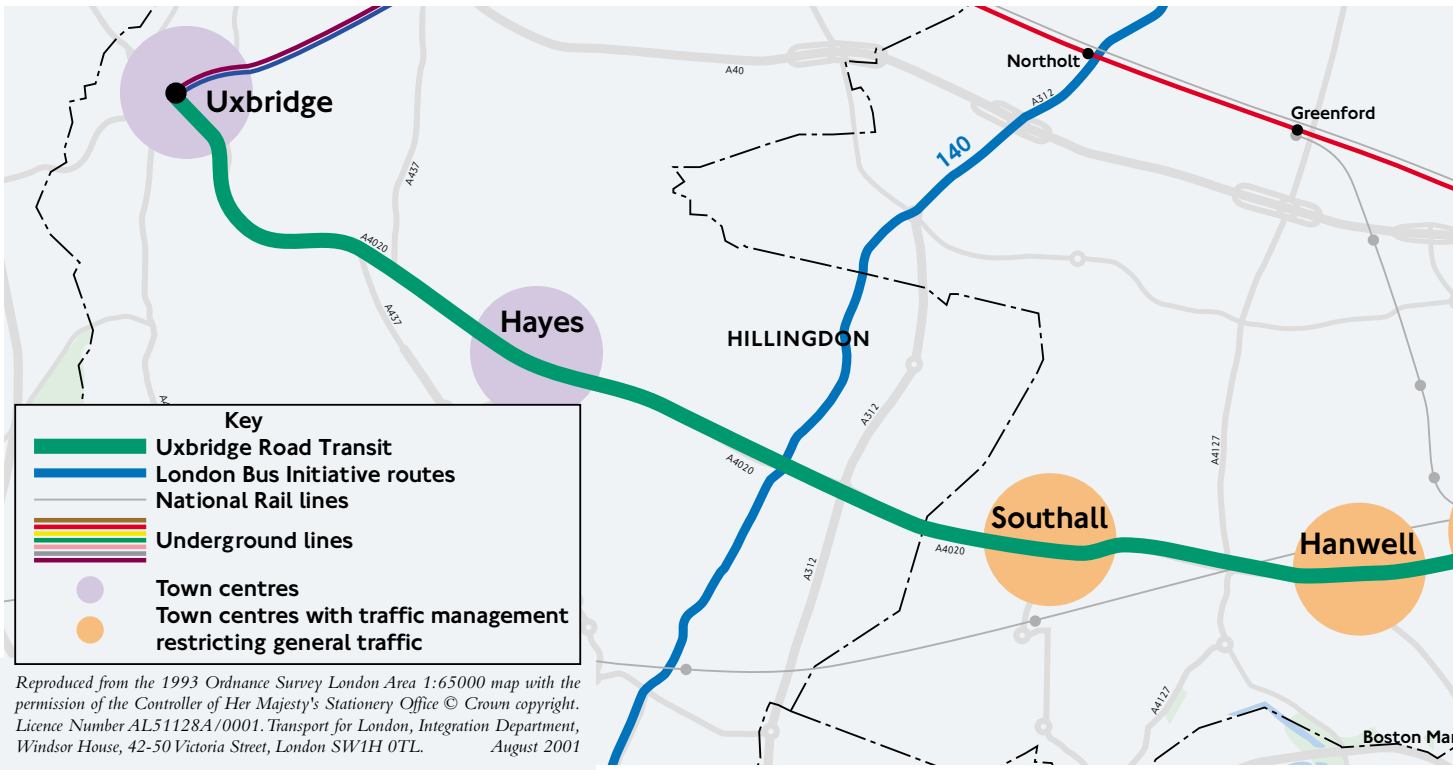
Planning objectives

- To improve general public transport accessibility in the local area
- To improve the environment
- To support the economic activity of local centres

Transport objectives

- To improve safety and transport quality in the local area
- To improve the transport efficiency of the area
- To provide a cost effective and worthwhile strategy

In order to determine the alignment to be evaluated, local centres were



identified using the London Planning Advisory Committee's (LPAC) definition of Strategic Town Centres with additional inputs from the relevant local authorities, who also identified development sites, transport nodes and other centres such as hospitals and universities.

Key centres identified along the Uxbridge Road are shown in the map below.

Within their Unitary Development Plans, each Borough sets out its policies and proposals for the development and use of land, including those relating to transport and traffic management.

The Unitary Development Plans of each of the affected Boroughs emphasise the importance of promoting sustainable development along the Uxbridge Road corridor through enhanced accessibility, particularly by public transport. In addition, a major theme of each of the UDPs is both the preservation and development of a range of shopping facilities on the Uxbridge Road. Other policies and proposals of the Boroughs aim to improve the quality of the overall environment in the area as well as providing equality of opportunity to residents, including improved mobility for the mobility impaired. In addition, each of the affected Boroughs recognise that new developments should be located in areas of high public transport accessibility and that attractive public transport services should be provided to these areas in order to reduce dependence on car travel.

The Transit alignment studied in the Project Definition stage of the project is similar to the core alignment shown in the earlier 1996 report and would run on the Uxbridge Road corridor between Uxbridge town centre and Shepherd's Bush. The route of the alignment is shown in the above map.

Study objectives

In general terms, the aims of the Project Definition study were to determine the economic, planning and engineering feasibility of Uxbridge Road Transit. Economic and planning feasibility including environmental impact have been taken to represent a wide spectrum of aspects, which have been incorporated within a Multi-Criteria Assessment Framework (MCAF). Engineering feasibility aimed to encompass all aspects of the physical impact of the route and stops, including terminal facilities and the depot, on the highway network and its users, as well as on property.

The study aimed to develop the scheme in sufficient detail only to establish this feasibility to a reasonable level of confidence and has not attempted to comprehensively cover all aspects of the project definition. It was recognised from the outset of the study, that some issues would need to be addressed during future, more detailed stages of development of the scheme, if this assessment indicated that Uxbridge Road Transit should be developed further.


Shepherd's Bush


West Ealing


Ealing Town Hall

5 Development of the scheme

Vehicle and technology options considered

For the initial stages, the study focused on the development of the route and stop locations, rather than the vehicle technology and details of service levels which would be justified in the corridor. The development work therefore proceeded assuming two broad alternative concepts for the intermediate mode: a tram/light rail based technology and a bus-based technology that would incorporate a guidance system for vehicles if and where necessary. The performances of two separate bus-based options were evaluated in this study - one using articulated trolley buses and the other high quality diesel buses.

Scoping study

Although the study adopted an open mind on the kind of technology assumed to operate in the corridor, from the outset it was recognised that there were sections of the Uxbridge Road where there would be problems with introducing a fully segregated route within the existing roadspace. It was therefore decided to carry out a scoping study to identify these difficult sections designated "hot spots" and to explore a range of options for providing maximum achievable priority for Transit while maintaining reasonable local access for other road users.

18m trolley bus

12 metre double decker diesel

Tram

A total of six hot spots were identified where the highway width would be inadequate to accommodate two lanes for Transit and two lanes for other road users and where some form of sharing either in time or space, would be necessary. The provision of these four lanes would require a minimum highway width of around 13.3 metres between kerbs or 17.3m between building lines assuming a pavement width of 2m. In addition, the incorporation of a cycle way would require an extra 2.6m width between building lines.

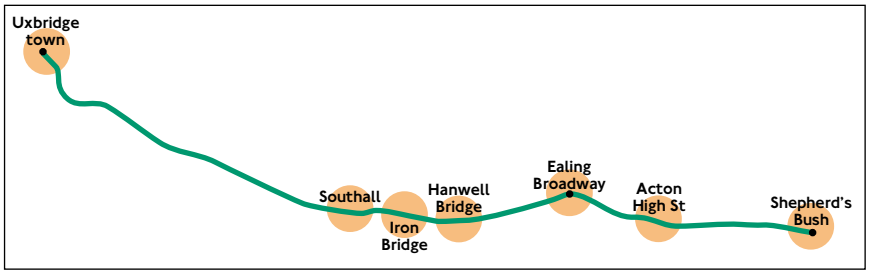
Distance between	Kerbs (m)	Building lines (m)
Shepherd's Bush	13	20
Acton High St.	8	13
Ealing Broadway	8	18
Hanwell Bridge	9	14
Southall	9	13
Uxbridge town centre	9	16
Minimum Required	13.3	17.3

As well as the six hot spots identified above, work was also carried out to establish how Transit would achieve priority through the complex and busy road junction at Iron Bridge.

The range of approaches considered in overcoming these hotspots included:

- reducing pavement width
- diversion in one direction of non-Transit/bus traffic
- traffic metering
- track sharing with Transit/bus
- complete closure except for Transit/bus

Hotspots



The acquisition of property to create more roadspace was in general considered unacceptable, apart from at a limited number of locations

The various approaches were studied against a range of priority levels for Transit covering a range between "maximum priority" in which Transit speed would be determined by vehicle performance, route geometry and stop spacing to "minimum priority" where Transit priority would be traded against the impacts on other road users. These two extremes provided estimates of the likely commercial speed of Transit which were later used to test the sensitivity of speed on Transit patronage. The highway measures considered necessary to achieve these speeds were also tested in terms of their impacts on other road users. By this iterative process, a preferred option designated "maximum practicable priority" was identified for the route through the hot spots.

In designing the traffic management measures, the fundamental aim has been to discourage more long distance traffic from passing through the hot spots, while maintaining reasonable access for more local journeys for both parking and the servicing of businesses.

The study has assumed that if a feasible solution could be identified for each of the hot spots, then remaining sections of route would not present any insurmountable difficulties. These other sections of route have therefore been developed in only enough detail to enable reliable running speeds, stop locations and costs to be identified for the purposes of the evaluation.

Description of route through hot spots

Shepherd's Bush

Transit would run in both directions on the north side of Shepherd's Bush Green. Other traffic, apart from buses and local access traffic, would be diverted either round the south side of the Green or on a new route via Arial Way, constructed as part of the new White City development. An alternative option would require Transit to circumnavigate the Green with the existing traffic, but within a segregated lane. This latter option would avoid the need to divert eastbound traffic from the north side of the Green.

