

# **WEST OF ENGLAND RAPID TRANSIT**

**Technology Review**

**Executive Summary**

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## EXECUTIVE SUMMARY

### Introduction

1. The four Unitary Authorities of the West of England, Bath and North East Somerset, the City of Bristol, North Somerset and South Gloucestershire, are currently undertaking a programme of work to develop a rapid transit system for the West of England area.
2. In 2006 the Greater Bristol Strategic Transport Study (GBSTS) identified the need to progress a rapid transit network for the sub-region, as part of a package to successfully and appropriately accommodate additional transport movements arising from predicted residential and employment development over the next 20 years. The study concluded that
 

*“further work is required to identify the type of vehicle used to operate the service but modern, low-floor, articulated buses are likely to be the most appropriate, flexible and cost effective vehicles to satisfy the requirements of the service”.*
3. GBSTS identified four Bus Rapid Transit (BRT) corridors, three of which have been included in the Joint Local Transport Plan (JLTP) and have a current financial allocation in the South West Regional Funding programme to 2016 totalling £71 million (2006 prices) with operation of the first route targeted to commence in 2013. To obtain this funding, the West of England Authorities are required to submit a Major Scheme Bid for the first part of this network at the end of 2008. The route identified for this application is from Ashton Vale to Temple Meads via Bristol City Centre.
4. As part of the programme of work to develop a rapid transit system, the West of England Authorities have considered different types of rapid transit technologies. A review of technologies was first undertaken in 2007, this looked at a range of options from monorail and light rail through to conventional buses. Work from this review has been incorporated in to this report.
5. The West of England Authorities wish to ensure that the most appropriate technology is identified for its rapid transit network and further work is being undertaken specifically to look at the opportunities provided by newer rapid transit technologies. As a result, Steer Davies Gleave has been commissioned to undertake a further review of appropriate technologies that could be used to deliver the Ashton Vale to Temple Meads via Bristol City Centre route but also the wider proposed rapid transit network.
6. For the purposes of this report and the comparison of different technologies, the following details on the Ashton Vale to Temple Meads route were used:
  - The Ashton Vale to Temple Meads route is approximately 7km long, with around 3km of this being proposed as a segregated corridor and 4km running on-street in Bristol City Centre.
  - The route is proposed to run from the existing Long Ashton Park and Ride site via an alignment through the proposed development at Ashton Park, crossing the Portishead railway line at Ashton Gate, to run alongside the Portishead railway

line until it crosses the existing Ashton Avenue Bridge to connect with the alignment of the Bristol Harbour Railway line. The route continues running along the south side of the Floating Harbour adjacent to Cumberland Road to connect through to the proposed development at Wapping Wharf and the Bristol Industrial Museum.

- There are still options for the on-street sections in Bristol City Centre but the route will connect Broad Quay, The Centre, Broadmead, Cabots Circus, Old Market and Bristol Temple Meads Railway Station.
- The system will be required to provide a maximum capacity in the order of 3,000 passengers per direction per hour.

### Study Process

7. This technology review has followed professional guidance documents and accepted industry practice<sup>1</sup>. In assessing the appropriateness of different technology options these advocate a process of:
  - Assessment at increasing levels of detail in a step-wise or iterative manner to progressively eliminate those options that are not likely to provide an appropriate or affordable solution to the identified need and objectives. To this end a staged process of firstly looking at a high level strategic assessment of the alternative technology options followed by a more detailed review of the most appropriate technologies.
  - Assessment against a set of criteria which includes:
    - Goals and objectives including policy objectives,
    - Current problems and future challenges, including issues of local context within which the transit system will be implemented and operated,
    - Physical opportunities and constraints that will influence the design or technology choice,
    - Deliverability.

### Public Transport Technologies

8. The consideration of all the different public transport options for a transit network in the West of England has previously been undertaken firstly by GBSTS and further as part of the rapid transit scheme development. These range from high capacity, high cost mass transit systems such as Heavy Metro (London Underground) to lower capacity and lower cost systems such as automated people movers and conventional bus systems.
9. A high level review of capacities and costs and previous assessment work undertaken, concluded that the technology options of mass rapid transit, heavy rail, light rail, conventional bus and automated people movers<sup>2</sup> are, in our opinion, not appropriate technologies for the proposed rapid transit network. This does not mean that these

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<sup>1</sup> For example: *Affordable Mass Transit Guidance: Helping you choose the best technology for your Area*, Commission for Integrated Transport, 2005 and *Bus Rapid Transit – Planning Guide 2007*, Institute for Transportation and Development Policy, June 2007.

