Appendix A

Study of High Quality Buses in Leeds

Final Report

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1. Rationale and Background

BACKGROUND

1.1 In January 2004 Metro and Leeds City Council, through liaison with the Department for Transport (DfT), were advised by the Secretary of State for Transport to develop alternative options to the original proposals for a three line light rail system for Leeds.

1.2 After an extensive period of option identification, three alternative options were developed for appraisal as potentially viable solutions to transport problems on the three Supertram corridors, as follows:

- A reduced tram option, based on the original three line Supertram network, but with deferral of part of the south line from Balm Road to Tingley;
- A Bus Rapid Transit (BRT) option, with a route closely based on the original Leeds Supertram network (without any deferrals), including the provision of Park and Ride facilities; and,
- A quality bus option, incorporating a significant upgrade to local bus services, along with rail-based Park and Ride provision on the Harrogate Line, to the north of Leeds, and on the York/Selby Line.

1.3 A full appraisal of these three options was submitted to Government in an Appraisal Document dated 12th November 2004.

THIS COMMISSION

1.4 In August 2005 Atkins Transport Planning was commissioned by DfT to undertake further examination of the potential for a high quality bus alternative to the Supertram proposal. The purpose of this current study was to 'identify and assess an optimised, 'showcase' bus option for the three Leeds Supertram corridors'. The aim was to consider whether buses can deliver a better solution than light rail when all possible existing levers are used in an imaginative and cost effective way.

1.5 This short study was intended to be undertaken in two stages. Stage 1 was to focus on the identification of an optimised bus option for the three Supertram corridors. Stage 2 was then to consider the appraisal of the optimised bus scheme, comparing the potential performance against that of the truncated tram scheme and the existing BRT alternative.

1.6 Upon review of the work previously undertaken by Metro and Leeds City Council, it was clear that a great deal of thought and effort had been put into designing a system that was as close to tram as possible. In order to identify an optimised bus scheme for this study, it was necessary to understand the appraisal of both the truncated tram scheme and the existing BRT alternative which had been put forward in the November 2004 submission. This revealed that the specification for the BRT alternative, as originally appraised, was already very high for the corridors under consideration, and that the system characteristics identified for both the tram and the BRT system were, insofar as possible, specified to be similar. This study therefore focused on some of the details and appraisal of the BRT alternative, to identify the key factors of the performance of the BRT compared to the tram. Due to time constraints associated with the study, a final optimised BRT solution was not identified. Instead the results of the initial outline tests have been used to assess the potential performance of the BRT, based on a truncated network similar to the most recent Supertram proposals.

STRUCTURE OF THE REPORT

1.7 The remainder of the report is structured as follows:

- Section 2 reviews the work undertaken on rapid transit options by Metro in their 12th November 2004 Appraisal Document;
- Section 3 reviews experience from rapid transit systems elsewhere;
- Section 4 discusses options for an optimised bus scheme;
- Section 5 sets out the results of the demand forecasting and economic appraisal of options;
- Section 6 summarises the wider appraisal of options;
- Section 7 reports on the consultation with key stakeholders;
- Section 8 discusses the implications for delivery of a bus rapid transit scheme; and,
- Section 9 presents conclusions on the potential for a high quality bus rapid transit scheme to deliver an alternative to light rail.

2. Review of Bus Rapid Transit Alternative

SUPERTRAM ALTERNATIVES IN THE NOVEMBER 2004 SUBMISSION

2.1 The November 2004 submission to Government examined two lower cost alternatives to the revised tram system: a Bus Rapid Transit (BRT) option; and the Yorkshire Bus Initiative (YBI) option. Whilst both options were bus-based, there was a clear distinction drawn between them, in both the technology and type of measures proposed.

2.2 The BRT option 'was designed to be as close to having the same characteristics of a tram scheme, while using innovative bus technology. It was considered to be sufficiently distinct from other bus services as to be perceived as a separate mode, predominantly due to having a reasonably high level of segregation, high levels of reliability both of journey time and headways, ultra-high quality vehicles, high quality waiting environments and a distinctive branding etc' (Appraisal Document, 12th November 2004, paragraph 4.34). Thus, the BRT option is designed to provide a new 'product' that can be clearly distinguished from existing bus services and thus would be perceived as a new mode in a similar manner to the Supertram proposal.

2.3 For the Yorkshire Bus Initiative, on the other hand, 'proposals involve the implementation of extensive improvements within the existing bus corridors, both in terms of bus priority measures and the quality of stops' (Appraisal Document, 12th November 2004, paragraph 4.35). Whilst this proposal would provide significant improvements to bus infrastructure, these improvements were assumed not to require land outside the highway boundary. The improved infrastructure would be used by conventional bus services and thus would not be seen to provide the new 'product' that would be the case with the BRT or Supertram options.

2.4 The November 2004 submission described the development of the truncated tram scheme, and the two alternative options, in both engineering and cost terms. It then concludes with an appraisal of the three options. It then concluded that of the two Supertram alternatives, the YBI option performed better in benefit to cost ratio terms than the BRT (and indeed the tram), but did not deliver the level of benefits that the BRT is forecast to (and also the tram, which was forecast to have higher benefits again). The BRT was also shown to go a long way to meeting the wider policy objectives of the tram scheme (discussed in more detail in section 5 of this report), which was not the case for the YBI. The YBI could therefore be considered to as incremental improvement to existing bus, whereas the BRT could be considered as a step-change in bus provision.

2.5 As the purpose of this study is to examine whether a high quality bus initiative can deliver a viable alternative to light rail, the earlier Metro submission suggests that any likely alternative has to take the form of a step-change in bus provision, as in the BRT alternative, rather than an incremental change to existing bus provision, as in the YBI.

2.6 The starting point for developing a high quality bus alternative, therefore, is the detailed BRT option already presented. The initial stages of this study involved an analysis of the detailed work already undertaken by Metro and Leeds City Council in the November 2004 submission. Details of the Metro BRT scheme are examined in the remainder of this section, and comparisons with the truncated tram are made where necessary to highlight key differences in the two schemes.

ALIGNMENT

2.7 The corridors selected for the BRT were the same as those identified for Supertram in the 1990 Leeds Transport Strategy. This was to allow the identification of the extent to which BRT met the same goals as Supertram. The alignment on each of the three corridors was defined as similar as practical to those developed for the tram to provide BRT with the maximum opportunity for segregation. This also had the benefit that it allowed a cost benefit appraisal comparison between tram and BRT. It should be noted, however, that the BRT option presented by Metro included the south leg as far as Middleton, rather than just the truncated Supertram scheme outlined in the November submission. Therefore, the two schemes examined were not directly comparable, as they did not have the same geographical coverage.

2.8 The nature of the BRT system, whether in guideway, segregated from general traffic, or mixed with general traffic, also generally followed that of the Supertram system, with guideways assumed in place of segregated tram running. The principle behind the alignment work was to provide as consistent a scheme with tram as possible. The alignments were developed in some detail, with feasibility level engineering drawings produced.

2.9 The alignment and nature of the BRT system (whether segregated, mixed with general traffic or running in priority lanes), is shown in Figures 2.1 to 2.3, alongside the comparable truncated tram system, for each of the three lines: north, east and south.

2.10 In the City Centre the tram is designed so that all three lines meet at the Headrow/ Park Row/Cookridge Street junction, with tramways running along the Headrow, and along Park Row and Boar Lane. Powers also exist to complete a loop in the city centre by running along Duncan Street, thus improving the overall operational flexibility. The BRT alternative has been designed to serve the same areas as the tram, with the city centre routing following that of the tram as closely as possible. It has not been possible, however, to provide the same level as segregation for the BRT as the tram, which results in slightly longer journey times for BRT.

2.11 For the truncated tram, three Park and Ride sites are assumed. These are at Boddington, at the extremity of the line to the north, at Grimes Dyke, at the end of the line to the east, and at Stourton, at the end of the line to the south.

2.12 For the BRT, a similar assumption has been made, with a Park and Ride site on each of the arms. On the eastern arm, however, Metro's assessment was that the site at Grimes Dyke was too remote to attract maximum 'park and ride' patronage, so an alternative site was specified at Wyke Beck. The location of the other two sites, at Boddington and Stourton, remain unchanged from the tram option.