West of the Green, Transit would negotiate a narrow section of the Uxbridge Road and serve a stop with staggered platforms just west of the Hammersmith and City Line station. For the section of route as far as

Bloemfontein Road, Uxbridge Road would be restricted to westbound traffic only with the eastbound direction diverted via Askew Road and Goldhawk Road. An alternative option retaining 2-way general traffic by reducing pavement widths is also being considered. Further west, the road width is adequate to accommodate two lanes for Transit and bus services on the north side of Uxbridge Road and two for other road users on the south side.

Shepherd's Bush (at the Hammersmith and City Line)

Acton High Street

Since Acton High Street is only 8m wide, the only realistic way that Transit could secure adequate priority would be to close the road to all vehicles, apart from Transit and buses. This would be achieved just west of the junction with Market Place and Church Road where all traffic apart from Transit and buses would be prohibited from driving between the two Transit platforms. Access to Uxbridge Road would be maintained however for parking and servicing and specially designated routes would be signed to route vehicles to and from parking/servicing spaces alongside the Transit route. A survey of the route revealed there would be substantial scope for increasing the number of businesses with rear servicing.

Acton High Street

Ealing Broadway

At Ealing Broadway, Transit and westbound traffic only would use the Uxbridge Road while eastbound traffic could be diverted via St Leonard's Rd, Carlton Road, Castlebar Rd, Haven Green and Madeley Road. An option to permit some eastbound traffic to be retained by sharing roadspace with Transit in the Uxbridge Road using traffic metering is also being developed at present.

A further option would be to also exclude westbound traffic from the Broadway and provide a diversionary route via The Common, The Grove (alternatively Grange Road) and Mattock Lane. However, the impact on these residential streets would need to be considered carefully and would only be likely to be acceptable if the diverted traffic were limited to local traffic.

The pavements within the Broadway would be widened to enable the environment for pedestrians to be improved. In addition, proposals are being developed independently of the Transit study to dramatically improve the interchange and pedestrian environment at Ealing Broadway Station. These proposals may also have a substantial impact on through-traffic passing the front of the station.

Transit in both directions would serve stops located opposite The Broadway which would minimise the walking distance to Ealing Broadway Station as well as ensure that it was visible from the Transit stops.

Traffic management measures would aim to direct local traffic to the nearest car park on either the north or south side of the Uxbridge Road, thereby eliminating the need for traffic to traverse the transit route in searching for a parking place.

Ealing Broadway

Hanwell Bridge

At Hanwell Bridge additional roadspace would be created by constructing a new bridge over the River Brent on the south side of the existing bridge. An

alternative would be to relocate the pavements onto a footbridge.

Westbound traffic would be diverted via Boston Road and Lower Boston Road enabling the Uxbridge Road to be restricted to Transit and eastbound traffic only. West of Hanwell Bridge, alongside Ealing Hospital, Transit would take over the present-day westbound side of the dual carriageway.

Hanwell Bridge

Iron Bridge

At Iron Bridge, Transit would be provided with absolute priority over all other traffic. This would be achieved by using traffic signals to hold all other traffic while Transit passed under the bridge. To reduce the impact on other traffic and to ease its flow, a traffic management scheme would be introduced. The existing ban on all right turns from the Uxbridge Road into both Windmill Lane from the west and Greenford Road from the east would be retained. Traffic from Uxbridge Road requiring to make these movements would make a "U turn" in a specially enhanced facility on either side of the Iron Bridge before making a left turn from the Uxbridge Road.

Iron Bridge

Between the Iron Bridge and Southall, Transit would take over the eastbound direction of the dual carriageway.

Southall

It is recognised that, because of the limited roadspace available, Southall is one of the most difficult sections of the route to achieve full segregation and priority for Transit. However, a number of options have been developed which would provide varying degrees of priority for Transit.

The preferred option assumes the complete closure of the Uxbridge Road to all through-traffic apart from Transit and buses immediately east of the junction with Lady Margaret Road and South Road. Between this point and the junction with Ruskin Road, immediately east of the Grand Union Canal, Transit would be run alongside the pavement on the southside of the carriageway leaving sufficient space for other road traffic on the northside of the road in an eastbound direction only.

Eastbound through-traffic on the Uxbridge Road would be diverted via Dane Road, Caryle Avenue, Burns Avenue and Dormers Wells Lane, while westbound traffic would be diverted via Avenue Road, Cambridge Road, South Road, Beaconsfield Road and Ranelagh Road. Alternatively a Southall bypass route to provide access to the former British Gas development site could be used as a diversionary route for general traffic. A route for access traffic to the centre of Southall would be provided from the west in an eastbound direction only and would leave the Uxbridge Road by turning either north or south at the junction of Lady Margaret Road and South Road.

It is recognised that some of the above mentioned roads would not be suitable for more than access traffic and longer distance traffic is assumed to reroute further afield. However, there is the possibility of a more substantial by-pass route being developed which would provide the dual role of providing access to a number of potential development sites

Southall

adjacent to the National Rail Network mainline as well as a bypass for through traffic between the Hayes Bypass and Windmill Lane at Iron Bridge.

Uxbridge Town Centre

At the junction of Hillingdon Road and Uxbridge High Street, Transit would cross the centre of the roundabout and enter Uxbridge High St using the centre of the road. Between the roundabout and the junction with Vine Street, Transit would share road space with other road users, while west of Vine Street, Transit would run through the pedestrian zone as far as the Underground station. A single stop would be provided to serve both the Civic Centre and the new Chimes Shopping Centre.

Uxbridge town centre

Terminal facilities

At its eastern end, Transit's terminus would be located adjacent to Shepherd's Bush Central line station which would be developed as a major interchange for Underground, National Rail Network (the West London Line) and bus services as well as for taxis, cyclists and pedestrians. This interchange would provide a major point of access to the proposed new development at White City. With the tram option, Transit would terminate at an island platform, allowing passengers waiting on the platform to be directed to the first tram to depart. With the trolley bus option, Transit would either reverse via a turn-round facility located just north of the interchange or alternatively, continue via the eastern access road and terminate and turn-round within the new bus station serving the development.

At its western end, the Transit terminus would be located adjacent to the Uxbridge Underground station. With the tram option, Transit would terminate and reverse in an island platform located immediately in front of the Underground station. In the case of the trolley bus option, Transit would continue eastwards and turn-round by either using the Harefield Road roundabout or the one-way route through the existing bus station and Baker's Yard.

Vehicle options

For the tram option, a relatively onerous case in terms of vehicle loading gauge was adopted based upon the vehicles used for Manchester Metrolink. The maximum capacity of a 40 metre long vehicle was assumed to be 288 passengers. For the bus-based technology, articulated guided trolley buses with a capacity of 120 passengers were assumed, while the diesel bus option assumed the use of double-deck Euro III low floor buses with a capacity of 80 passengers.

Guidance

It has been assumed for the purpose of the evaluation, that the trolleybus option would be guided throughout its length by an electronic guidance system. This system would consist of a cable buried in the road emitting a signal which would be picked up by detectors mounted within the vehicles and which would control the Transit vehicle steering mechanism.

Guidance is seen as having a role in improving both Transit's ride quality and the accuracy of "docking" at stops. A further benefit of guidance would be in providing improved safety for pedestrians by defining a clear "swept-path" for the vehicles that could be marked on the roadway. There are also options to restrict guidance to sections of the Transit where pedestrian safety is a major issue.

It should be noted that electronic guidance is a new technology and remains unproven in a passenger-operating environment. As a result, considerable research into its development needs to take place. There is therefore considerable uncertainty about the future availability of this technology within the timescale of this scheme.

Fares and ticketing

At this stage of the project's development, the precise fare structure of Transit has not been determined, although the evaluation has assumed average fares similar to those currently charged for the existing public transport network.

It is planned that Transit tickets would be available from ticket vending machines located at stops as well as from a range of convenient outlets such as newsagents, Underground stations and travel information centres.

Stops

High quality stops would be provided at an average spacing of around 475 metres apart from the diesel bus option which would retain the existing Route 207 stop spacing. Stops would consist of a raised platform, 300mm above road level, and a maximum of 40 metres in length. With the exception of the termini, most stops would have side platforms that would be incorporated as part of the pavement where space was limited. Stops would be furnished with a range of equipment including ticket machines, CCTV surveillance, real-time and fixed travel information, shelters with seats, and a passenger security alarm system.

Busway – Trans Val de Marne, Paris

Depot facilities

There are a number of options being considered for the location of the depot required to both service and maintain the vehicles, as well as accommodate the vehicles when not in service. The evaluation has assumed that the depot would be located in Southall in the former gas works site, south of the Uxbridge Road. The depot would be accessed via a single-track link adjacent to the Hayes Bypass or via Beaconsfield Rd and a new bridge over the Grand Union Canal. This bridge would be shared with a new general-purpose road proposed to provide access to the development site.

Integration with existing bus and rail services

The evaluation of the scheme has assumed that the whole of bus routes 207 and 607 east of the Hayes Roundabout would be replaced by Transit. Because the bus network is continually being developed to match changing demand, it is impractical to attempt to define the precise pattern of future bus services at this stage of the scheme's development. Therefore, for the purpose of the evaluation, it has been assumed that all other bus routes in the study area would remain unchanged following the opening of Transit and some bus routes would run in parallel with Transit. However, at the time that the Transit system would open, it is envisaged that the existing bus network would be modified to ensure it would complement rather than compete with the Transit service. These modifications would include any bus service alterations necessary to cover any "gaps" created by the removal of routes 207 and 607.

In principle, bus services would be able to share the alignment with Transit and thereby benefit from the priority measures. However, to avoid Transit being delayed by bus services due to differences in stop dwell times, conventional bus services would use separate stops located clear of the Transit way. Buses could however in some situations be delayed by Transit at stops. The operability of combined bus and transit services would need to be fully investigated at the stage of developing the bus network.

Rail and Underground services would continue to serve key interchanges such as Uxbridge, Ealing Broadway, Ealing Common and Shepherd's Bush Metropolitan and Central line stations. As far as possible co-ordinated passenger information and services would be provided between bus, rail and Transit modes.