<sup>2</sup> Reference should be made to the Section 3 of the full report for an explanation of these.

technologies are not appropriate in specific circumstances but they fit less well with the proposed objectives of the rapid transit scheme and they are less likely to provide a successful case for government funding for this particular scheme.

10. This technology review therefore concentrates on the rapid transit technologies of Tramtrain, Light Weight Rail and Bus Rapid Transit.

### Technical Review

#### *Tramtrain*

11. Tramtrain was developed in Germany to enable tram style services to be developed over the wider suburban heavy rail network, making use of improved proximity and connectivity of existing tram networks within the urban centres. Tramtrain is a vehicle solution not an independent mode such as bus or tram. The vehicles are capable of operating on both the heavy rail network and on urban low floor tram networks, which depending on the location and application, requires the ability to work on differing overhead line power supplies and possibly independently through the use of on board diesel generators.
12. There are currently no Tramtrain schemes within the UK. The Tyne and Wear Metro extension to Sunderland does incorporate some aspects of Tramtrain in that it runs on the heavy rail network in conjunction with rail services. A trial of Tramtrain in the UK is to be undertaken by Network Rail on the 37-mile Penistone Line between Huddersfield and Sheffield. The current service will be replaced using five Tramtrain vehicles between 2010 and 2012 and will look at the environmental, operational, passenger and lifecycle benefits along with the technical suitability of the technology. The vehicles may then be trialled on the Sheffield Supertram network to assess the suitability to a UK tram network.
13. The key benefit of Tramtrain is the ability to use existing rail infrastructure to operate on, using tram infrastructure to provide improved connection to city centres. In the case of the rapid transit scheme, a city centre network would need to be constructed out to the main rail termini. As a result it has many of the same issues that light rail options present. Alternatively, Tramtrain in the UK may have more of a focus on better utilising branch lines on the existing national rail network with an aim of improving frequencies and reducing cost of provision and operation.
14. Tramtrain vehicles provide the highest capacity of the modes reviewed. It is though, also the most expensive. Vehicles cost in the order of £2.8 million to £3.2 million each. The estimated cost of delivering the infrastructure on the Ashton Vale to Temple Meads via Bristol City Centre route is in the range of £90 million to £110 million (for the equivalent route as the proposed BRT route)<sup>3</sup>. The total scheme cost would be in the range of £118 million to £142 million including vehicles at 2007 prices. This excludes costs such as land, environmental works and contingency.

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<sup>3</sup> It is important to note that this is a desktop study and therefore has not involved site inspection or an engineering review of the feasibility of this technology. Please see Section 4 of the main report for a description of the cost estimate.

*Light Weight Rail or Ultra Light Rail*

15. Light Weight Rail has been developed by Parry People Movers (PPM) as an intermediate mode between bus and tram and is also being promoted by Sustraco/Ultralight Rail. The aim is to provide a lower cost intermediate mode which could run in place of branch line services on the national rail network or as a lower cost alternative to tram technology.
16. The PPM system has been trialled on a number of segregated routes and will operate a two vehicle branch line service in Stourbridge from December 2008. The vehicles will have a capacity of 50/60 people and will be powered predominantly utilising a flywheel charged by an LPG engine. The PPM system has successfully managed to obtain dispensation from Network Rail's Railway Group Standards (which facilitates its operation) mainly due the route's ability to be disconnected from the remainder of the rail network.
17. The proposals for Hybrid Ultra Light Rail (HULTS) for a system between Bristol and Long Ashton Park and Ride are at a concept stage and could use a similar vehicle to the Stourbridge scheme. Vehicles would cost in the order of £300,000 to £350,000 each.
18. The key benefits of this technology are its proposals to run on lower emission fuels and provision of a fixed rail system at a lower cost than a light rail systems. The HULTS report states that fuel consumption could be up to 40% below that of a standard diesel bus.
19. Deliverability is a significant concern with this technology as, to date, only development vehicles have been produced and trialled on a number of short rail routes, where the vehicle's operation can be segregated from other uses. Some of the operating issues that would need significant investigation to determine the cost and risk include:
  - System capacity – single unit vehicles do not have sufficient capacity to carry the required number of passengers on the proposed rapid transit system. The promoters state that vehicles can be coupled together but the PPM bogie technology upon which the vehicle would rely is also currently a concept and has not been developed. The development of this vehicle would require a radical redesign of the current PPM vehicles. Without the ability to run two vehicles together, or build a higher capacity vehicle, this system would have insufficient capacity to deliver the rapid transit service. Therefore development of an appropriate vehicle would be essential.
  - Utility diversion – the main issue with utilities is their ongoing access and serviceability. In order to prevent disruption to service and expensive works, utilities are usually moved out of the path of fixed rail systems. This can add significantly to the capital costs (in the order of 20% of total costs). HULTS promoters state that utility diversions would not be necessary and that HULTS services would be diverted when access or work were required. The proposed ULR track was discussed with local Utility Companies at a meeting in July 2008. The representatives of the Utility Companies were not in principle against the concept of a track which could run on top of their assets within the highway but raised a number of issues including the need for planned and emergency access to