Figure 2.1 – Route Alignments: North

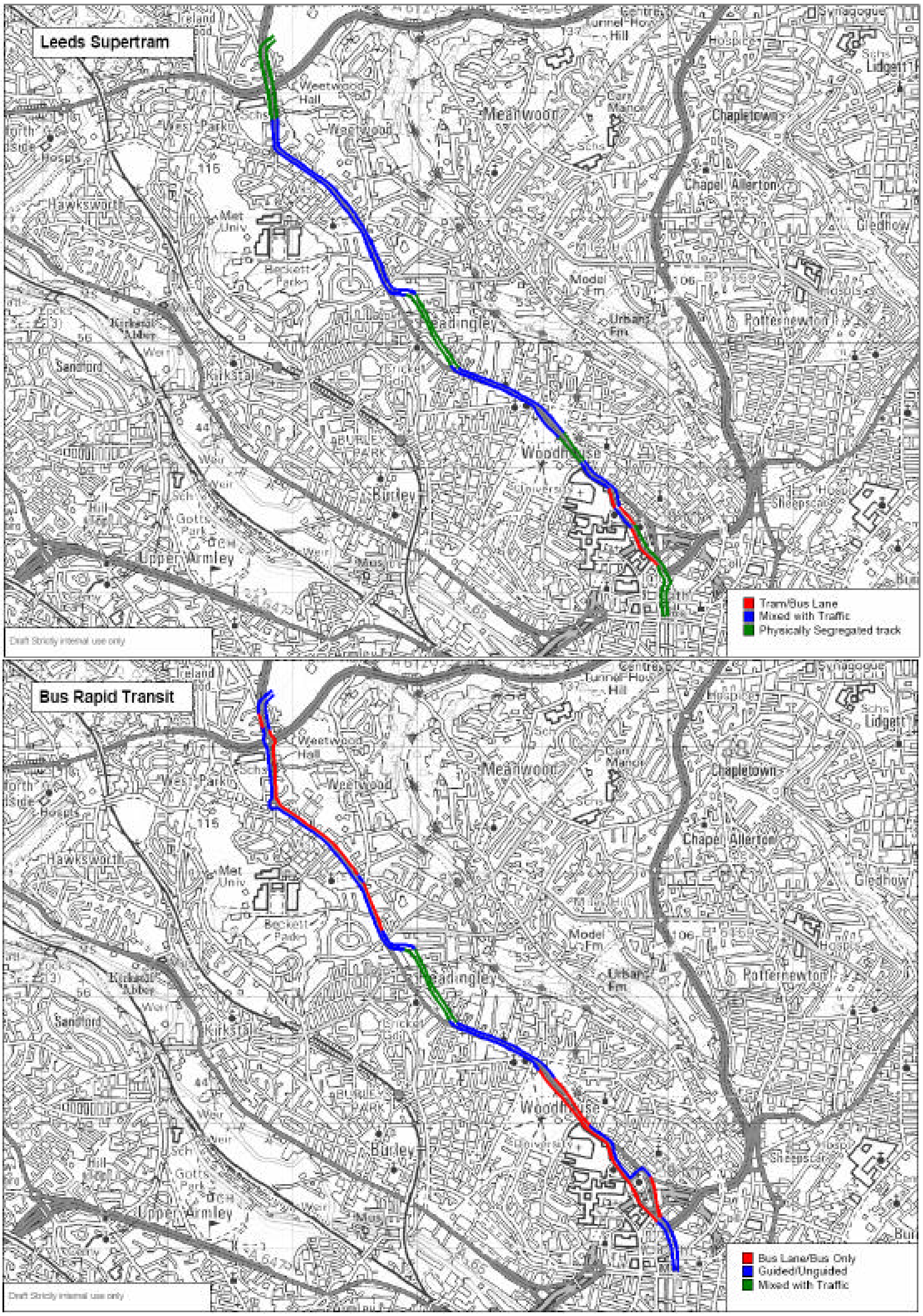


Figure 2.2 – Route Alignments: East

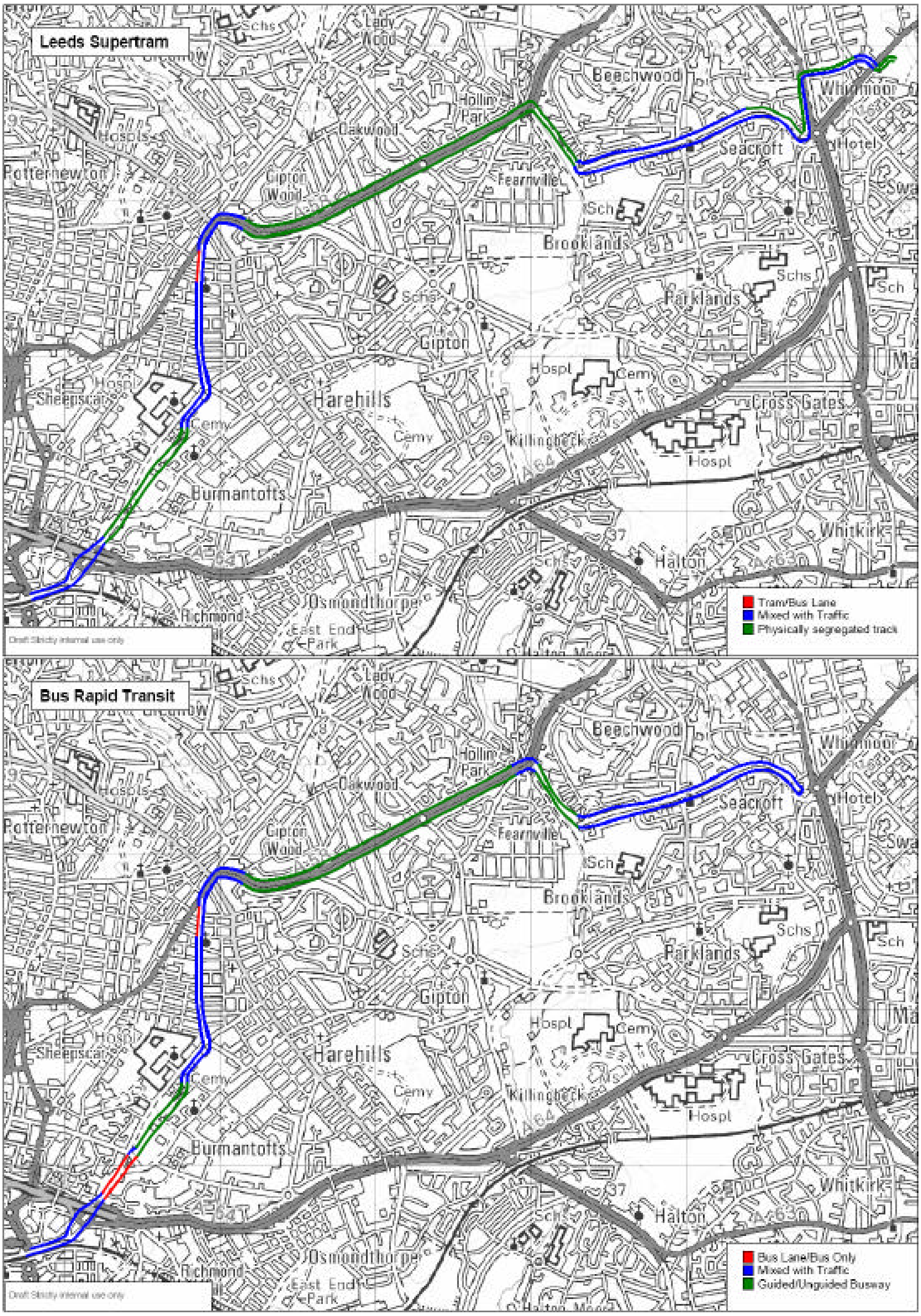
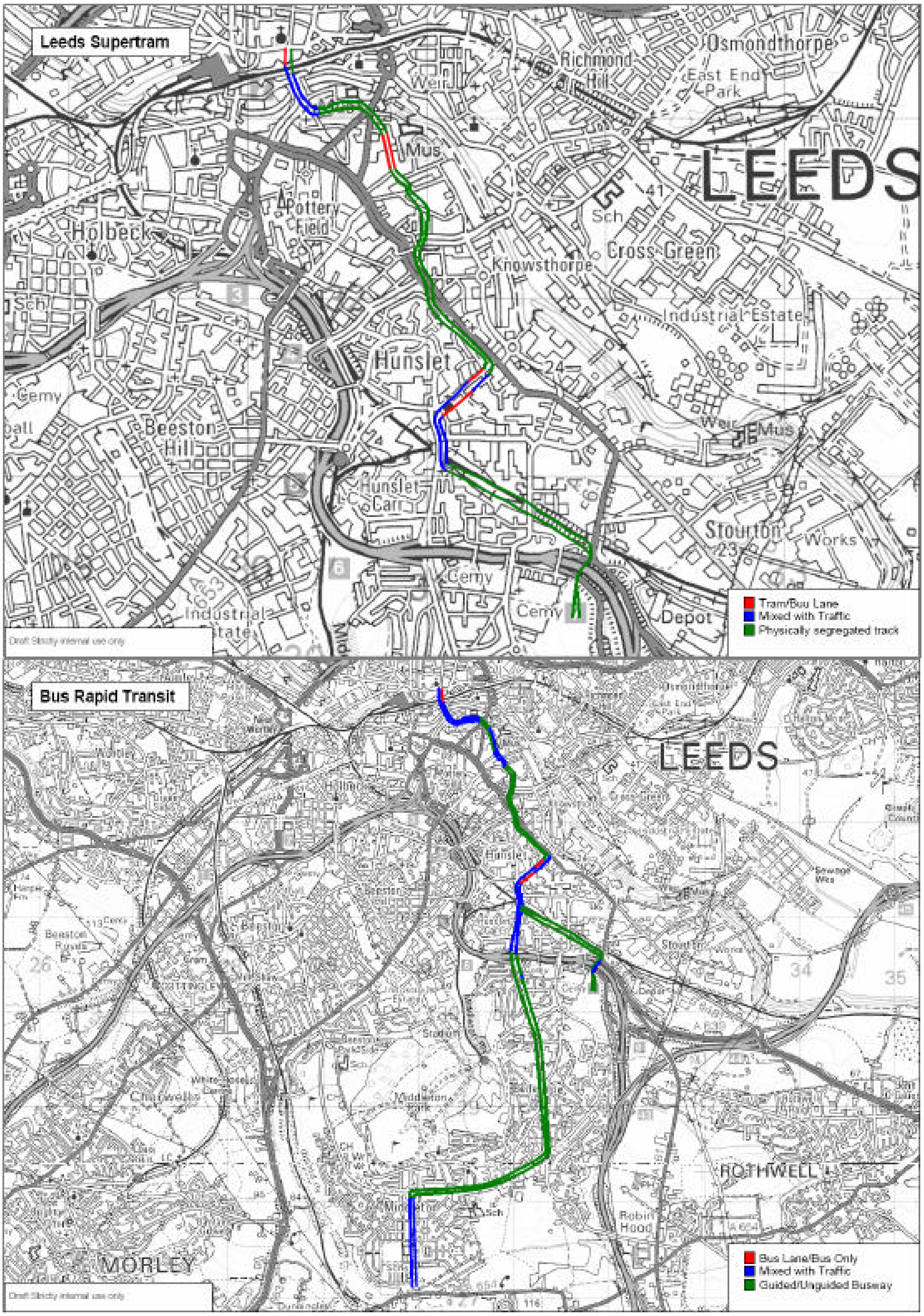


Figure 2.3 – Route Alignments: South



2.13 The absolute level of segregation provided to the rapid transit scheme (either tram or BRT) varies by corridor. There is a lower level of segregation provided to rapid transit on the line to the north, for instance, with vehicles running in mixed traffic for approximately half of the route. On the southern line, a higher level of segregation is provided. The majority of the route to the Stourton Park and Ride site is segregated for both tram and BRT. Similarly, on the section from Balm Road south to Tingley, where only the BRT option is proposed, the majority of the route is segregated from general traffic in dedicated guideways.

JOURNEY TIMES

2.14 Overall journey times by public transport comprise the access journey to the origin stop, the wait at the stop, the in-vehicle time, and the egress from the destination stop to the ultimate destination. The BRT alternative was developed from the tram scheme, with consistent assumptions made about the location of stops. This results in any access to, and egress from, the system being the same for the two alternatives. Any differences in actual journey times offered by the two alternatives, therefore, are as a result of in-vehicle time, or wait time (which is related to the frequency of service).

In-Vehicle Times

2.15 Alongside the engineering design, a detailed BRT run time model was established on behalf of Metro, compatible with the tram run time model.

2.16 This section describes the journey times forecast to be attainable by Bus Rapid Transit in the run time model in the work for the November 2004 submission, and shows how these journey times compare to those forecast to be achievable by Supertram.