Ealing Common Underground station

6 Estimation of public transport and highway impacts

The transport impacts of the scheme were assessed using a highway model working in tandem with a public transport demand model. Linkages between these models allowed an iterative process to be developed which estimated the impacts of the improvements to the public transport network and associated highway traffic management measures on modal shares and demand patterns on both networks. These impacts were assessed for a range of options, including sensitivity tests.

LT commissioned the construction of a forecasting model to predict the likely passenger demand for Transit services on the Uxbridge Road. This model, which was based upon the existing LT/TfL Railplan model, was validated against observed 1995/97 ridership data for both bus and rail networks, and then factored up using assumed growth rates to represent year 2003. The model was used to predict demand in both the morning peak (0700-1000) and interpeak (1000-1600) periods.

In a similar way, LT also commissioned the construction of a model to predict the impact of Transit on highway flows within the study area. This local model was based upon the existing London-wide NAOMI model, which was developed in a similar way to the passenger demand forecasting model.

In order to link the demand forecasting and highway impact models, a mode-split model was also developed to assess the impacts on both Transit and highway flows of changing the relative costs of travelling by public and private transport. This model was used to predict, for example, the reduction in highway trips that would be expected to occur in the study area by the increased private vehicle journey times generated as a result of the Transit priority measures introduced on the Uxbridge Road.

A number of sensitivity tests were carried out to explore the impact of a range of Transit service speeds and service levels on passenger demand for Transit, as well as the effect of a range of traffic management measures on highway flows in the study area. These sensitivity tests were carried out for all three Transit technologies and for both the morning peak and interpeak time periods.

This analysis resulted in the identification of a preferred option for each of the three possible Transit modes. These preferred options were considered to provide the best balance between maximising passenger benefits of public transport users, while at the same time minimising highway disbenefits. These preferred options, which were later evaluated using a multi-criteria approach, were also defined in terms of service levels and vehicle capacities, adopted to ensure acceptable Transit passenger load factors. These definitions are shown in the table below:

Service pattern for preferred options

Transit option	Vehicle Capacity	Route Section	Am Peak Vehicles per hour
Diesel			
Route 607	80	Uxbridge to Shepherds Bush	6
Route 207	80	Uxbridge to Acton	10
Route 207	80	Hayes to Shepherds Bush	20
Trolley bus			
	120	Uxbridge to Shepherds Bush	20
		Hayes to Shepherd's Bush	10
Tram			
	288	Uxbridge to Shepherd's Bush	10
		Hayes to Shepherd's Bush	10

Estimation of transit run times

In order to derive the preferred Transit options, it was necessary to estimate the likely commercial speeds that could be expected to exist along the Transit alignment. These speeds were derived from a specially constructed run-time model and was also used to calculate the number of vehicles that would be required to operate each of the Transit service options.

This run-time model used as its inputs the key aspects of the Transit route design such as track alignment and stop spacing, Transit vehicle performance as well as the proposed junction and traffic management measures and pedestrian zones to produce estimates of travel times for each section of route. This model predicted that the estimated commercial speeds for the tram and trolley bus options would be 22.7kph, and 21.6kph (Rt 607) and 17.3kph (Rt 207) for the diesel bus option. The diesel bus option for Rt 207 was assumed to have a lower commercial speed due to the higher number of stops (77 versus 36) and the longer stop dwell times associated with the fewer number of doors.

7 Estimation of construction and operating costs

Both construction and operating costs were estimated for the preferred options outlined in the previous section. In addition, the production of these costs was part of the process required to identify the preferred options in that net revenue, which includes operating costs for both Transit and the conventional bus network and vehicle cost estimates, were required for a range of service patterns considered.

Operating costs

Operating costs were estimated using an operating cost model that used inputs such as service patterns and speeds by time of day and day of week for each section of route to derive annual operating costs for the three Transit options. Changes in operating costs of the existing bus network were derived in a similar manner to produce estimates of changes in the combined Transit and conventional bus networks. These operating cost changes are shown in the table below:

Operating costs in £million pa

Option	Transit	Existing Bus	Combined change
Diesel bus	8.8	-7.0	1.8
Trolley bus	9.4	-7.0	2.4
Tram	9.5	-7.0	2.5

Capital costs

Land and property costs

It was assumed that land acquisition costs would only be incurred on those short sections where the Transit alignment would be located outside the highway, such as at the depot in Southall. The required amount of property acquisition associated with these sections of the Transit alignment were estimated and costed by LT Property. It is TfL's view that, with further development of the route and stop location, the extent of the land and property acquisition required for Transit could be reduced. It is proposed that this further level of refinement is incorporated into the next stage of the scheme's development.

Civils and trackwork

The main civil engineering structures on the route would be the new bridge across the River Brent at Hanwell and a bridge over the Grand Union Canal to reach the depot. With the exception of these structures, there would be limited sections of the alignment (around 3.3 kilometres) where the route would be located outside the existing carriageway and where new foundation/formation would be required. For the tram option a cost for trackwork of around £1.03 million per km has been assumed, while for the trolley bus option, the cost of resurfacing and burying guidance cable has been assumed to be £220,000 per km.

Utilities

Given that most of the alignment would be located on the existing highway, it would be necessary to relocate a substantial amount of the

utilities buried under the roadway. It has been assumed that in sections within the town centres - around 9 kilometres of the route - it would be necessary to relocate all the utilities for the tram option and 60 % of the total for the trolley bus and diesel options at an estimated cost of £4m per kilometre.

Power supplies and overhead wiring

Power supply costs include estimates for providing transformer/rectifier units, DC feeders, overhead line supporting poles, single overhead line for trams and double for trolley buses, earth leakage protection and switchgear. Once detailed design work is undertaken, there may be opportunities to reduce the number of supporting columns required for the overhead electrification equipment, by using building fixings or utilising existing lighting columns.

Traffic management and signalling

Along the Transit route there are a number of junctions and traffic signals that would need to be modified to provide Transit and conventional buses with priority over other traffic. Costs incurred at these locations would include the provision of new traffic signals and vehicle detectors. Off the Transit alignment, a large number of traffic management measures would be required, associated with the traffic diversions and to discourage "rat-running" through sensitive areas. These measures would incur costs in providing signage, traffic signals, road and kerb re-alignments and road markings.

Vehicle costs

Vehicle fleet requirements were derived from estimates of the total forecast journey times for the Transit options, produced by the run time model. The estimates of fleet size include allowances for layovers at the end of the routes as well as different service frequencies on sections of the route. The table below shows the fleet size estimates adopted as part of the evaluation.

Estimated Fleet Size

Option	Peak Service Frequency vehicles per hour	Fleet Size
Diesel bus	16/36	136
Trolley bus	10/30	67
Tram	10/20	40

A vehicle cost of £1.4 million per unit was assumed for the tram option and £440,000 per unit for the trolley bus option. The assumed cost of the diesel bus was approximately £140,000.

Depot

Depot costs include the cost of buildings, trackwork, overhead power supplies, maintenance equipment and machinery and office equipment. The cost of the land required for the depot is included within overall land and property costs of the project. An area of 40,000 sq metres has been assumed.

Stops

The cost of each Transit stop including the construction of a raised platform and providing the shelter, CCTV surveillance, Countdown type passenger information, ticket machines and telecommunication link has been estimated at around £44,000.

TfL have derived initial capital cost estimates for the three Transit options. In addition, initial capital costs have been derived for the base "Do-minimum" situation that represents the capital costs that will be incurred in maintaining and developing the existing bus network in the area. These costs are shown, broken down into categories, in the table below:

Breakdown of initial construction costs (£millions)

	Base	Diesel	Trolley bus	Tram
Land and property	5.6	16.9	16.9	16.9
Utilities		21.6	21.6	34.9
Civils and trackwork		13.6	13.6	23.3
Stops		3.2	3.5	3.6
Power supplies		0	10.3	9.1
Signals and telecommunication		3.4	3.4	3.7
Vehicles	15.9	20.8	30.2	56.9
Depot (excluding land)	8.4	12.3	8.1	7.1
Traffic signalling		3.7	3.7	3.6
Road construction		2.2	2.2	2.1
Traffic management		2.1	2.1	2.0
Design & management	1.6	7.4	9.1	15.8
Contingency	2.6	9.2	10.6	16.0
Totals	28.5	116.4	135.4	194.9

Price Base = 1998

The depot costs reflect the vehicle fleet size (see table on page 27)

8 Evaluation

Outline of evaluation process

The evaluation of Uxbridge Road Transit has been carried out using a Multi-Criteria Assessment Framework (MCAF) developed by LT. Although the concept of multi-criteria assessment is not new, it is becoming accepted as a more-embracing evaluation technique than the conventional cost-benefit analysis approach, due to the recognition that many of the impacts of transport schemes are beyond monetisation and so must be excluded from cost-benefit analysis.

The use of multi-criteria assessment has been given added impetus by the Government's recent White Paper on Transport which emphasises the five strategic objectives of the Government transport policy – environment, safety, economic, accessibility and integration. These objectives are more wide-ranging than those that would be captured by more conventional evaluation methods. On the basis of these strategic policy objectives, the Government has devised a New Approach to Appraisal that summarises the achievement of schemes against these objectives. This allows a comparison to be made by decision-makers between schemes on a range of appropriate indicators that include, but do not give undue prominence to monetary ones. Initially devised for highway schemes, the New Approach to Appraisal has now been adapted for multi-mode situations, as documented in the Department of Environment, Transport and Regions' (DETR's) Guidelines on Multi-Modal Modelling Studies.