utilities and the different requirements for different types of utilities. In addition it is likely that the Utility Companies would be looking to the owner of the track, the Local Authorities, to be responsible for undertaking and paying for any reinstatement works creating an ongoing cost for the Local Authorities.

- An on-street version of the system is untested in passenger operation including, importantly, how it integrates and operates with other general traffic. The technology does not currently have a UK Safety Case for this type of operation. This is of course obtainable but introduces an element of risk to costs, delivery and timescales.
20. Light Rail systems are currently costing in the order of £10 to 15 million per kilometre and have increased significantly over the last few schemes developed. A conventional on-street tram scheme therefore has an average cost in the order of £12 million per km. The HULTS promoter notes a cost of £3 million. Removing both the electrification and all the utilities cost from the average tram cost could account for a possible reduction of 33% in the cost of construction producing a track cost of approximately £8 million. The removal of all but the site preparation, highway and trackwork costs results in a cost of £5 million compared to the promoters' quoted £3 million rate.
21. An estimate of costs has therefore been undertaken on three bases: firstly, the HULTS promoter cost of £3 million per km, secondly, the HULTS promoter cost of £3 million per km plus an allowance for structures and highway works required in the city centre and thirdly, an estimate based on low cost tram costs.
22. Using HULTS £3 million per km estimate the total scheme costs would be in the order of £38 million (2007 prices). Using the HULTS promoter cost but adding in an allowance for structures and highway works provides a cost in the order of £45 million (2007 prices). Our estimation of costs per kilometre for this system, based on current tram costs but allowing for the proposed reductions proposed by HULTS for track work is in the order of £103 million. These all exclude costs such as land, environmental works and contingency but include vehicles and are at 2007 prices<sup>3</sup>.

#### *Bus Rapid Transit*

23. Bus Rapid Transit aims to deliver the characteristics of fixed rail systems but with bus-based technology. This consists of a variety of physical measures in conjunction with operational and system elements such as a segregated alignment, high quality dedicated vehicles, improved stop infrastructure, on-street priority, improved passenger information and high frequency services.
24. There are still relatively few high quality BRT systems in operation, although this is increasing. Systems to date have applied the suite of different BRT measures, both physical and operational in varied ways. There have also been significant issues with the quality and reliability of bespoke bus technologies developed, which have tried to use innovative technologies such as Phileas, Guided Light Transit etc. There has also been some criticism of the ride quality of slip-form kerb guidance (which is very dependant on the quality of construction).
25. Bus Rapid Transit does have a number of key benefits :

- Flexibility – routes are more easily adaptable to change through the life of the system and changing needs of urban conurbations. Bus services from a wider geographic area can also benefit from the infrastructure investment improving the reach of the system.
  - Value for money – BRT systems cost considerably less than comparable fixed rail systems.
  - Mode shift – BRT systems are delivering good reliable services and as a result showing much higher levels of mode shift than conventional bus systems.
26. Hybrid vehicles can significantly reduce emissions. Evidence from tests in London show a 38% reduction in CO<sub>2</sub> emissions from hybrid buses compared with standard Euro 4 diesel bus. Hybrid bus performance is similar to LRT and LWR/ULR in terms of CO<sub>2</sub> emissions. Hybrid vehicles could be available for around an additional £60,000 per vehicle (current prices) and the technology and market for vehicles continues to evolve, with additional manufacturers providing products into the UK market.
27. The equivalent BRT system cost for the Ashton Vale to Temple Meads via Bristol City Centre route, i.e. one that excludes costs such as land, environmental works and contingency and includes vehicles is in the order of £24 to £26 million (2007 prices) depending on the choice of vehicle.