2.17 As part of the analysis we also examined current day bus run times in the same corridors from published bus timetables. The result of these analyses, for the entire route of each corridor, is shown in Table 2.1 below. The table shows the times for inbound trips along the entire length of each line. In some instances there was no comparable bus route to the proposed rapid transit option, so approximations had to be made based on nearby bus services.

Table 2.1 – Approximate Corridor Run Times (in-vehicle time only)

Corridor	Existing Bus	BRT	Tram
North	25 mins	21 mins	19 mins
East	28 mins	21 mins	19 mins
South (Total)	30 mins	20 mins	19 mins
South (Middleton to Balm Road)	15 mins	14 mins	14 mins

2.18 Table 2.1 provides an indication of the likely in-vehicle journey time savings to be made by BRT (and by the tram), compared to existing scheduled bus journey times. On the line to the north, for instance, the existing buses are scheduled to take approximately 25 minutes to reach the City Centre. Introducing priority measures with the BRT proposal will reduce this to 21 minutes, a saving of 4 minutes. Introducing a tram will then reduce this further, to 19 minutes, a further saving of 2 minutes over BRT. There is a similar picture on the other two lines, although the savings from existing buses to the BRT option are much greater, reflecting the higher degree of segregation provided on these two lines.

2.19 On the line to the south there is little time saving from Middleton to Balm Road, with either the BRT or tram, compared to the existing bus times. The BRT is forecast to save 1 minute over existing bus, with the tram forecast to save little additional time. It should be noted that in the current submission the tram has been truncated to the south, and will not run over the section between Middleton and Balm Road. The reference to journey times has therefore been made with the original untruncated tram scheme, purely for comparison purposes.

2.20 Atkins has met with Metro's technical advisors to establish the differences between the forecast tram and BRT run times, and in particular to establish the locations where the BRT gains or loses time compared to the tram. Detailed analysis on the difference between the run times on the two modes is shown in Appendix A. The time differences are as a result of specific differences in infrastructure provision between the two systems, along with some general assumptions on differences arising from the characteristics of the mode.

2.21 The key locations where there are specific differences are shown in Table 2.2 below.

Table 2.2 – Locations where BRT loses time compared to Tram

Line	Details
South Line	Hunslet Road – BRT has to cross the Hunslet Road more slowly than tram, due to the tighter geometry required for BRT drivers to safely negotiate the highway (there is no guidance), in order for the BRT to cross from the nearside to the offside, and enter the guideway safely.
North Line	City Centre – BRT is specified to run on-street via Woodhouse Lane, whereas the tram uses Cookridge Street and Millennium Square (see discussion below).
	BRT runs in a kerbside bus-lane on the approach to the Lawnswood roundabout, removing the need to remove rows of mature trees. This decision was taken based on a) the local sensitivities, b) safety issues with running BRT through the middle of the narrow roundabout island, and, c) the desire to locate a stop on the south side of the Ring Road. This leads to additional junction delay for the BRT.
East Line	The BRT terminates at Seacroft Centre, and some time is lost whilst the BRT negotiates a roundabout in order to reach the terminal stop.
	The BRT alignment differs from the tram alignment at the proposed BRT Park and Ride site on Wetherby Road. At this location, delays accrue to the BRT due to the fact that the tram has no Park and Ride facility here, and can proceed without mixing with Park and Ride traffic. The Park and Ride junction causes additional traffic conflicts which constrain the level of priority which can be provided to BRT. In addition, BRT needs to negotiate the roundabout before entering the guideway on Easterly Road whereas the tram runs segregated. This is due to the additional vehicle conflicts at the Park and Ride junction and the narrow width of the proposed roundabout island (see Lawnswood Roundabout for similar issue).

2.22 The levels of time lost due to the factors listed in the Table above range from 15 seconds to just over 70 seconds. The highest delay is that on the north line approaching the City Centre, on the section between the University of Leeds and the Civic Precinct, where the BRT has to negotiate the congested section of network around Woodhouse Lane. The tram is specified to take an un-congested route through the pedestrianised Millennium Square to avoid this section.

2.23 The Leeds Supertram team have advised that the decision to allow trams to run through Millennium Square and not the BRT vehicles was taken following consideration of environmental, safety, ride quality, traffic and deliverability grounds for the BRT option. They considered that unguided rubber tyred vehicles would require a distinct running surface, with kerb upstands and probably blacktop surfacing, to maintain quietness, ride quality and safety/legibility of route in this important area in the centre of Leeds. They also considered that a tram, on the other hand, could maintain legibility by the rails and use of coloured blockwork, and surface finish would not be affected as rails could be inset. There were also further issues relating to noise and emissions from BRT vehicles, and a decision to construct a new vehicle deck for tram but not BRT. There were also concerns related to the inherent safety of allowing buses to traverse Millennium Square. All of these factors resulted in the Supertram team seeking advice from Leeds City Council, which concurred with the decision not to include this route for BRT. It is Metro and the City Council's view that this is a firm decision which will not be revisited.

2.24 In addition to these specific locations, the BRT loses time, compared to the tram, for a number of other reasons. Firstly, on-carriageway tramlines have been assumed to be effectively "self-enforcing", whereas it has been assumed that on-carriageway bus lanes can be blocked by stopping / loading vehicles. This results in lower average speeds for BRT in these sections. It is recognised that the visible presence of tram infrastructure will assist with self-enforcement, particularly as drivers recognise that tram vehicles cannot drive around obstructions. However, it is Atkins' view, but not that of Metro, that BRT vehicles running at higher frequencies (typically double) than those of tram are likely to be more visible than trams, a factor which will help with self-enforcement. In addition, BRT vehicles will also be able to steer around obstructions which trams cannot. This can be a particular issue at 'yellow box' junctions. It is possible that a rigorous enforcement regime could be implemented which would solve this problem, but this would have ongoing cost implications which are difficult to quantify and the costs of such a regime have not been included in the appraisal work reported herein. The run time differentials have, therefore, been maintained in the subsequent appraisal work undertaken in this study.

2.25 A second area where the BRT is forecast to lose time compared to the tram is at traffic signals. It has been assumed that on-street bus priorities will not be dedicated to BRT, but would instead cater for all buses. It is the view of the Highway Authority that at signals it would, therefore, be more difficult to interrupt the normal signal cycles in order to give BRT priority. As the BRT would run at a higher frequency than the tram, combined with the general bus operation in the corridors, the over-riding of the signal settings would have to occur more frequently, and it is likely the level of priority made available to buses would have to be reduced in order not to disadvantage other traffic. With BRT vehicles running at a frequency of 12 buses per hour on most sections, then giving priority to the peak direction is only one vehicle every 5 minutes, which is much higher than an average cycle time. However, it is possible that priority would have to be given to other non-BRT bus services operating in the same corridor, unlike the tram where priority could be given over existing buses. In our work for CfIT on Affordable Mass Transit, we found that Transport for London assume difficulties in delivery of effective priority at signals occur at frequencies of around 20 to 30 vehicles per hour per direction and above. Thus, whilst priority could be given to the BRT and non BRT bus services, it is acknowledged that this may at a reduced level compared to the tram.

2.26 The run time models for both tram and BRT had a common set of assumptions on dwell time incorporated. It is assumed that the vehicles stop for 15 seconds at each stop for the boarding and alighting of passengers. It was assumed that tickets were purchased off vehicle for both modes. The other major factor influencing dwell time was, therefore, the number of doors to allow passenger access. Whilst the tram would have more doors per vehicle, the BRT would operate at a greater frequency, which means that a similar number of doors would be available throughout the day on the two systems. We therefore believe that this consistent assumption between the two modes appears to be reasonable.

2.27 Atkins considers the run time work to have been undertaken in a thorough manner. There are areas where the assumptions can be revisited, with changes proposed, if appropriate. We acknowledge that any changes would, however, involve changes to the infrastructure and thus cost of the scheme. The current study is such that there has not been time to undertake a systematic review of potential changes, so the work carried forward has kept the same basic assumptions as those proposed by Metro.

It is the promoter's view that the report overstates the capability of reducing BRT journey times through enforcement, does not adequately reflect dwell time differences between BRT and tram, and does not recognise that priority for BRT has been included in the journey time forecasts.

Wait Times

2.28 The service frequency of BRT was calculated by assuming 80% of the tram demand, and then dividing this by the capacity of the design vehicle for each corridor. This resulted in an assumed frequency for BRT approximately double that for the tram option. The tram is assumed to run at 6 trams per hour (one every 10 minutes) on the outer sections of the corridors, and 10 trams per hour (one every 6 minutes) on the inner sections.

2.29 The wait times for a public transport system can be derived from the service frequency. For public transport services running at these levels of frequency, a uniform passenger arrival pattern is usually assumed. Thus, for tram, an average wait time is assumed to be 5 minutes for stops on the outer sections of the lines, and 3 minutes for stops on the inner sections. For BRT, the average wait time would be 2.5 minutes on the outer sections of the lines and 1.5 minutes on the inner sections.

Total Journey Time

2.30 The total journey time for the two modes is derived by adding together the access/egress time to the system, the wait time, and the actual in-vehicle journey time. In the earlier section on run times, it was seen that the BRT over the full length of a corridor was forecast to be between 2 and 3 minutes slower than the tram. Given that the BRT vehicles run at higher frequencies than the tram, then any actual advantage to tram in terms of in-vehicle time is likely to disappear once the higher frequency, and thus lower waiting times, of BRT is taken into account.

2.31 An example of total journey time for a trip on the entire line to the north is given in Table 2.3 below. This assumes that walk times at either end of the journey are equal.

Table 2.3 – Approximate Total Journey Time – North Line

Journey Time Element	BRT	Tram
Walk Time	-	-
Wait Time	2.5 mins	5 mins
In Vehicle Time	21.3 mins	19.2 mins
Total Journey Time	23.8 mins	24.2 mins

2.32 From Table 2.3 it is apparent that, in terms of total journey time, BRT and tram are forecast to offer very similar journey times for trips from the outer stops to the city centre. For trips from closer to the city centre, the tram and BRT frequencies have been strengthened resulting in a lower wait time advantage to BRT over tram. At this point in the journeys the absolute run time differences will also be less, resulting in a lower run time advantage to tram over BRT. It is anticipated, therefore, that again total journey times between the two modes will be similar.

VEHICLES

2.33 In Metro's November 2004 submission, the BRT was assumed to be operated with high quality 'CiViS'-type vehicles, with a design life of 20 years. These vehicles were costed at £700k each. More information on vehicle types is given in section 3 of this document.