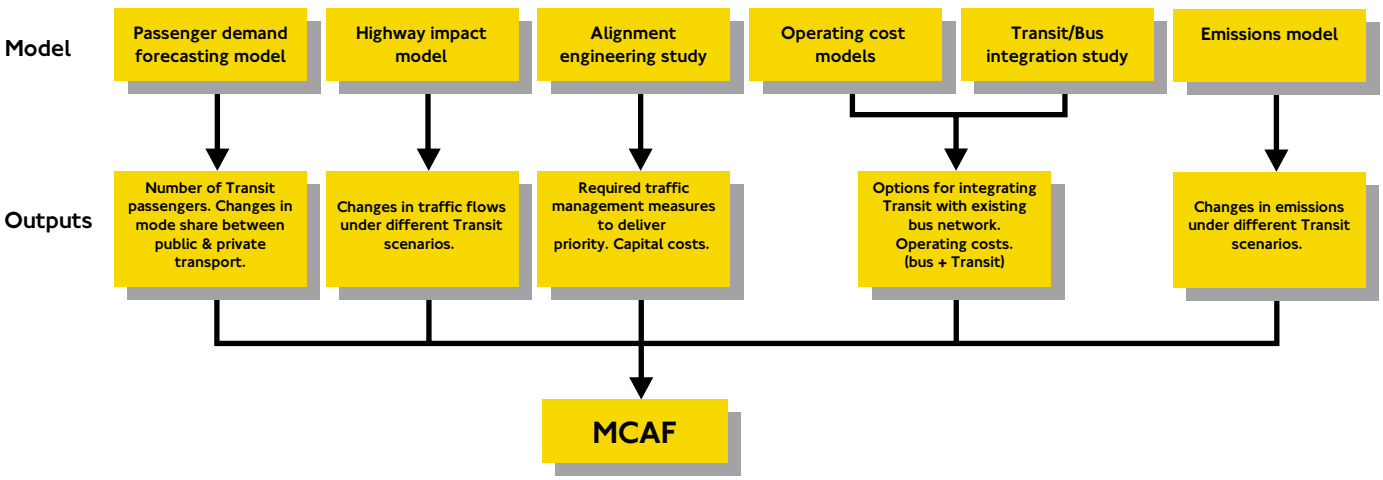
The MCAF was developed to be as consistent as possible with the Government's new approach, although a number of "bespoke" aspects

Ealing Broadway

have been introduced for its use in intermediate modes. The main appraisal criteria for the MCAF, along with selected indicators, are shown below.

MCAF criteria and indicators

Criteria	Sub-criteria	Indicators
1 Environmental impact	Natural environment	Noise, local air pollution, global emissions, energy and fuel consumption, land-take, townscape, ecology
2 Safety and security	Accidents and personal security	Public and private transport accidents, personal security
3 Economic	Costs, time savings and revenue	Capital and operating costs, public and private use, public and private journey times, revenue, cost-benefit analysis
	Transport capacity	Capacity of corridor, crowding, frequency
4 Accessibility	Public transport accessibility	Pedestrian access to public transport, access to local centres
	Accessibility to other modes	Community severance, pedestrian space, parking and servicing access
5 Integration	Integration with other modes	Interface with other modes
	Accessibility impacts on regeneration and social inclusion	Access to development sites, access to deprived areas, access to employment
	Other local policy/plans Regional economic impact	Local policies, tourism National/EU objectives



Results of evaluation

Environmental

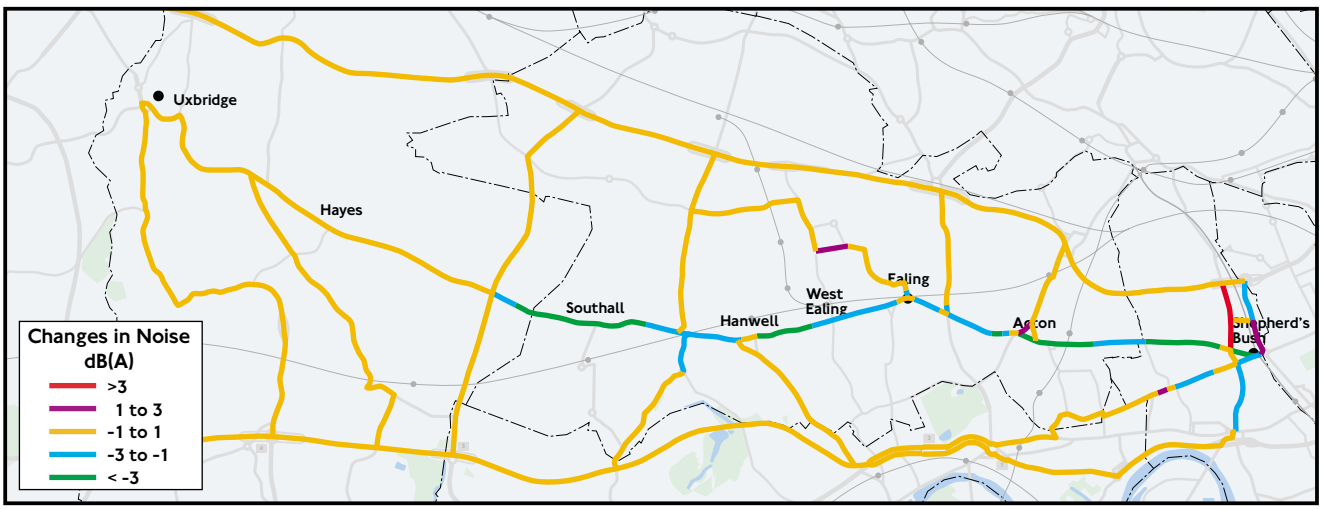
If not otherwise stated, the results shown refer to the tram option.

Noise impact

Traffic is one of the principal sources of urban noise. The results of the assessment show that the scheme would provide a large overall benefit in terms of road traffic noise impact, since a relatively high modal shift from private to public transport is forecast. However a number of residential properties would suffer from an increase in ambient noise levels associated with traffic displaced from the Uxbridge Road. Overall, the properties that experience a disbenefit, represent around 10 percent of those that benefit from a noise reduction. In particular, most of the Uxbridge Road would receive greatly reduced noise levels due to the traffic management measures introduced along the corridor, although there would be some areas of localised disbenefit on alternative routes to the Uxbridge Road.

The Transit vehicles used in the tram option would generate levels of noise considerably below the level at which any residents of adjoining properties would be annoyed by their operation. No assessment of the trolley bus option has been undertaken since the noise impact of these vehicles is less than for trams.

Summary of noise impacts



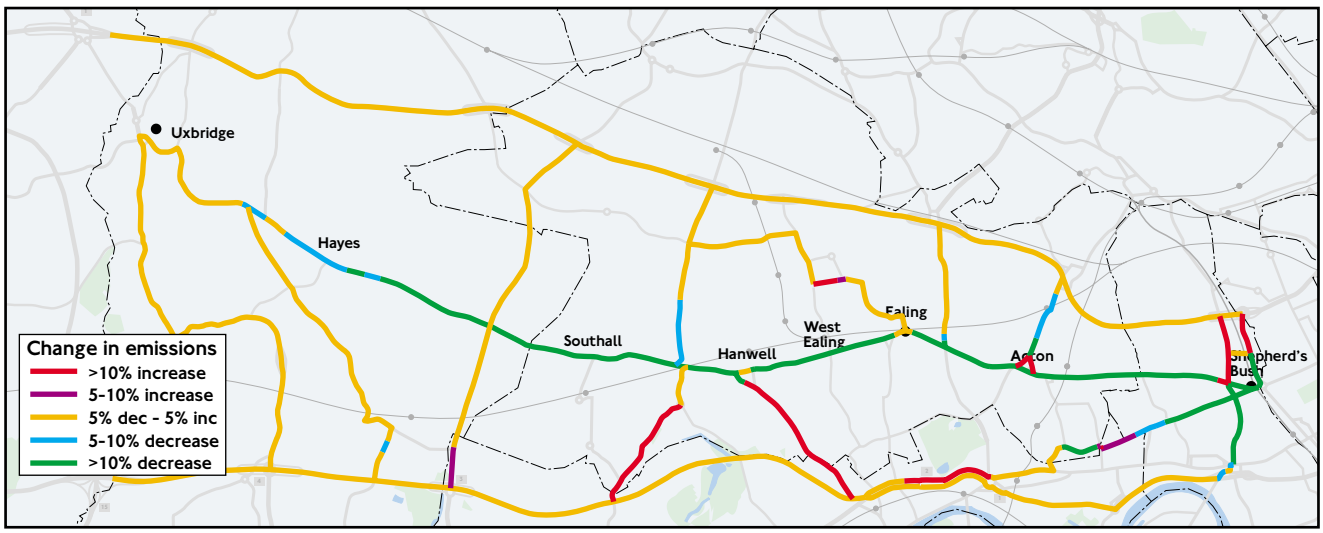
Local air pollution

Transport is a major producer of air pollutants. The main local pollutants included in the MCAF are carbon monoxide (CO), hydrocarbons (HC), nitrous oxides (NOx) and total particulate matter (TPM). Using TfL's Emissions Model, changes in emission levels have been calculated for the same selected roads within the study area as used for the noise calculations. Properties were selected on these roads where the change in emissions was calculated to be greater than 5%.

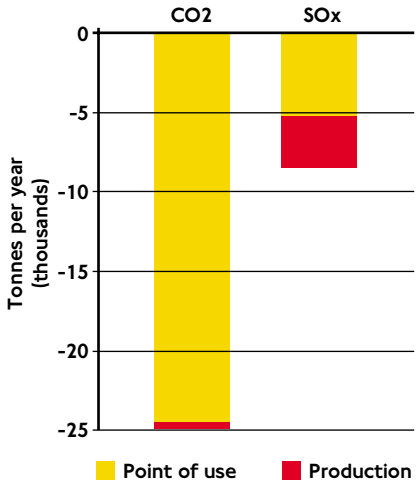
The analysis shows that Transit would reduce local pollution levels within the study area due to modal shift away from private to public transport. Particular benefit would be expected along the Uxbridge Road itself, due to the additional effect of traffic management measures along the road. However, this would also result in areas of localised disbenefit, as a result of traffic redistributing to other roads within the study area.

Overall a net reduction in local emissions is forecast to occur for each of the analysed pollutants. Based upon the average number of properties affected by each pollutant, it is calculated that there would be a net overall benefit to 8,650 properties in the study area. This is classified as a "large benefit".