#### *Fuel Technology*

28. Alternative fuel technology is still in its infancy and is continuing to evolve. There are some encouraging developments including work being undertaken by Bath & North East Somerset Council and their partners First Group through the European Commission's CIVITAS Plus Initiative 'Testing Innovative Strategies for Clean Urban Transport for Historic European Cities'. This initiative will include a demonstration project in Bath and trial a 'green' fuel articulated bus, appropriate for a historic city environment. The outcomes of this will be an important consideration for rapid transit scheme development.
29. A key issue is the operational feasibility of alternative technologies for a large scale network, including the infrastructure investment required, maintenance and reliability. This, and the small fleet size, could manifest itself in high vehicle costs.
30. For the present and short to medium term, diesel power is likely to remain the most widely available fuel for local bus based vehicles. The ongoing development and adoption of hybrid drive systems is likely to reduce their cost and increase their capability and reliability. Hybrid vehicles could be a viable alternative in the next few years.

#### **Comparative Assessment**

31. Tramtrain would only provide additional benefit over that of a tram route if it were able to be integrated with and operate on the existing rail network in the area. There are significant deliverability issues with the implementation of Tramtrain in the UK, and potentially capacity issues on the existing rail network in the West of England area. A significant amount of work would need to be undertaken to identify the opportunities and constraints for the adoption of the technology in the area.

32. Tramtrain vehicles provide the highest capacity of the modes reviewed. It is though the most expensive and if it were only deliverable on dedicated routes separated from the existing rail network, electrified tram technology would be more appropriate and more deliverable for a similar cost.
33. Light Weight or Ultra Light Rail could provide a lower capacity, environmentally friendly transport system. At this stage of development there are considerable unknowns and in our opinion, the technology would need to be developed and tested further before it could be available to be applied to a rapid transit network of the size and nature proposed in the West of England.
34. Bus Rapid Transit compares favourably both against the technical requirements for the proposed rapid transit system and the scheme's objectives.
35. The BRT mode is the lowest cost of the three options. Tramtrain could be in the order of six to seven times the cost of BRT and ULR could be in the order of 1.5 to 5 times the capital cost of BRT. BRT has the lowest deliverability risk. Vehicles can run on the highway in Bristol city centre and access the areas outside the main urban conurbation. On dedicated corridors the infrastructure could be either an exclusive highway or for guided sections utilise kerb guidance which can be constructed in a number of ways. All of which have been undertaken in the UK.

### Summary and Conclusions

36. The Penistone Tramtrain trial on the heavy rail network is planned to conclude in 2012 with a further trial on an LRT network potentially thereafter. The trial will hopefully set the UK vehicle standards for Tramtrain, which, if the manufacturers are able and willing to provide a suitable vehicle depending upon the market demand, could significantly de-risk future Tramtrain projects and potentially provide a competitive market. This is unlikely to happen before 2016 and would therefore fall outside the current regional funding allocation programme. In our opinion costs for Tramtrain are also likely to significantly exceed the current funding available for rapid transit.
37. Tramtrain may provide a future suitable mode as part of a public transport network in the West of England area. It would however need to be compared at that time with electrified tram technology which could be more appropriate and more deliverable for a similar cost, particularly in connecting the city centre destinations. The delivery of rapid transit corridors using bus technology should not preclude the corridors from being changed to Tramtrain in the future should this prove to be deliverable.
38. LWR/ULR is also still in development. Both the vehicles and the track for ULR need to be developed, trials undertaken, required approvals obtained and large scale procurement and construction undertaken. This is unlikely before 2016 and therefore it would fall outside the current regional funding allocation programme. In our opinion costs for LWR/ULR are also likely to significantly exceed the current funding available for rapid transit.
39. ULR may provide a future suitable mode as part of a public transport network in the West of England area. However significant development work is needed on the technology before a major scheme application based on ULR could be put forward.

The delivery of rapid transit corridors using bus technology would not preclude the corridors from being changed to ULR in the future should this prove to be deliverable.

40. A bus rapid transit network, particularly if all the elements of the system are delivered (segregation, fast/frequent services, direct access to destinations), meets the scheme objectives and can be delivered within the current regional funding allocation programme. The risks associated with delivering bus rapid transit are considerably lower than the other two technologies we have reviewed.
41. Whilst Euro V diesel power remains the most practical for now, modern vehicles offering low emissions such as hybrid technology could possibly be a viable alternative in the next few years, subject particularly to reduction in their capital cost. Progress on this technology should be monitored for application to the rapid transit network and reviewed for its appropriateness and viability.
42. In our opinion, Bus Rapid Transit should be pursued for the Ashton Vale to Temple Meads rapid transit route as it best meets the rapid transit scheme objectives; is the most cost effective and flexible; and can be delivered within the current programme and available funding.

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