SUPPORTING INFRASTRUCTURE

2.34 The supporting infrastructure for the BRT system was defined to be as close to that of the tram as possible. Stops, for instance, were taken to be in the same locations as those proposed for the tram (insofar as possible), and distinct from general bus stops. The design also includes (for) raised platforms and other facilities mirroring those provided for tram, including high quality shelters, real time information, ticket machines, lighting, and CCTV. It was also assumed that each BRT stop will be an all-day bus clearway with appropriate restrictions on the approach to the stops.

COST

2.35 The cost of the BRT scheme proposed by Metro is £209 million. This sum does not include any adjustments for optimism bias. It has not been possible to compare the cost of the BRT directly against that of the tram, as the tram costs are commercially confidential, and have thus been withheld from consideration in this study.

2.36 The breakdown of costs for the BRT scheme is shown in the table below.

Table 2.4 – BRT Capital Costs (£, Million)

Section	Cost (£,M)	% of scheme costs	% of infrastructure costs
City Centre	9	4.4	5.6
North Line	35	16.7	21.5
East Line	46	21.9	28.3
South Line to Balm Road	18	8.8	11.4
Stourton Spur	23	11.0	14.2
Balm Road to Middleton	31	14.7	19.0
Miscellaneous (including depot)	20	9.6	N/A
Vehicles	27	12.9	N/A
Total	**209**	**100.0**	**100.0**

2.37 The capital cost breaks down into approximately £162 million for the infrastructure in the corridors, with a further £47 million for miscellaneous items, such as the provision of the depot and vehicles.

2.38 The breakdown of costs shows the large cost associated with the construction of the line to the south. The entire line to Tingley, including the spur to Stourton, is forecast to cost £72 million, some 44% of the total infrastructure cost. The main cost within this is the section from Balm Road to Middleton, which is forecast to cost £30 million, which alone is 19% of the overall infrastructure cost. The vehicle costs are approximately £27 million, or 12.9% of he total scheme cost.

2.39 Further information has been supplied on the costs of the infrastructure to allow the costs to be broken down by cost element, rather than by geographical coverage. In this analysis, the major items associated with the construction of the BRT are junction improvements at £32.8 million, stops (including constructing Park and Ride facilities) at £31.3 million, landscaping at £29.2 million and the guideways at £24.5 million.

2.40 If implemented, a BRT scheme in Leeds would represent the first large-scale BRT scheme in the UK. It is, therefore, difficult to find other scheme costs with which the Leeds estimates can be compared. There are examples of scheme costs quoted in studies of mass rapid transit systems, which are explored in more detail in section 3 of this document. Brand and Preston, for instance, in their paper, 'Which Technology for Urban Public Transport?', quote infrastructure costs for guided bus, in 2000 values and prices, of between £2.5 and £5.8 million per two-way kilometre, with an average of £3.7 million per two-way kilometre. Hass-Klau, in her paper, 'Bus or Light Rail: Making the Right Choice', quotes costs in the range £2.2 to £4.1 million per kilometre two-way at 1998 prices.

2.41 The Hass-Klau report includes a system cost of approximately £4.1 million per kilometre, in 1998 prices, for the scheme on the Scott Hall Road in Leeds (excluding Park and Ride), for the guideway section, including stops and environmental treatments. The entire system, including a section of bus lane, cost £3.2 million per two-way kilometre. The cost included a factor of 1.8 to take it from one-way to two-way.

2.42 The infrastructure costs for the Leeds BRT system (excluding vehicles), as detailed in the November 2004 submission document, equates to £6.7 million per two-way kilometre, in 2004 prices. For the guideway sections, the average cost of guideways is £3.0 million.

2.43 Even accounting for the differences in price bases between the sources quoted, the overall infrastructure costs for the BRT option appear to be at the upper end of those quoted in the research, particularly as the costs quoted generally relate to sections where guideways have been constructed, which is only relevant for approximately one-third of the route in Leeds. The costs for the guideways themselves, however, look to be in line with those previously constructed in Leeds. It should be noted that the costs quoted from the research are for guided busway systems and do not reflect the full quality attributes of the BRT system, such as tram-like stops and other associated infrastructure, which will obviously increase the cost over general guided bus costs.

2.44 In order to draw firm conclusions about the scheme costs a detailed cost audit would need to be undertaken, with information required at a much greater level of detail than that currently examined. More pertinently, it is considered that a detailed review of costs would require a much longer study than the one currently being undertaken. If a BRT option were to be pursued after this current study, then it is recommended that a detailed value engineering exercise be undertaken, including a thorough review of infrastructure and its cost.

2.45 In the subsequent appraisal work that is detailed later in this document, the cost forecasts quoted in this section have been used.

CONCLUSIONS

2.46 This section has been concerned with the examination of the BRT scheme proposed by Metro in the November 2004 submission to Government. It is obvious that a great deal of thought and effort was put into designing a system that was as close to tram as possible. Such a system had an obvious concentration on quality and is reflected in the operational performance of the BRT described in this section.

2.47 The BRT scheme designed provides almost the same infrastructure and quality features as Supertram. The level of segregation provided on each of the three lines is very similar, as are all of the supporting measures such as high quality shelters, real time information and CCTV.

2.48 The fact that almost the same infrastructure has been provided results in there being relatively little difference in actual journey times between the two modes. The Supertram proposal is of the order of 10% faster in terms of run-time, but this is offset by the higher frequency, and thus reduced wait time, of the BRT. The actual journey times forecast to be achieved by the two modes are, therefore, very similar.

2.49 The reasons for the differences in in-vehicle time have been examined. We consider that there could be scope to reduce some of the differences in run times, but there would be a cost associated with doing so. In the remainder of this report, the run-times, as derived by Metro, have been used.

2.50 The line to the south provides the highest level of segregated running for the BRT (it has been removed from the tram proposals), but appears to provide little in terms of time savings. The cost of this line is therefore high, to reflect the high levels of segregation proposed. It is therefore proposed that options are examined with the removal of the infrastructure on the southern line.

2.51 On the cost side, it is suggested that if a BRT option is taken forward following this study, then a detailed value engineering exercise should be undertaken to quantify the costs involved, and thus identify potential savings, if any, that can be made.

3. Experience from Elsewhere

INTRODUCTION

3.1 This section reviews the experience from elsewhere relating to the delivery and performance of high quality tram and bus based public transport systems. The review is based upon the literature research undertaken for the project to develop Guidance for Affordable Mass Transit Systems for the Commission for Integrated Transport. This Guidance identifies some 53 literature sources covering all aspects of mass transit systems throughout the world. The focus of the review in this report is upon 13 of the reference sources (as detailed in Appendix B) that provide information relating to bus based systems, examine research comparing bus and tram systems, and discuss recent experience of tram based systems in the UK. Finally, this section examines some of the vehicles currently available for a high quality bus based system.

OVERVIEW OF RESEARCH RELATING TO TRAM AND QUALITY BUS SYSTEMS

Overview of Sources Available

3.2 The performance of bus-based systems relative to light rail systems and the ability of each to deliver sustained benefits to both users and non-users is a subject which has attracted considerable debate. Extensive research has been undertaken into outcomes from the implementation of light rail schemes across the world, and a number of authors (particularly Hass-Klau and Compton, and Brand and Preston) have sought to directly compare these with those of bus-based schemes.

3.3 A variety of literature also exists on the impacts of higher quality bus schemes, especially those in North and South America. In particular, evidence has been drawn from such examples to develop guidance on what lessons have been learned and what could be applied elsewhere (see particularly publications by the Transportation Research Board and the Federal Transit Administration).

3.4 Within the context of this report, and given the volume of available literature, it is felt appropriate that this section provides a summary of research into quality bus and tram systems and not a comprehensive literature review. For further detail on individual sources, the reader is directed towards the full bibliography in Appendix B which also provides detail on what is covered within each source.

Experiences of Quality Bus compared to Light Rail

3.5 In order to better evaluate the performance elements which form the core of the quality bus-light rail debate, further consideration is given here to the ability of each system to deliver patronage growth, modal shift from the private car, journey time savings and journey time reliability and offer environmental benefits.

3.6 A summary of the key benefits of light rail and quality bus schemes, as determined through experiences with each mode, is included in Table 3.1.

Patronage and modal shift

3.7 Research on public transport patronage growth suggests that the greatest proportion of passengers transferring to both light rail and quality bus systems do so from existing public transport (see, for example, Hass-Klau and Compton, Brand and Preston, and the National Audit Office report).

3.8 It is clear, however, from much of the available literature that a key attraction of light rail over quality bus has been its ability to influence modal shift away from the private car. Ranges presented by Brand and Preston (2003), show that between 18% and 25% of UK light rail users previously made their journeys by car compared to between 7% and 11% for the Leeds Scott Hall Road guided bus scheme and the East Leeds Quality Bus Partnership scheme.

3.9 Furthermore, research by Hass-Klau and Compton (2000) suggests that UK light rail schemes have proven more adept at sustaining modal shift than quality bus schemes, where the proportion of passengers who were former car drivers has tended to decline relatively quickly after an initial peak.

Table 3.1 – Quality Bus and Light Rail – a summary of the perceived benefits

Light Rail	Quality Bus
• Perceived by the public as a more attractive mode than the bus • Proven to deliver greater and more sustained modal shift than bus priority measures • Offers a fixed asset which has a greater perception of permanence than bus options, giving confidence to potential investors • Better suited to the medieval street layouts of European centres which inhibit penetration by bus • More publicly acceptable in urban areas than high frequency bus services • High vehicle capacity means that passengers can be carried more efficiently than by bus and best use can be made of junction priority • A high quality of ride can be offered throughout the length of the journey • The environmental impact of light rail in urban areas is lower than bus	• Infrastructure capital costs per kilometre are generally lower than light rail • Design standards can be altered in accordance with capacity needs • Quality Bus offers greater flexibility than light rail • Services can be extended into areas of low population density without the need for a transfer between vehicles • Systems can be implemented quickly • Quality Bus can offer a comparative level of ride experience to light rail if the quality features of light rail are incorporated into system design

Journey time savings and journey time reliability

3.10 Research by Brand and Preston (2003) suggests that light rail schemes have been found to offer greater in-vehicle journey time benefits compared to bus priority alternatives. Furthermore, there appears to be no correlation between the length of a bus priority scheme and journey time savings, with most offering savings of between 0 and 5 minutes. The key influence on this is journey speed, determined principally through factors such as the number of stops, vehicle acceleration, fare collection systems and traffic priority.

3.11 Similar factors are also felt by Hass-Klau and Compton (2000) to favour light rail in providing reliable journey times. Key reasons for this are suggested to be greater vehicle loading efficiencies (particularly due to multiple vehicle access points and off-vehicle fare collection) and the more efficient use of priority measures at junctions. Quality Bus examples in Rouen and several North American cities, however, suggest that such issues can be largely overcome (see Transportation Research Board and Federal Transit Administration).