Summary of local emissions



Changes in global emissions



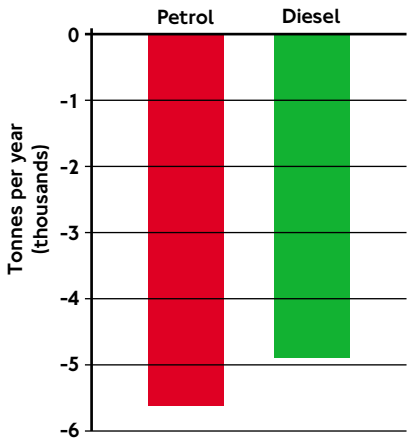
Global air pollution

Two important greenhouse pollutants are produced by road transport – carbon dioxide (CO_2) and sulphur oxides (SOx). Using TfL's Emissions Model, changes in global emissions have been calculated for Uxbridge Road Transit, based up on single electrically-powered option. Changes in global emission levels have been calculated for both the point-of-use (exhaust pipe) and production (power station) stages of the fuel cycle and include an allowance for the electricity generated to power Transit.

The assessment shows that emissions of CO_2 and SOx would decrease at both the point-of-use and production stages. Overall, Transit is forecast to result in a decrease of nearly 25,000 tonnes (4.5%) per year in CO_2 emissions and 8.5 tonnes (4.2%) per year in SO_2. These decreases are due to the forecast modal shift in the corridor from private travel to "cleaner" public transport modes.

In terms of their overall impact, these reductions are categorised as providing a "slight benefit" to global pollution.

Changes in fuel consumption



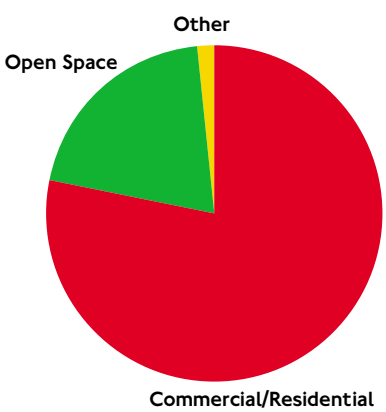
Energy and fuel consumption

Transport is a major and increasing user of energy, consuming about a third of all energy in the UK. The assessment of energy and fuel consumption examines the changes in transport-related energy and fuel consumption examines the changes in transport and fuel consumption, both at the point-of-use and production stages. Results for a single Transit assessment, measuring only private vehicle emissions, has been used in the MCAF.

Transit is forecast to achieve reductions in the consumption of petrol and diesel within the study area, which in turn would result in a reduction in energy consumed. This decrease in fuel consumption is due to the net modal shift from private to more energy-efficient public transport modes.

In terms of their overall impact, these reductions are categorised as providing a "slight benefit" to energy efficiency.

Land-take - existing land use of land taken



Land-take

Construction of Transit would involve a degree of land-take and property acquisition. In total, an estimated land take of 75,000m2 would be required, of which 50,000m2 would be required to provide the depot for the stabling and maintenance of the Transit vehicles. This estimate of land-take is based upon a common alignment for the three Transit options, which does not take into account differences in the turning radii and swept path requirements for each option. The selection of a non-tram mode would allow the land take requirement to be reduced, although it is acknowledged that this difference would be relatively small in terms of area consumed. Further detailed work on the development of the

alignment and location of stops is likely to reduce the required land-take for Transit.

The land for the proposed depot for Transit would use land that is currently in temporary use as a car park, while most of the remaining the land-take for Transit would be from the commercial land uses that predominate along the Uxbridge Road as well as some areas of open l and at Hanwell/Ealing and Acton.

Construction

Croydon Tramlink: overhead electrification in residential area

The construction of Transit would introduce impacts that may be significant for properties located along its alignment. The strength of these impacts will depend upon the nature of the construction work and its duration.

For Uxbridge Road Transit, the majority of the construction work would be associated with the introduction of the necessary traffic management measures along the alignment. In addition, work would be required to erect overhead electrification equipment for the tram and trolley bus options, the removal of utilities from the carriageway and the laying of rails for the tram option.

The MCAF concludes that nearly 4500 properties fronting the proposed alignment would be affected during the construction of the scheme. At this stage in the project, it has not been possible to estimate the length of time that these properties would be affected by the construction works. However, it is likely that the construction impacts of the tram option would be most severe both in terms of the nature and duration of the works required.

In addition to the 4500 properties directly affected by the construction works, additional impacts would be imposed on an unquantified number of road users due to road and lane closures and temporary traffic diversions during the construction phase of the project.

Townscape

The main townscape consideration when introducing transport schemes is to improve and protect buildings and areas, which, by their visual architecture or historical association, contribute to the local character.

The MCAF concludes that in spite of the visual impacts of the overhead cabling in the electrically powered options, Transit would have an overall beneficial effect on the townscape areas through which it passes, by enhancing a "sense of place", providing a feeling of better connectivity and amenity and also providing the scope for new landscaping to enhance the visual character of the area. In addition, reduced traffic levels and greater pedestrian space would lead to further benefits. It is concluded that these positive effects would be greatest in locations where the level of current townscape quality are poorest, such as Hayes End and Wood End,

as well as Acton and Ealing town centres were traffic congestion is severe and pedestrian space is of poor quality.

Ecology

Ecology is concerned with the conservation of wildlife species and their habitats.

The scheme has no direct impact on any of the ecological sites identified along the corridor including Brent Lodge Park and Dormers Wells Golf Course. However, the removal of traffic from the northern side of Shepherds Bush Green would result in a slight benefit to this Nature Conservation Area. However, the overall effect of the scheme has been classified as "Neutral".

Safety and Security

Accidents

The contribution of Transit to reducing accidents has been calculated on the basis of "equivalent fatalities". This is a standard measure whereby ten major and one hundred slight injuries are each deemed to equal one fatality. Changes in estimated levels of fatalities for both private and public transport have been calculated.

The results of the evaluation shown that the modal transfer from private to public transport and the corresponding reduction in the number of car journeys in the area arising from Transit is forecast to lead to an overall reduction in the number of road accidents. Based on data used in the assessment of highway improvements, it is estimated that the monetary values associated with these accident savings are between £170,000-£340,000 per year.

Lack of data has meant that it has not been possible to estimate the impact of Transit on the number of accidents involving cyclists and pedestrians. The impact of Transit on pedestrians is dealt with under "community severance (page 41), while for cyclists it is recognised that their needs must be fully taken into account in the detailed design of the project, should it proceed to the implementation stage.

Personal security

It is proposed that CCTV would be installed at all Transit stops and it is assumed that all Transit passengers switching from existing bus services, cars or newly generated trips would benefit in terms of increased security. However, it is assumed that Transit passengers switching from rail modes would not benefit any further, as security measures are already provided for them. For each of the Transit options, it is estimated that approximately 50 million passengers per year would benefit from improved perception of security with the implementation of CCTV.

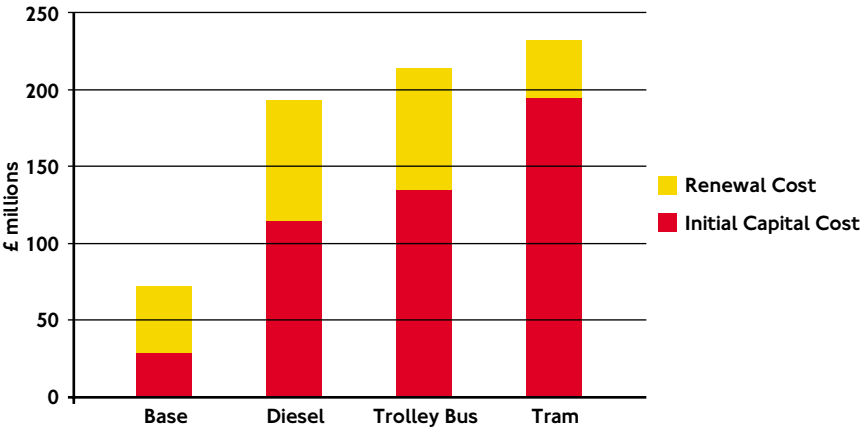
Economic

Capital costs

TfL have derived initial capital cost estimates for the three Transit options. In addition, initial capital costs have been derived for the base "Do-minimum" situation that represents the capital costs that will be incurred in maintaining and developing the existing bus network in the area. These costs are shown on page 28 of this report.

Scheme options: initial capital and renewal costs

Renewal costs are shown as undiscounted values
Price base = 1998



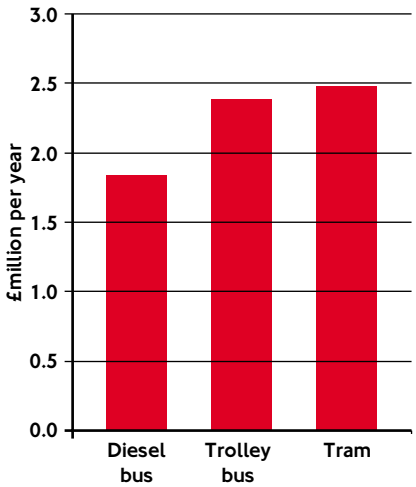
The major reason for the differences in the initial capital costs of the Transit options are the higher purchase cost of trolley bus and trams compared to diesel buses and the need to provide overhead electrification equipment for these options.

Further renewal and replacement costs would also be incurred during the life of the project, including the cost of refurbishing and replacing bus and Transit vehicles. These costs have also been estimated and together with the initial capital costs have been input into the cost-benefit analysis.

An overall assessment of the capital costs of the project show that the diesel bus option would be the cheapest of the options to implement while the tram would be the most expensive. However, the difference in cost of these options is greatest at the initial construction stage and narrows somewhat if the on-going renewal costs are taken into account. This is mainly the result of the longer vehicle lives of trams compared to buses.

The cost-benefit analysis has been carried out on the basis of the incremental cost of each of the Transit options; for example, the initial capital cost of the tram option relative to the base is £166.4 million.

Changes in annual operating costs



Operating costs

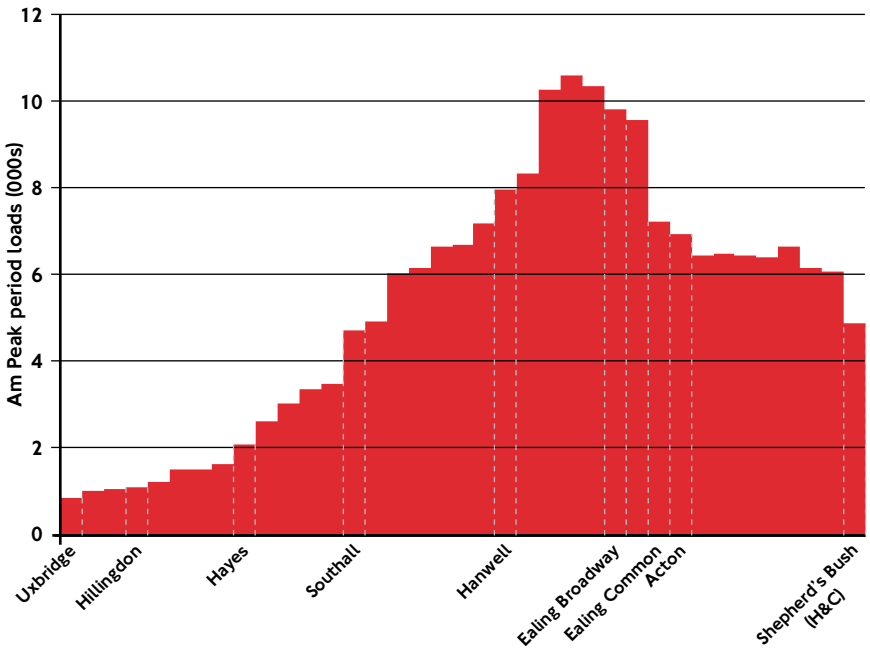
Operating cost for the Transit options are shown here as net changes in the cost of operating the current bus network in the study area and reflects the overall change in operating costs to both Transit and other bus services in the study area.

The assessment shows that net operating costs of Transit would be highest for the tram option and lowest for the diesel bus option.

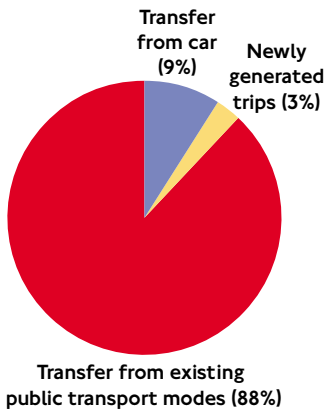
Transport use

The number of passengers predicted to use each of section of the Transit route in the morning peak period is shown below for the eastbound direction. The results predict maximum flows on eastbound and westbound Transit services of over 10,000 and 5,000 passengers respectively. Flows in both direction peak in the Ealing Broadway area and reflect the attraction of this area, both as an employment area and as a transport interchange.

Maximum flows, am peak



Origin modes of transport passengers



Although the majority of passengers on Transit would be existing public transport users there are also forecast to be additional public transport trips created, largely due to car drivers switching to public transport.

Apart from analysing the number of passengers using Transit services, transport use can also be measured in terms of passenger-kilometres travelled. Changes in passenger-kilometres travelled can be calculated for both public and private transport and as such, is a very useful measure of the effectiveness of policies to encourage a shift from private to public transport.

The results indicate that Transit would result in increases in public transport use of between 50 and 78 million passenger kilometres/year, while private transport use would reduce by between 45 and 67 million passenger kilometres/year. Overall, each Transit option would result in an increase in kilometres travelled by passengers, which in sustainability terms represents a disbenefit of the project. In terms of trips in the am peak period, the effects are as shown in the table below.

Change in overall demand (trips), AM peak period

	Public transport	Highway	Total
High quality bus	4,500	-4,000	400
Trolley bus	5,800	-4,550	1,250
Tram	7,350	-4,900	2,450

Journey time changes

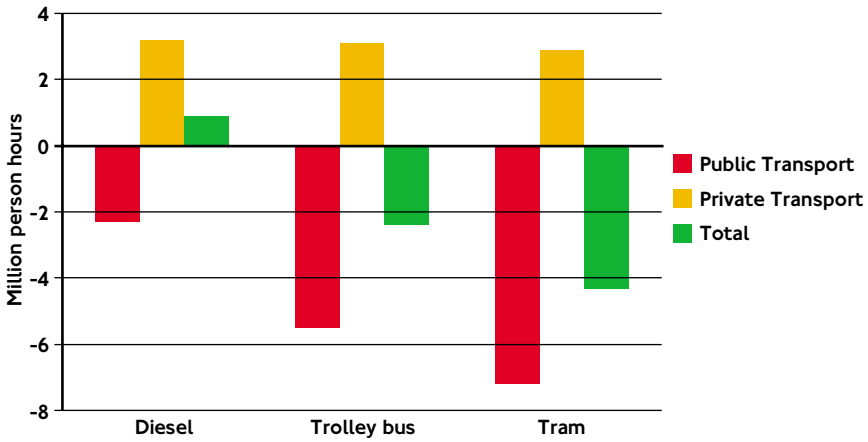
Journey time is an important element in the analysis of new transport schemes. From the supply side, the objective of most transport schemes is to improve accessibility and reduce journey times while from the demand side, the main journey attributes from the traveller's point of view are cost and time.

Despite the fact that the total number of public transport journey would increase with the implementation of Transit due to modal shift from private transport, the total travel time spent on public transport is forecast to decrease by between 2.3 and 7.2 million passenger hours per year. These reductions in journey time, particularly for the tram option, are high and result primarily from the traffic priority measures introduced on the Uxbridge Road.

Conversely, the introduction of these traffic priority measures would increase private transport travel times by between 2.9 and 3.2 million passenger hours per year with Transit.

Overall, with the trolley bus and tram options, there are net reductions in time spent travelling as a result of Transit. However, with the High Quality Bus option, overall travel time increases since the public transport travel time savings would be outweighed by the private vehicle journey time increases.

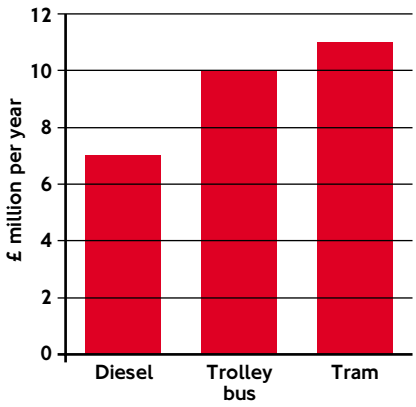
Changes in journey times



Crowding

The level of crowding is an important aspect of the quality of service provided by a transport system. It indicates whether or not a satisfactory level of service is provided to meet the demand for travel comfortably. The methodology for assessing the effects of crowding on public transport services is based on the estimation of the proportion of passengers who experience crowded situations, including the need to stand.

Changes in Net revenue



Revenue

The Transit options result in overall increases in revenue to public transport of between £7 and £11 million/year. These increases are mostly the result of additional passengers attracted to Transit due to mode shift from private transport. The figures shown in the diagram are net figures that include offsetting reductions in revenue on other modes, particularly bus services.

Cost-benefit analysis

The results of the cost-benefit analysis indicate that using the DETR method of calculation, the following ratios are achieved for the different Transit options:

	Diesel Bus	Trolley Bus	Tram
Benefit:cost ratio	Negative benefits	2.58:1	3.48:1

Analysis shows that each of the scheme options would generate sufficient additional revenue to cover their construction and operating costs. However, the diesel bus option has a negative benefit:cost ratio since the time saving benefits to passengers are substantially outweighed by the time disbenefits to highway users. This result needs to be treated with caution in that it reflects in part the limitations of the evaluation methodology. The traffic management measures and track alignment have been assumed identical for all three technologies considered, whereas in reality, the greater flexibility of the diesel bus option could lead to a lower cost alignment and less traffic impact. The trolley bus and tram options generate positive benefit:cost ratios since they are forecast to generate higher levels of passenger benefits that outweigh the highway disbenefits.

The benefit: cost ratios shown above are all substantially reduced by the need to include a large disbenefit to reflect the time-penalties imposed on private vehicle users as a result of the traffic priority measures introduced for Transit. In the absence of this disbenefit, the benefit: cost ratios for the various Transit options would increase significantly:

	Diesel Bus	Trolley Bus	Tram
Benefit:cost ratio	3.22:1	5.24:1	5.30:1

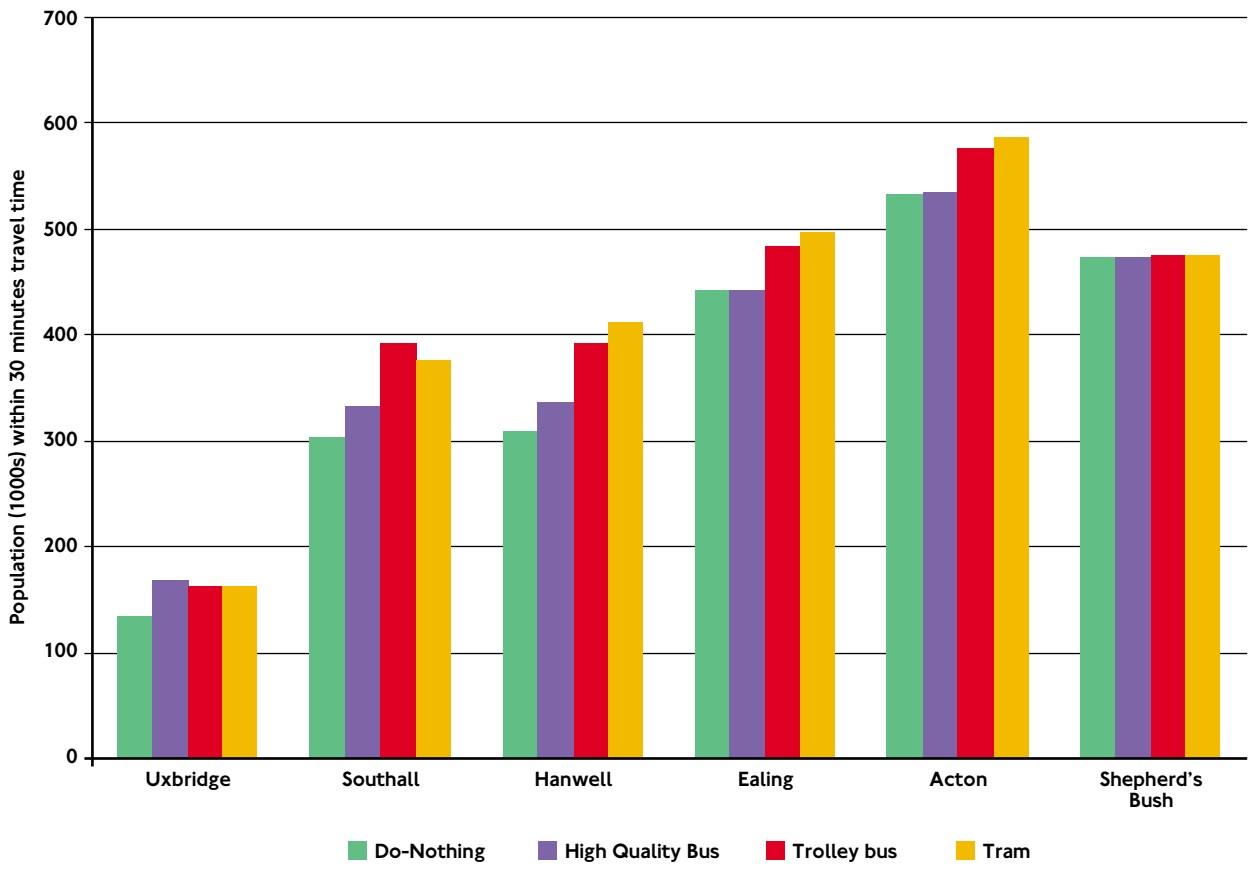
Accessibility

Access to local centres

All the Transit options result in increases in the population within 30 minutes travel time of the major local centres in the study area. This is a result of the higher running speeds achieved for both Transit and other bus services through the introduction of the traffic priority measures.

In overall terms, a moderate to large benefit in terms of accessibility of local centres is predicted for the trolley bus and tram options with the diesel bus option recording a small to moderate benefit. These benefits are not evenly distributed between centres, however, and those centres which are currently relatively inaccessible, such as Hanwell and Southall, are forecast to benefit the most. At Hanwell, for example, the tram option would increase the catchment population within 30 minutes travel time by over 30% compared to the pre-Transit scenario.

Access to local centres - changes in population catchment served



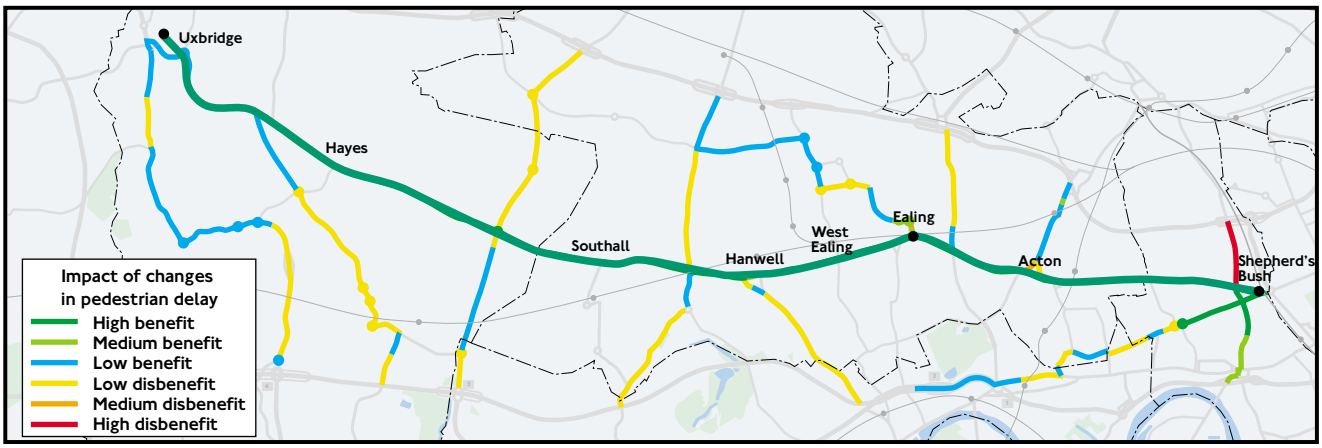
Community severance

Community severance is measured in terms of pedestrian delay. Pedestrian delay when crossing a road is mostly the result of the waiting time for a suitable gap in the traffic or for a signal phase that allows pedestrians to cross over safely.

The assessment shows that the scheme is forecast to bring about a small overall reduction in pedestrian severance, with more roads (75%) experiencing a reduction in severance than an increase (25%).

On the Uxbridge Road itself however the localised impacts would be expected to be much greater due to modal shift and traffic re-routing. A large benefit has therefore been forecast along much of the road, particularly through the commercial and more built-up areas where pedestrian flows are higher. In addition, Transit has been planned with the needs of the pedestrians in mind - as a result, many new pedestrian crossing facilities are proposed at Transit stops.

Severance impacts



Pedestrian Space

The route of Uxbridge Road Transit passes directly through several key town centres including Ealing, Acton and Uxbridge. Uxbridge High Street is already pedestrianised and Transit is therefore forecast to have little impact on pedestrian space. However, in the centres of Ealing, Acton, Southall and Shepherds Bush Green considerable changes to the pedestrian environment would occur, due to the introduction of traffic metering and the closures of stretches of Uxbridge Road to certain types of traffic.

The assessment shows that the increased space available to pedestrians as a result of Transit produce only slight benefits in each of the four local centres identified above. This is because surveys of existing pedestrian levels in these local centres along the Uxbridge Road show that sufficient space is already provided there for pedestrians.

Parking and servicing areas

The assessment has shown that Transit would impose an overall moderate disbenefit in terms of parking and servicing. This is the result of the severity of the new stopping restrictions along the alignment required for the Transit to have priority. The methodology for assessing the parking and servicing impacts of Transit has been designed to include extra weightings for restrictions close to commercial properties along the alignment, where the level of resistance to such proposals is likely to be strongest.

Despite these disbenefits, the needs of legitimate parking and servicing functions have been taken into account in the planning of the Transit alignment. In particular, the highway designs, whilst restraining through-traffic on the Uxbridge Road, do provide routes for traffic access to bays specifically for parking and servicing in the town centres.

However, this study has been necessarily approximate and has not had the opportunity to investigate and develop detailed parking and servicing proposals along the whole alignment. Further work on these issues will be required should the project proceed to the next stage of development.

Parking and servicing impacts

Integration of policy

Accessibility impacts on regeneration and social inclusion

Access to development sites

The main development sites within the Transit study area are White City Uxbridge town centre, and the British Gas site at Southall. It is widely recognised that a relationship exists between accessibility and the potential for development, although this relationship is not a precise one.

The assessment of changes in accessibility to local centres (page 40) included locations at Shepherd's Bush Green and Uxbridge Town Centre and it was decided that these locations could also be used to adequately reflect the changes in accessibility to the development sites. As a result, a separate assessment of the changes in accessibility to White City and Uxbridge Town Centre were not carried out.

Based on the changes in accessibility to Shepherd's Bush Green and White City, Transit would only produce a small improvement in accessibility to the development sites in the corridor since these locations, particularly Shepherd's Bush, are already well served by public transport.

Access to deprived areas

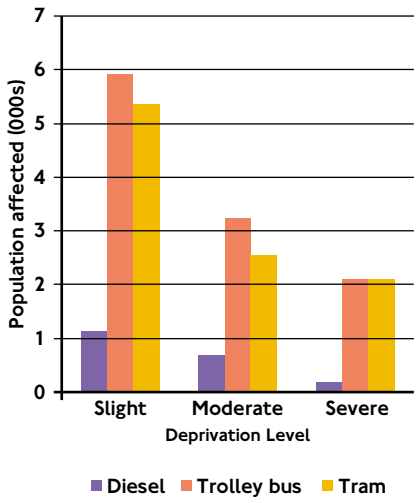
An objective of Transit is to improve access to deprived areas, in order to help reduce unemployment, enhance social cohesion and increase social inclusion.

The analysis was based upon calculating the number of people within the deprived population experiencing changes in travel time to reach the nearest local centres as a result of Transit. Deprivation levels are based upon the Index of Local Conditions produced by the Government and for this analysis all wards within 400 metres of the Transit alignment were included.

Each of the Transit options would provide benefit to deprived areas by reducing travel times between a number of deprived areas and their local centres along the Uxbridge Road corridor. The diesel bus option would improve accessibility by over one minute for 2000 people, while the trolley bus and tram options would give similar accessibility improvements for 10,000 and 11,000 people, respectively.

The trolley bus and tram options offer greater benefit than the diesel bus option due to the higher service speeds offered. The trolley bus option performs slightly better than the Tram, due to the greater frequency of service, favouring local access.

Access to deprived areas - changes in population catchment with Transit



Integration with other local policies and plans

Local authorities are committed to following local policy objectives that relate to improvements in various areas of competence. Shown opposite are the main local policy objectives for the Local Authorities within the

Transit study area, along with a qualitative assessment of the extent to which Transit would contribute towards achieving them.

Main local policy objectives for the local authorities within the Transit study area

Policy	Comment	Effect of Transit
Promote sustainable development	Transit would promote switch from private transport modes	✓✓
Provide a decent environment	As above	✓
Enhance the built environment	Transit would improve townscape, safety and the environment	✓✓✓
Maintain and develop a range of shopping facilities throughout the Borough	Transit would improve public transport access to town centres but also maintain local access by private vehicles	✓✓
Improve accessibility by promoting public transport and traffic restraint and improved facilities for pedestrians and cyclists	Transit would improve access by public transport	✓
Enhance local areas	As above	✓
Provide equality of opportunity including in personal mobility	Transit would be designed to be fully accessible to the mobility impaired	✓✓
Sustain employment and encourage new developments to locate in areas of high public transport accessibility	Transit would improve access to local centres and development sites along its alignment	✓✓

The review of the UDPs for Ealing, Hammersmith & Fulham and Hillingdon did not reveal any policies that would contradict with the Uxbridge Road Transit scheme. Overall, the scheme is in line and in support of the relevant policies identified, broadly covering:

- Aiding development of sustainable land use/transportation strategies
- Aiding accessibility within the boroughs
- Enhancing the built environment
- Improving environmental conditions

9 Conclusions

As described earlier in Section 4, the aims of the project definition stage of the project were to determine the economic, planning and engineering feasibility of Uxbridge Road Transit. The scheme has been developed to a level of detail sufficient only to establish this feasibility within a reasonable level of certainty leaving some issues and points of detail to be addressed as part of future stages of the project.