Environment Impacts

3.12 In a comparison of the environmental impacts of light rail and buses, Brand and Preston (2003) suggest that total environmental bus costs (at around 1 pence per passenger kilometre) are higher than urban rail costs (around 0.7 pence per passenger kilometre). Such costs vary significantly, with bus costs especially high in densely populated urban areas. Advances in vehicle technologies, though, through advanced diesel propulsion in the short-term and hybrid electric vehicles and fuel cells in the longer-term would offer significant benefits for bus-based systems.

Influencing the success of Quality Bus

3.13 Research into the success of quality bus schemes, particularly those in North America and continental Europe, by the Transportation Research Board (2003) and the Federal Transit Administration (2004) suggests that the most successful schemes have been those with features which have, as closely as possible, replicated those of light rail schemes. Design features which have been found particularly important include:

- A system which largely operates on exclusive rights-of-way, ideally with wide distances between stations to ensure high vehicle speeds;
- Attractive stations which offer a waiting environment suited to all weather conditions;
- High quality timetabling, including the provision of real-time passenger information;
- Clearly and distinctively branded buses;
- Off-vehicle fare collection which helps to reduce bus dwell times;
- Quiet, easily accessible modern multi-door vehicles;
- A frequent, all-day “turn-up-and-go” service;
- The implementation of accompanying measures to improve traffic management, including bus lane camera enforcement;

- The provision of passing spaces in stations to prevent services being delayed by the loading of other vehicles; and
- Fitting vehicles with tracking equipment so that any incidents which will affect journey times can be quickly responded to.

MODERN TRAM SYSTEMS IN THE UK

The National Audit Office report 'Improving public transport in England through light rail'

3.14 The National Audit Office (NAO) report, published in April 2004, examined the DfT's work to date in funding the construction of light rail systems in England. Since 1980, seven new systems had been provided, with a total cost of £2.3 billion and a total DfT contribution in excess of £1 billion. The report also examines a number of systems that were still in the planning stage at that time, including Leeds Supertram, and notes the trend towards increased costs as systems were developed. Whilst the NAO report is focused upon light rail, it is of relevance to this study as it demonstrates a history of patronage shortfall in the systems delivered to date.

3.15 The NAO report details ten overall conclusions:

- The expenditure by the DfT has been kept within budget on all but one scheme;
- There has been incomplete evaluation of existing systems;
- Light rail has improved the quality and choice of public transport;
- Anticipated benefits have been overestimated and systems are not being exploited to the full;
- Light rail systems in France and Germany are designed differently from those in England;
- Systems in England have been running at a loss;
- Light rail systems in France and Germany have higher patronage levels than similar systems in England;
- The DfT needs to do more to improve value for money and there are barriers to wider take-up of light rail;
- The forecast costs of schemes currently under development have risen; and
- There are fewer barriers to light rail in France and Germany.

3.16 From the above conclusions the report details six overall recommendations as follows;

- The DfT should commission comprehensive evaluation of the costs and benefits of each of the systems. This information should be made widely available;
- The DfT should require authorities to include where appropriate: integration with other public transport modes; complementary measures such as Park and Ride; and secure 'speedy and punctual' services by ensuring priority to light rail vehicles over other road vehicles;
- Financial viability should be improved through identification of the most cost effective procurement methods;

- Cost reductions should be sought through greater standardisation; use of appropriate safety standards; better risk management for utility diversions; review of the allocation of the costs of utility diversions; consideration of the potential for application of energy saving grant schemes to light rail; and consideration of the potential for use of heavy rail infrastructure through conversion or track sharing;
- Developing other sources of funding for light rail schemes; and
- Adoption of a more strategic approach to light rail system development, with DfT advice as to the types of context as to where light rail may be most appropriate.

3.17 The implemented systems reviewed by the NAO report are detailed in Table 3.2 below:

Table 3.2 - Light rail systems in the UK (NAO Report)

System and date	Construction Cost (£m)	Length (km)	Patronage 2003/4 (m)	Forecast Patronage	Patronage shortfall
Manchester Metrolink Phase 1 - 1992	145	31	19	18	5% excess
Sheffield Supertram - 1994/5	241	29	12	22	45%
Midland Metro - 1999	145	21	5	8	38%
Croydon Tramlink - 2000	200	28	19	25	24%
Manchester Metrolink Phase 2 - 2002	160	8.2	Included above	Included above	Included above
Sunderland extension (Tyne & Wear) 2002	98	18.5	n/a	n/a	n/a
Nottingham NET - 2004	180	14.3	n/a	n/a	n/a

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3.18 The NAO report notes that, with the exception of Manchester Metrolink, there has been a consistent shortfall in patronage compared with that forecast. Since the publication of the NAO, report the Nottingham NET has reported the first full year of operation and is showing annual patronage slightly in excess of that forecast.

3.19 As noted in the conclusions above, the NAO report demonstrates that the light rail systems that have been delivered have provided the high quality transport facilities intended. However, the history of a shortfall in patronage has reduced the benefits delivered by these systems. The report identifies a number of reasons for the shortfalls:

- Over-optimistic forecasting;
- Change to the patronage base;

- Early operational problems;
- Competition with buses; and
- Physical limitations on the selected route.

3.20 Atkins notes that the poorest performing system was that in Sheffield (South Yorkshire Supertram, for which Atkins undertook the monitoring study). The reasons for the shortfall in this case are complex and include all the factors noted above. The Supertram system suffered in particular from competition with bus operators, with competing services using new buses providing faster journey times than Supertram on some routes. The monitoring study showed that the Sheffield system was relatively successful in capturing former car users but did not achieve the level of transfer from bus that had been forecast.

3.21 With the exception of South Yorkshire Supertram (which has a mixture of segregated and unsegregated alignment following existing highway routes), the recent UK light rail systems make extensive use of heavy rail alignments, either through conversion (as with Metrolink and Tramlink), use of a disused alignment (as with Midland Metro) or use of spare physical space (as with Nottingham NET). The use of heavy rail alignments provides a high degree of segregation and faster running times than possible road based systems, providing a clearer differential in journey times between light rail and competing bus services.

3.22 Atkins notes that analysis from monitoring of these systems has been unable to identify with certainty the precise factors affecting patronage shortfalls, due to the complexity of the variables affecting user choice. However, there has been a trend towards optimistic forecasting, suggesting that light rail may be less attractive relative to other transport modes than has been assumed in the forecasting process for these systems. The evidence of lower than forecast bus transfer from the Sheffield system indicated a readiness to continue using bus services where the tram did not offer clear travel time advantages.

The PTEG ‘What Light Rail can do for Cities’ report

3.23 This report was commissioned by the Passenger Transport Executive Group (PTEG) to address concerns regarding the affordability and financing of light rail schemes. The report acknowledges the work in the NAO review and seeks to identify the benefits that have been delivered by the light rail schemes in the UK. The report makes some comparisons between bus and light rail systems, which are discussed below.

3.24 A number of important features offered by light rail systems are identified:

- Penetration of town and city centre with permanent, visible and acceptable infrastructure;
- Predictable, regular and reliable journey times and service patterns;
- Accessible and visible stops;
- A high quality ride throughout the entire journey;
- Short dwell times;
- High passenger carrying capacity;

- Additional capacity provided in a sustainable way;
- Park and Ride facilities attractive to car users
- Integration with new developments;
- Linking major traffic generators/attractors;
- Integration; and
- Permanence.

3.25 The report notes that a particular feature of light rail is the ability to carry more passengers than bus based alternatives (up to 20,000 passengers per hour per direction) together with attractive journey times. It is noted, however, that most light rail systems in the UK are carrying lower volumes of up to 2,500 passengers per hour per direction.

3.26 The report notes the opportunities for improving bus services but that there are some features of light rail that cannot be provided by bus based systems, notably level boarding throughout the system and guaranteed service quality provision in the long-term. Thus, whilst costs for bus systems are likely to be lower, the scale of benefits delivered will also be lower.

3.27 The report reviews current light rail usage in the UK and notes that systems:

- Operate at or near capacity at peak times;
- Carry significant numbers of people outside the peak periods; and
- Show steadily increasing patronage over time, despite increased fares and in contrast with overall bus usage (outside London) where fares have risen and patronage fallen.

3.28 Light rail is considered to be a 'feasible and affordable way of reducing urban traffic levels' as it is attractive to car users. It is noted that about 20% of light rail passengers in peak periods, and up to 50% at weekends, have been attracted from car. Quality bus services in the UK are shown to have attracted much lower levels of demand from car users, typically 4.1% to 6.4%.

3.29 The report notes the limited abilities for system promoters to secure integration with other modes or the delivery of complementary measures, but identifies the successes that have been achieved. It is noted that the involvement of the local bus operator in the operation of the NET system in Nottingham has resulted in greater integration.

3.30 The impact of light rail upon local business is examined and the importance of the image of light rail is discussed. The importance of the physical infrastructure associated with tram systems is identified, giving a more 'tangible presence' than is possible with a bus based scheme.

3.31 The report also notes the role of light rail systems in the delivery of greater social inclusion, environmental benefits and safety benefits.

3.32 Section 3 of the PTEG report examines the use of bus systems as alternatives to light rail. This notes that bus systems will generally deliver a very much lower level of benefits than a light rail scheme for the following reasons:

- Significant journey time improvements cannot be secured without provision of segregation commensurate with light rail;
- The quality of journeys cannot be improved over the whole journey to the same extent as light rail. Buses will suffer from poorer ride quality; disruption due to roadworks for utilities access; and lower levels of visibility and presence;
- Car users' perception will be lower for bus than light rail;
- Improvements offered in accessibility, safety and security are likely to be less; and
- Uncertainty over provision of services within a deregulated industry.

3.33 The report notes that there are few examples of major bus infrastructure schemes in the urban areas in the UK and no systems comparable with the French 'tram-like' systems in Nancy and Caen.

3.34 Atkins note that the PTEG report is based upon experience of existing light rail and bus based systems in the UK. The report identifies the lack of major bus based infrastructure schemes in the UK. Thus the report was not able to address the degree to which a bus based system could deliver the benefits of a light rail system when the bus based system is delivered in a similar manner, with a similar level of performance and quality features, as is proposed in the BRT option.

3.35 Examination of the light rail features detailed in paragraph 3.24 above indicates that BRT would deliver most of these features, with the exception of:

- Less visible infrastructure;
- A slightly lower level of reliability;
- A lower degree of vehicle accessibility at stops with partial level boarding;
- A slightly lower ride quality (although the costs include resurfacing of the full route); and
- Less guarantee of service permanence.

3.36 The BRT option would also address some of the disadvantages noted in 3.32 above, offering similar overall journey times, journey quality, safety and security.

BUS RAPID TRANSIT SYSTEMS IN THE UK

3.37 The work undertaken by Atkins to prepare 'Guidance on Affordable Mass Transit Systems' for CfIT revealed the lack of information relating to the performance of, and responses to, high quality bus systems in the UK. The principal reason for this is the lack of implementation of such systems on a systematic basis that would provide comparison with light rail systems in the UK.

3.38 Similarly, there is evidence available from studies where new or alternative vehicles have been adopted, and in some cases (such as London) these studies provide a comparison between differing vehicles including buses and trams. However, these do not provide evidence as to the effects of a systematic approach to high quality bus, where this is implemented in a similar manner to an LRT system and presented as a new 'product'.

3.39 For example, those guided bus projects that have been implemented (such as in Leeds and Bradford) have typically represented incremental developments of existing services. Thus these have not provided a 'step change' in service quality or image.

3.40 A brief overview of experience from some sample enhanced bus systems is given below.

Enhanced conventional bus services

3.41 Overall bus patronage (outside London) has been in a slow decline for many years, with the most recent figures (2005 Transport Statistics bulletin) showing a fall of 2.3% between 2003/4 and 2004/5. However, against this background of decline there are a number of examples where investment in bus services has resulted in large increases in bus patronage. Two such examples are discussed below.

3.42 **Brighton and Hove:** Bus patronage in Brighton and Hove has increased by approximately 50% over the last 10 years. This growth, against a national background of declining bus use, has been achieved as the result of a partnership between the City council and the major bus operator (Brighton and Hove Bus and Coach Company operates some 98% of services in the area). Features of the improved bus offer and associated measures include:

- Enhanced service frequencies;
- Some new fast bus services have been introduced, serving major employers;
- Introduction of a £1 flat fare, which reduced the fare paid by many passengers;
- Faster boarding times and reduced delays as a consequence of the flat fare;
- Investment in new vehicles, reducing the average age of the fleet to just over 5 years, and with over 60% of buses being low floor, kneeling or fully accessible;
- Over 100 accessible bus stops, funded through a combination of Section 106 payments and Local Transport Plan funding;
- Bus priorities, which have increased the reliability of journeys for passengers;
- On-street Real Time Information signs (visible to passengers and motorists) and RTI signs inside the main railway station and in the foyer of a major out of town retail centre;
- Parking enforcement by the city council, keeping bus routes clear of illegally parked vehicles;
- Extension of the controlled parking zone, with charges introduced for on-street spaces that were previously free;
- The bus company now operates the travel office in the main railway station and has extended the opening hours;
- Weekend and night buses operated primarily on a commercial basis, but with some support from local leisure facilities, provided through S106 agreements.

3.43 Whilst bus patronage has grown, traffic levels into the city centre have remained at their 1997 level. It is also believed that cycling trips in the city have increased and economic indicators show that the city has been improving its performance in terms of employment, commercial property prices and occupancy rates, although it has not been possible to obtain detailed data. There is no monitoring information available to quantify the nature of the patronage increase and (in particular) the mode transfer from car.

3.44 **The Kick Start approach in Perth –** Stagecoach undertook a pilot project on a poor performing, low frequency route in Scotland, located in a corridor of aged owner occupiers with high car ownership. In partnership with the local authority, the following improvements were introduced:

- Bus priority measures, including transponder controlled priority at signals;
- New bus shelters;
- Low floor buses;
- Doubling of service frequency;
- Simplification of fares;
- Marketing strategy including launch publicity, direct marketing to households, on-bus marketing, children's competitions, pensioners' lunches etc;
- Door to door market research; and
- Free trip offer to prospective customers.

3.45 The project achieved a 56% growth on the service over a two year period, with (unquantified) mode shift from car to bus and break-even forecast for year four.

Guided Bus services

3.46 Guided bus systems have been provided in Ipswich, Leeds, Bradford, and Edinburgh. The experience in **Leeds and Bradford** has varied by corridor, although all corridors have seen an increase in patronage. The system on the Scott Hall Road corridor uses a number of relatively short sections of guideway, constructed within the highway boundary, to provide segregation at key points in the network. An increase in patronage of 75% was recorded, although this was partly due to other services being brought in to the corridor. Guideways have subsequently been constructed on other corridors in Leeds and the Manchester Road corridor in Bradford. There is no clear evidence as to the scale of mode shift achieved by these guided bus initiatives. Work undertaken by ITS Leeds for First Group estimated that 10% to 20% of new passengers in the Scott Hall Road corridor had transferred from car, but this has been challenged by other research.

Crawley 'Fastway'

3.47 The Crawley 'Fastway' system is the only example currently operating in the UK of a systematic approach to a high quality bus system that incorporates most of the features associated with a tram system, including:

- Extensive priority measures including segregated route sections;
- Real time information using satellite vehicle location technology;
- Dedicated stops;
- Unique branding and livery;
- Dedicated high quality vehicles with unique appearance; and
- Level boarding.

3.48 The priority infrastructure for the Crawley Fastway system is being delivered on an incremental basis and during the initial period the vehicles have been operating through road works sections where guideway is being constructed. The complete system will be 24km in length with 9km of bus lane and 2.5km of guideway.

3.49 The Fastway system serves Gatwick airport, which is an important source of patronage and accounts from some 35% of Fastway trips. Currently, the Fastway system is reported as having patronage some 40% in excess of forecast. However, there is no detailed monitoring study being undertaken and thus there is no evidence available as to the nature of, and reasons for, the additional patronage.

Overview of evidence from UK bus based systems

3.50 The PTEG report discussed earlier in this section, gives a useful overview of the effects of enhancement of existing bus systems in the UK upon patronage and mode shift. This notes that large patronage increase can be achieved through measures such as guided bus and quality bus corridors, although in some cases this has been achieved through service restructuring bringing more services into a corridor. Thus the scale of patronage increase will be highly dependant upon the context and the changes that have been introduced, but increases in a range of 9% to 55% are given for quality bus corridors in Manchester. This is similar to the increases of 50% (over 10 years) recorded in Brighton and 56% over two years on a single route as result of the Kick Start project in Perth.

3.51 Evidence on mode shift is limited as this requires more detailed survey and analysis work. However, the literature research undertaken by Atkins identified a range of mode shift from car due to bus based system improvements of 3% to 10%. This is similar to the range of 4.1% to 6.4% indicated in earlier research for CfIT and quoted in the PTEG report.

3.52 Atkins concludes that there is no evidence available to quantify with certainty the relative attractiveness of a bus based system and a light rail system when these are implemented on a near equivalent basis. There is evidence that investment in bus systems can achieve significant patronage growth and mode transfer from car, but not as to the scale of these effects when a bus system is delivered with a comparable performance and features to a light rail system. The results from the Crawley system suggest that a systematic bus system of that type may be more attractive to passengers than previously forecast.

COMPARATIVE RESEARCH INTO BUS AND TRAM

Transport for London

3.53 Transport for London (TfL) have undertaken a detailed study of the key characteristics of tram and bus based public transport modes, including conventional bus, maximum bus priority and segregated busways. The TfL analysis has concluded that street tram (on street light rail) in the London context is most appropriately used in major corridors requiring high capacity services but not served by frequent heavy rail services. The TfL analysis shows that the total costs per passenger place/km for bus priority based systems exceed street tram above a crossover point dependant upon the nature of the corridor. For a medium cost corridor (as in Croydon Tramlink) the crossover is between 2500 and 3000 passengers per hour per direction, for a high cost corridor the crossover point increases to 4000 passengers per hour.

3.54 TfL also note that bus service quality worsens with increased frequency and that the maximum vehicle flow to obtain good priority through junctions in one direction is 25 vehicles per hour in the London urban traffic control system, with a preferred value of 20 vph and an absolute maximum of 30 vph. With 25 vehicles per hour and articulated buses with a capacity of 120, this gives a maximum hourly capacity in one direction of 3000. This figure is consistent with the crossover capacity discussed above.

3.55 On the basis of the above, current TfL policy is to pursue street tram where forecast peak hourly patronage is likely to exceed the levels discussed above and to pursue bus based measures for lower flow corridors.

Brand and Preston 'Which technology for urban pubic transport'

3.56 A paper entitled 'Which technology for urban public transport' by Christian Brand and John Preston (Transport Studies Unit, University of Oxford) was published in the 'Proceedings of the Institution of Civil Engineers: Transport 156' in November 2003. This paper examines the evidence relating to the technical and financial characteristics of urban public transport systems, including light rail, guided bus, bus priority and suburban rail systems. The paper was prompted by statements in the 1998 White Paper 'A New Deal for Transport' regarding the potential role of light rail and bus systems and the '*conflicting empirical evidence in the UK and abroad'* noted by Brand and Preston relating to the performance of such systems.

3.57 Brand and Preston examine:

- Technical characteristics and performance;
- System costs;
- Operating costs and fare box revenue;
- User benefits;
- Non-user benefits; and
- Wider benefits and impacts.

3.58 The paper provides a number of conclusions, including:

- LRT systems cost more to build than bus based systems but generally carry more passengers and provide a higher mode shift from car;
- Operating costs per passenger-km are similar for most systems;
- Time savings are generally greater for light rail than bus systems, but this is largely due to investment in bus systems being focused on '*congestion hotspots'* rather than the overall length of a route; and
- Electric propulsion is currently the best option to mitigate local air quality and noise issues but new vehicle technologies (including advanced diesel propulsion) '*are poised to play a major role in reducing emissions in the future, in particular for bus-based systems*'.

3.59 When comparing the benefits from light rail and bus systems Brand and Preston note that '*we do not compare like with like, as bus priority and guideway sections often signify only a small percentage (<5%) of the total service line, whereas, for example, light rail benefits are a result of the performance of the entire line/service'.*

Hass-Klau et al 'Bus or Light Rail: Making the Right Choice'

3.60 This report examines the experience of existing public transport systems, including light rail, guided bus, busway and bus lane systems. An extensive review is presented of such systems throughout the world. The examination includes technical and financial aspects of existing systems and also presents some survey results on attitudes and judgements of passengers.