The main conclusion reached by the study is that the scheme would be feasible within the terms defined by the study. The study has involved a number of stages encompassing scheme development, impact assessment and evaluation. During this process a number of key assumptions have been adopted and the affect of these assumptions on the results of the evaluation carefully considered. The study has necessarily involved an iterative process endeavouring to balance different aspects to maximise scheme benefit while attempting to minimise any negative impacts. Inevitably this process was constrained by time and resources and could have been continued further to provide improved level of scheme development. This has applied particularly to the level of highway restraint/transit priority which is crucial in its effect on passenger benefits and highway disbenefits.

Engineering Feasibility

The dominating aspect of the engineering feasibility was that of the limited road space particularly within the town centres. Given the assumption that substantial property acquisition would be unacceptable, the feasibility depended upon making the best use of the existing road space and a workable balance between the needs of transit/buses and those of other road users. The approach adopted by the study was to assume that the corridor would no longer be available for the more long distance through traffic which would either reroute onto the more strategic road network such as the A40/M4 or transfer to using public transport. Access by car to local centres would be maintained and arguably improved through improved traffic management measures and parking facilities. Transit and remaining bus services would provide improved access to town centres which would benefit from improved environmental standards made possible by the reduced through traffic and increased pedestrian/cyclist space.

Traffic Management and Transit Priority

The study has explored a range of traffic management measures with the aim of achieving adequate priority for transit while maintaining the disbenefits to other traffic at an acceptable level. The priority assigned to transit affects both passenger benefits through travel time savings and ridership/revenues as well as the transit operating costs and vehicle requirements. Traffic management measures can lead to longer journey times by car both in time and distance. There is no exact relationship between the key components of traffic management/restraint and the commercial speed of transit. Hence this was a matter of judgement based on experience elsewhere. It was recognised that this was a key feature of

the analysis and results will be sensitive to the assumptions adopted. The highway model was by its nature a strategic model not capable of modelling local traffic impacts and at best only a guide to overall general impacts. The approach assumed that the traffic management measures in the Uxbridge Rd would need to be accompanied by measures in the neighbouring street network to manage the traffic displaced from the route itself. Each area would need to be examined in detail and an appropriate scheme developed.

Parking and Servicing

One of the key impacts which were identified as being potentially quite significant was that on parking and servicing of properties along the Uxbridge Rd. Much of the route has shops and commercial businesses located where there is limited off-street parking or rear access and which therefore depend on parking spaces within the Uxbridge Road itself. Transit operation could be compromised in two ways: congestion delays associated with vehicles routing to and from parking locations and delays due to parked vehicles blocking the path of transit. Transit would require space for a continuous track or route and any stationary vehicle would cause delay and inconvenience both in terms of passengers and operations. The evaluation concluded there would be an overall moderate disbenefit associated with parking and servicing and the extent of this would depend upon the degree to which adequate space for parking could be found clear of the route and the development of effective designated routes for vehicles to access parking/servicing areas. Further detailed work will be required in developing such proposals for each of the town centres.

Impacts on Property

At this stage of the project's development, the evaluation concluded that some property acquisition would be unavoidable if the preferred level of priority was to be achieved. This was particularly true in the tram option since both diesel bus and trolley bus vehicles would be more manoeuvrable albeit at the expense of passenger comfort and vehicle speed. However, further work on developing the precise alignment and stop location would be likely to identify ways of reducing the number of properties affected.

Environmental Impacts

The evaluation identified both positive and negative environmental impacts. Both noise and air quality impacts were classified as "large benefits". The impact on townscape was positive in terms of improved pedestrian space and scope for improving landscape to enhance the visual character of areas but with negative visual impacts associated with the overhead electrical equipment associated with tram and trolley bus options. Again there is a difficult balance to be reached between an improved town centre environment associated with reduced traffic and the impact on residential streets from diverted/displaced traffic.

Transport and Economics

Uxbridge Rd Transit was found to be particularly strong in terms of transport and economics. Having described above the critical need to

establish the best balance between transit needs and those of other highway users, for the solution identified as the preferred design, the evaluation indicated that the public transport benefits for the tram option were 2.3 times higher than the highway disbenefits and 1.5 times higher for the trolley bus option. Given that the traffic management measures were common to all three technologies evaluated, the analysis suggested that the associated highway disbenefits were critically sensitive to the extent of the modal transfer and the reduction in the number of car trips travelling in the corridor. The tram option therefore, with 20 percent more reduction in car trips than diesel bus, caused 30 percent less highway disbenefit.

The analysis also indicated for all options how sensitive both public transport passenger benefit and ridership were to commercial speed and hence need to maintain the level of priority.

For each of the three technologies examined, the evaluation was based on a preferred level of service adopted as a reasonable balance between passenger revenues, operating costs and vehicle load factors. Alternative levels of service could be operated depending upon priorities such as the proportion of seated passengers.

Choice of Technology

The study suggests that all three technologies had many positive impacts included as part of the MCAF evaluation. In terms of more the limited transport and economic benefits, although the most costly in terms of construction and operations, the tram option provided the highest returns followed by the trolley bus. Whereas the trolley bus option is around 20 percent less costly and attracts around 20 percent less benefit than the tram, the smaller reduction in car traffic leads to almost 25 percent higher highway disbenefit thereby halving the total benefit. The trolley bus option therefore has a lower BCR of 2.6 compared with 3.5 for the tram. In the case of the diesel bus option, the passenger benefits were more than off set by the highway impacts giving rise to negative overall benefits. However some caution is necessary when interpreting this result owing to the limitations associated with the study methodology. For instance, the sensitivity of highway impact to mode split has a key influence on this result.

Overall however, the levels of ridership estimated to be attracted to transit in this corridor, would be more appropriate to the high capacity offered by the tram option. The very high bus frequencies implied by these results may call into question the operability of the diesel bus option particularly in terms of the impacts on other traffic at junctions and dwell times at stops.

10 The Way Forward

Based upon the results of the work summarised in this report, TfL and the local authorities have decided to proceed to the next phase in the development of Uxbridge Road Transit. The purpose of the consultation is to establish what level of support exists for the Transit from the public as well as potential private sector partners who might build, fund and operate the system. It will also be used to help inform the formal decision to be taken by TfL and the Mayor as to whether to proceed with the development and implementation of the scheme.

Preliminary public consultation

This study has shown that the overall benefits of Transit significantly outweigh any adverse impacts. However, it is intended that preliminary public consultation is carried out to seek views on the principles of the proposals. In particular, consultation will seek to explain the proposals and establish:

- Whether there is support for the principle of road space re-allocation in favour of Transit and vulnerable road users through the use of traffic management measures;
- Whether there is support for the proposed Transit alignment;
- The perceived advantages and disadvantages of the alternative technologies; tram or trolley bus - which could be guided on all or part of the alignment.

It should be noted that much of the detailed planning work for Transit remains to be carried out, including the design of the area-wide traffic management measures and the planning of the service patterns for Transit, including any accompanying changes to existing bus services. These issues will be addressed at a later date if it is clear that there is sufficient support to progress the project further.

Seeking Expressions of Interest from the Private Sector

The work completed to date has demonstrated that Transit is a cost-effective proposal. At the same time as preliminary public consultation, TfL will be seeking the views of potential funders and/or operators in the private sector of the transport industry on Transit. This will enable the Mayor and local authorities to decide on the options available and to identify a preferred approach to progress any proposals through to implementation. Private sector involvement in similar projects in London, including Croydon Tramlink and the DLR extension to Lewisham has proved successful and has reduced the funds required from the public sector by between 40-70%.

At this stage, TfL will be seeking the views of private sector companies will be sought with respect to:

- The types of vehicle that may be suitable for Transit
- Packaging of system (builder/operator)
- Concession arrangements
- Timing and involvement in the process
- Risk taking
- Funding options

Decision to proceed

The information from public consultation and the private sector, together with the results from existing and further studies, will be used by the local authorities and the Mayor to decide whether they wish to proceed with the development and implementation of the scheme. If it is decided to proceed, two options are available for seeking powers to implement the scheme. Firstly, for any scheme not involving electric power or guidance, conventional planning and highway powers can be sought.

Alternatively, Transport and Works Act powers can be pursued. The latter is the most likely approach, as it would ensure that all the necessary highway powers are obtained and safeguarded. It would also help overcome the biggest risk to the scheme - namely the local authorities ability to deliver all the priority measures necessary for the scheme.

Seeking powers through the Transport and Works Act Order process would require carrying out further detailed design work and additional consultation along with a Public Inquiry if any objections to the schemes were received. This process would probably take two to three years, depending on the extent and nature of the scheme. This process and timescale also applies to the other intermediate mode proposals currently under consideration by TfL.

Deciding to work in partnership

Although it will be for the Mayor to decide which intermediate mode schemes, if any, should be progressed, local support will be essential for any scheme to be developed beyond this stage. If the local authorities or the Mayor are unable to support the proposals no scheme will proceed. Therefore, the local authorities are invited to demonstrate their commitment to these proposals for Transit and introduce policies and practical measures that will assist in the development of the project.

In addition, should there be agreement to proceed to the stage where construction powers are sought for Uxbridge Road Transit, local authorities would need to enter a formal partnership with TfL and the private sector prior to carrying out preparatory work for the Transport and Works Act Order. TfL would also be encouraging each local authority take a clear and unambiguous cross-party political decision to support and promote the project. This would avoid the risk of construction being disrupted by any political changes resulting from elections during the implementation phase of the project. These approaches were adopted successfully on Croydon Tramlink and were designed to encourage local ownership and ensure that real benefits were delivered to local residents and businesses. In TfL's opinion, local authority involvement in new transport projects is vital for their success and without such a formal agreements for Uxbridge Road Transit it will not be possible to proceed with the project.

In the interim, TfL will be vigorously pursuing bus priority, vehicle and service improvements in a way compatible with the ultimate construction of Transit.

It is TfL's hope that local authorities will respond with vision to the opportunities, as well as challenges, that are offered by Uxbridge Road Transit.