3.61 The report notes the lack of experience regarding bus based systems and the trend for major investment to be focused on light rail systems. In particular, it is noted that '*So far there is no City in the world which has implemented a full guided bus network, so the experience is meagre'.* The report continues that '*it is a matter of concern for British current thinking that apart from Leeds, none of those other few cities which built guided busways, have expanded them further'.*

3.62 The review of technical aspects notes that:

- Light rail generally has higher capacity than bus, but some busway systems can carry similar numbers of passengers to light rail;
- Buses on busways are the fastest mode, light rail tends to be faster than bus when sharing space with general traffic;
- Noise and air quality considerations favour light rail but '*innovations in diesel technology will in future provide zero emission buses';*
- *'Running comfort for passengers is best with light rail but can also be good with buses';* and
- '*Light vehicles operating on their own corridor will rank slightly higher than buses in terms of space, speed, capacity, comfort, pollution and noise although buses could do equally well in terms of capacity and speed, and modern buses also compare well regarding pollution'.*

3.63 Hass-Klau compares infrastructure costs per kilometre, vehicle costs and operating costs. The report concludes that infrastructure costs can be similar (per kilometre), light rail vehicles are much more expensive than buses but have longer life expectancy and that light rail operating costs can '*only be cheaper than bus if it is running at or near full capacity*'.

3.64 The report notes that European cities with light rail systems have generally shown higher levels of passenger growth than cities reliant upon buses but that this may be due to more effective car restraint measures in the former. With regard to mode transfer from car it is noted that for light rail '*transfers of more than 20% are very much the exception and not the norm'* with transfer to buses generally lower, although an exception is Dublin with 16% of passengers attracted from car.

3.65 Hass-Klau states that complementary measures (such as road or parking charges) have a decisive influence upon modal transfer regardless of the public transport mode. The report also notes that the '*actual figures for transfer will – in all cases –*

depend on the actual service, speed and fares offered'. Hass-Klau continues to note that there is insufficient research available to determine whether people prefer rail to bus under equal conditions, with '*the problem for analysis is that conditions are usually not equal'.*

3.66 The report includes the results of a survey of some 1,800 car drivers from four UK cities (Edinburgh, Manchester, Leeds and Sheffield). These showed that car users' preferences for public transport improvements (in order of importance) '*were for higher frequency, more routes, better reliability and a cheaper service*'. Preferences between light rail and bus were also tested, based upon photographs of the existing guided bus in Leeds (operated by conventional buses) and the '*almost space-age'* LRT vehicles from Strasbourg. On the basis of these photographs, the results for Leeds showed a majority (48% to 37%) in favour of light rail. In Edinburgh, however, half the survey sample were shown the Strasbourg picture and half pictures of more '*traditional'* light rail vehicles and stops from Manchester and Karlsruhe. Whilst the Edinburgh survey showed an overall majority favouring light rail, the group shown the '*traditional'* light rail photographs showed a small majority in favour of the guided bus. The subsequent surveys in Sheffield and Manchester used a mix of photographs as in Edinburgh. The results from Manchester showed a majority (62% to 21%) favouring light rail whereas in Sheffield the majority favoured guided bus (52% to 32%). The overall survey result showed a majority preferring light rail (47% to 36%).

3.67 Finally the report considers the implications for policy arising from the research. This concludes that:

*'the decisive influence on the success of a policy of expanding public transport is not the specific mode favoured, but the political commitment to an overall strategy of reducing the dominance of car use in urban areas. Any of the main public transport modes, whether it is bus, guided bus or light rail, can secure expanding demand – **if** a high density, high quality service is provided , and **if** complementary measures (parking charges, large scale pedestrianisation, land-use policies etc.) are vigorously implemented''.*

The report continues to note that the main advantages of light rail are its high cost and inflexibility, leading to '*a high profile as a symbol of commitment*' and ''*inflexibility' becomes redefined as 'security' – the population……can therefore plan their lives knowing that the system will be there in the future'*. Conversely the main disadvantages of a bus based system are described as its cheapness and flexibility. This leads to cautious implementation with the result that service improvements tend to be *'too small to make a great impact'*. Busways and guided buses are noted as '*useful additions to the instruments available………but probably limited to a specific fringe role'.* New types of guided bus are considered to have a potential future, '*especially in medium sized towns where they would operate like trams not buses and therefore would have some of the characteristics of light rail'.* It is concluded that more practical experience and research is required before conclusions can be drawn as to the role of the new generation of guided buses.

Ben-Akiva and Morikawa 'Comparing ridership attraction of rail and bus'

3.68 The paper by Ben-Akiva and Morikawa was published in 'Transport Policy 9' (2002) in the U.S. The research described in the paper seeks to determine whether there is evidence indicating a preference for rail travel over bus. The research undertaken is based around two case studies, one using stated preference data and one using revealed preference from large scale census data.

3.69 Atkins has had recent discussions with Professor Ben-Akiva regarding this research. It is understood that the work was undertaken some years prior to publication and publication was prompted by the volume of requests for information regarding the research. Ben-Akiva has not undertaken further research comparing the attraction of rail and bus and is not aware of any similar research having been undertaken or published.

3.70 The first case study examined analysis of revealed preference data using data relating to travel mode choice by commuters in Washington (U.S.). The 1980 census data was used, comprising a sample of 1 in 12 households. Four mass transit modes were available to commuters; rapid transit (metro), commuter rail, express bus and local bus and models were developed for three car ownership groups. The research examined the relative attraction of bus and rail in eight different corridor types. The results show that the preference for a particular mode varies by corridor and by car ownership group. The overall results showed a preference for metro, but from the comparison of alternative corridor types Ben-Akiva concludes that this is due to '*advantages along with other attributes that were not quantified'.* Ben-Akiva continues to note that '*in some situations, and in particular for express bus service operating on an exclusive lane, the preference toward metro vanishes'.* Thus the final conclusion from this revealed preference exercise is '*that a high quality express bus service with exclusive right-of-way may be equally attractive to metro service*'.

3.71 The second case study is based upon analysis of stated preference (SP) data collected in Boston (U.S.). This data had been collected as part of a study examining preferences between bus and proposed restoration of light rail services in Boston's south-west corridor. The SP data was collected to examine the preferences between the current situation (a bus service in the corridor connecting to an existing light rail service), a through light rail service or one of two alternative bus-rail transfer options. The analysis by Ben-Akiva introduced dummy variables relating to 'bus' and 'rail' in order to test the impact that mode may have upon use choice. Ben-Akiva concludes that the results of this case study '*indicate no preference between rail and bus, but a strong aversion to a bus-rail transfer*'.

3.72 Ben-Akiva's principal conclusion is that '*rail and bus services which provide similar service attributes have the same ridership attraction'.* He continues to note that '*A bus service with 'metro-like' attributes should be analysed using the same alternative specific constant used for a comparable rail service'.*

Overview of evidence from comparative research

3.73 The evidence available shows that there are few high quality bus systems that have been delivered in a manner comparable with light rail systems. Typically bus systems have investment focused on key locations along the route whereas rail based systems have investment throughout the route length. Comparison of bus and light rail systems is therefore not on a 'like for like' basis and typically shows that bus systems tend to be lower cost but deliver lower levels of patronage and mode transfer and thus lower levels of benefit. It is concluded that '*more practical and research experience is required before conclusions can be drawn as to the role of the new generation of guided buses'*.

3.74 Bus based systems can deliver high levels of capacity, but the larger vehicle size and carrying capacity of light rail provides operational and economic advantages at higher levels of flow. Work undertaken in London suggests that for on-street systems, buses are more effective at flows typically less than 3000 passengers per hour per direction and light rail more effective at flows greater than 3000 pphpd.

3.75 Light rail systems have noise and air quality advantages at the point of delivery but advances in diesel engine technology have resulted in reduced impacts from bus vehicles. Light rail vehicles are likely to give the best ride quality but buses can also deliver good ride quality.

3.76 Attitudinal surveys based upon photographs have shown a range of reactions to guided bus and light rail systems. Whilst surveys have shown an overall preference for light rail over guided bus, this varied by location and the systems depicted, with some surveys showing a preference for guided bus over light rail.

3.77 Analytical research has shown no evidence of a 'rail bias' when system service attributes are similar, leading to the recommendation that bus and rail systems with similar attributes should be modelled with the same mode choice parameters.

3.78 The success of a public transport system is less affected by the choice of specific transport mode than the adoption of measures to control car usage.

AVAILABILITY OF HIGH QUALITY BUSES

3.79 There has been an increased emphasis in recent years upon improving the quality of road based public transport. In the UK there has been increased use of lower floor and kneeling buses offering improved, and in some cases, level, boarding and alighting. Other improvements to vehicles have included:

- Improved seating;
- Double glazing;
- Air conditioning;
- Low noise and low emission diesel engines; and
- Use of articulated single deck vehicles to replace double deck vehicles.

3.80 In addition there has been production of a number of demonstration and prototype vehicles aimed at providing a 'tram-like' vehicle that can operate on conventional roadways, in some cases with use of a guidance technology.

3.81 Table 3.3 illustrates the range of vehicles currently available or being demonstrated. The original BRT assessment was based upon the guided, articulated CIVIS vehicle and adopted a vehicle capital cost of £700,000. More recently, FirstGroup plc has been demonstrating the 'ftr' vehicle, developed in conjunction with established vehicle manufacturers the Wright Group and Volvo. This is an articulated single deck bus designed to provide the appearance and facilities of a 'tram' type vehicle. Whilst a new vehicle, the 'ftr' uses existing propulsion technology based on a Volvo low emission engine and drive-train combination that is already in extensive use in conventional buses.

Table 3.3 - Vehicle types and characteristics

Vehicle type	Example	Description	Passenger capacity	No of doors	Fuel type	Approximate cost
Standard single-deck bus	*Optare - Excel*		*45 - 63*	1	Diesel	£110,000 - £135,000
Standard double-deck bus	*Optare - Spectra*		*78 + standing*	1	Diesel	£140,000 - £160,000
Standard single-deck articulated bus	*Mercedes Benz - Citaro G*		148	3	Diesel	£200,000
Innovative tyred vehicle with guidance	*Bombardier - TVR*	*Double-articulated bus guided by steel guide channel embedded in street. Also capable of normal operation*	143	3	Diesel	£800,000
	Irisbus (MATRA and Renault)- CiViS	*Optically guided using stripes painted in a priority lane. Also capable of normal operation.*	104	4	Hybrid	£400,000
Innovative tyred vehicle without guidance	*Irisbus (MATRA and Renault) - Cristalis*	*Single-deck articulated. Non-guided version of CiViS.*	106	3/4	Hybrid	£350,000 (Standard) £500,000 (Artic)
	Wright Bus / First Group - StreetCar (FTR)	*Developed to be intermediate mode between bus and tram. Wheels are covered and driver positioning and interior design comparable to tram.*	100	2	Diesel	£300,000

3.82 The use of a conventional drive-train in the 'ftr' reduces vehicle costs but results in the vehicle having more restricted low floor area and access arrangements when compared with an electrically propelled vehicle such as the CIVIS. The 'ftr' also has doors on the near-side of the vehicle only; this reduces the access options but enables a greater proportion of seating to be provided. Other features of the 'ftr' are similar to the CIVIS, including double glazing, air conditioning, off-vehicle ticketing, and on-board CCTV and real-time information.

3.83 A typical cost of £300k is quoted for the 'ftr' vehicle, although it is understood that Metro have been advised of a cost of £315k by FirstGroup. This compares with a current cost of £200k for a Mercedes articulated bus, with the 50% additional cost presumed to arise from the additional quality features adopted in the 'ftr'.

CONCLUSIONS

3.84 An extensive literature review of the performance of high quality bus and tram based public transport systems has been undertaken as part of this project. This review indicated a general lack of evidence relating to the performance of high quality bus systems. In particular, there appears to have been very little detailed monitoring undertaken of existing schemes, relating to levels and source of patronage.

3.85 Research by Hass-Klau et al and Brand & Preston shows that the quality bus systems that have been delivered, have been of lower cost, with greater flexibility than tram systems, but they are generally considered to be of lower quality. These systems, however, have generally been '*congestion-busters*', with priority measures focussed on key congested locations. Such systems have typically been afforded much lower levels of priority than equivalent tram schemes and have thus delivered lower levels of benefits. Thus, there is little evidence available as to the performance of bus based systems delivered in a similar manner to a light rail system, and over a network of routes. Indeed, research in the U.S. has suggested that the most successful examples of quality bus have been those that closely replicate tram systems.

3.86 There is mixed experience associated with recent tram systems in the UK, as documented in the NAO report. Whilst these systems have generally delivered the anticipated services and features, this has not always been matched by the expected patronage levels. The reasons for this are complex, and it is not possible to draw firm conclusions, but the experience to date suggests that the preference for tram over bus may be lower than previously anticipated.

3.87 An examination of the key features of light rail systems has shown that a bus rapid transit system, as proposed in the BRT option, would deliver most of these features but be likely to provide:

- A lower level of visibility and permanence;
- A slightly lower level of journey time reliability;
- A lower degree of vehicle accessibility; and
- A slightly lower ride quality.

3.88 Whilst bus usage in England outside London is in decline in overall terms, there are a number examples of UK bus systems that have shown high levels of patronage increase in response to investment (such as Brighton and Hove). However, there has only been one example of a bus system in the UK, Crawley Fastway, which has been delivered in a systematic manner more akin to a tram system. The Crawley Fastway system has many of the attributes of a tram system (such as highly visible branding, dedicated stops, level or near level boarding, real time information, unique vehicles, high frequency) but is of lower quality that the BRT proposal for Leeds. The Crawley system has been more successful to date than anticipated, with patronage some 40% higher than forecast. There has been no detailed monitoring of the Fastway system, so all that can be concluded is that the system has proved more attractive than originally anticipated. Experience of bus investment in the UK indicates that the largest increases in bus patronage appear to have occurred where there has been a systematic approach to improvements, including high quality vehicles, priority measures, simplified fare systems and associated marketing.

3.89 There is little comparative research examining bus and rail based systems, largely due to the lack of systematically improved bus based systems noted above. Attitudinal research surveys in the UK based upon photographs of light rail and guided bus systems showed an overall preference for light rail, but this was strongly influenced by the nature of the systems depicted and the locations surveyed, with some surveys showing a preference for guided bus.

3.90 There is one research paper from the U.S. (Ben-Akiva) where detailed analysis has been undertaken using two separate data sets and analysis techniques to test whether there is a preference for rail based travel over bus based. This research concluded '*that there is no evident preference for rail travel over bus when quantifiable service characteristics such as travel time and cost are equal*'.

3.91 On the basis of the available literature, Atkins conclude that there is no clear evidence that a high quality bus based system providing most of the attributes of a tram system would not attract similar levels of patronage and deliver similar levels of benefit. It is recognised that a significant difference between the systems is the fixed infrastructure associated with a tram, which may give a perception of greater permanence compared with a bus system. However, there are few bus systems that have been delivered in a systematic manner comparable with a tram and thus it is not possible to establish the significance of this perception.

4. Revised Bus Rapid Transit Alternative

INTRODUCTION

4.1 It is apparent from our review of experience elsewhere, and the work undertaken to date, that a 'showcase' bus option must be of a high quality to compete with light rail, and, as such, should be introduced in a systematic manner as a complete package or system of measures, in much the same way as a tram would be. This is in line with the specification of the BRT alternative, set out in the November 2004 Appraisal report, which notes that the BRT 'was designed to be as close to having the same characteristics of a tram scheme, while using innovative bus technology…having a reasonably high level of segregation, high levels of reliability both of journey time and headways, ultra-high quality vehicles, high quality waiting environments and a distinctive branding etc'.

4.2 The remainder of this section describes revisions to the BRT alternative already appraised by Metro, along with a brief discussion of potential alternative modes of operation. There is then an examination of the quality features associated with the BRT. Finally, vehicle types are considered.

COVERAGE

4.3 The original intention in the brief was to examine if routes other than the three Supertram corridors could be incorporated into a system to generate greater patronage, but was curtailed to examine the three corridors only. Examination of the features of the BRT proposed by Metro in the previous section points to the relatively weak performance of the line to the south, from Balm Road to Tingley, compared to those to the north and east. This was presumably why this line was deferred when it became apparent that there was an affordability issue with implementing the complete tram network.

4.4 Examination of the modelling work undertaken by Metro and Leeds City Council suggests that the line to the south has the lowest demand associated with it. Additionally, the Park and Ride site at Tingley intercepting the M62, was not considered to be worthwhile with the BRT system in this corridor, thus further reducing demand.

4.5 Examination of run times, on the other hand, suggests that there is very little gain in journey time between the BRT running in guideway and the existing bus times in the corridor, despite the fact that most of the route is segregated. Much larger run time savings are forecast on the section from Balm Road into the City Centre and it is assumed that it is this that is driving the benefits associated with the line to the south. The inclusion of the additional infrastructure south of Balm Road adds significantly to the cost of the system whilst adding proportionately less to the benefits, thus reducing the value for money of the BRT system.

4.6 Any optimised BRT system, if pursued, would require a detailed option development exercise by way of the levels of the infrastructure needed, particularly on the southern arm. This may be particularly relevant given the low levels of car usage in the corridor and it may be that some additional bus priority measures could produce journey time savings comparable to those forecast with the guideway in place. Alternatively, as with the tram system, the section to the south could be deferred to a later date.

4.7 One important feature of a bus-based vehicle is its flexibility. Unlike a tram it is not constrained to fixed tracks, allowing it to respond better to changing circumstances, particularly in the light of the levels of development taking place on the periphery of the city centre. One feature that could be examined is expanding a BRT system out of the three corridors currently being examined to serve other areas of the city. Buses to the Stourton site to the south, for instance, could be extended to Rothwell or Wakefield. Any plans such as this would have to be carefully considered, however, as it could dilute the concept of a distinct BRT system, and come to be seen as an extension of the general bus network. There is the flexibility, however, to undertake such an extension, but it would have to be undertaken very carefully, with all the quality features retained. The BRT system assessed in this report does not assume any use by such ‘feeder’ services.

4.8 A further innovation that could be introduced is the concept of express buses from the Park and Ride sites. This could particularly work for the Stourton site, which is the most successful site in attracting patronage, if there were the full two lines running to the south of the city. Given that the majority of the patronage from Stourton is travelling to the City Centre then the vehicles could run non-stop into the city. Given the associated removal of acceleration/deceleration and dwell times associated with stopping, it is estimated that an express BRT vehicle from Stourton could be quicker than the equivalent tram journey. In such a two line system to the south, the stops along Hunslet Road into the city could be made by the vehicle which originated at Tingley.

4.9 Both expansions to the network, and express services, would have to be considered in greater detail if a bus-based system is pursued subsequent to this study. Independent work on Park and Ride undertaken by Metro suggests that there is scope to run viable Park and Ride services, particularly at the Stourton site.

QUALITY FEATURES

4.10 Table 4.1 overleaf provides Atkins’ summary of the quality features of the revised BRT and the truncated tram schemes.

Table 4.1 - Revised BRT and truncated tram schemes quality features

Characteristics	Revised BRT	Truncated tram
General		
Enhanced marketing	✓	✓
Unique livery and branding	✓	✓
Infrastructure		
Level boarding	Partial level boarding at all stops	✓
High quality shelters	✓	✓
Real time information	✓	✓
Off-board ticket machines	✓	✓
Lighting at all stops	✓	✓
CCTV at all stops	✓	✓
Operating on segregated tracks/lanes	✓	✓
UTC system providing priority at junctions	✓	✓
Length of segregated track/lane	12km	12 km
Route length on existing highway	15km	15 km
Vehicle Characteristics		
Capacity	100	180
Vehicle type	Ftr	Tram
Vehicle length	18.7 m	approx. 30 m
Power source	Low emission diesel	Electric
Automated ticketing equipment (including smartcard and barcode readers)	✓	✓
Public address system with 2-way communication	✓	✓
CCTV and real time information linked to automatic vehicle location	✓	✓
Air-conditioning	✓	✓
Double-glazing	✓	✓
High levels of sound-proofing	✓	✓
System Attractiveness to users		
Interior		
Seating quality	++	++
Visual obstruction	+++	+++
Noise	+	++
Lighting	+++	+++
Temperature control	++	++
Exterior		
Noise	+	++
Emissions	+	++
Ride Quality		
Running surface affects passengers	++	+++
Jerk during acceleration/braking	+	++
Performance		
Speed	++	+++
Acceleration/braking	++	++
Reliability/punctuality	+++	+++
Regulation of operator performance	++	++
Boarding/alighting times	++	++
Accessibility		
Level boarding/stop alignment	++	+++
Visibility of route to potential users	+++	+++

VEHICLES

4.11 The BRT bus option is presumed to be based upon a high quality 'tram-like' vehicle similar to the FirstGroup 'ftr'. The 'ftr' is new articulated bus vehicle, developed by First Group in conjunction with the Wright group (one of the largest UK bus constructors) and Volvo. Whilst based on conventional bus mechanical technology, the vehicle is designed to provide the quality and interior features of a tram, coupled with a 'tram-like' external appearance, although the propulsion technology does not permit a level floor throughout the vehicle. The 'ftr' vehicle is expected to cost £315k, with a life of 20 years and 2 or 3 intermediate refurbishments.

4.12 The BRT proposals allow for carriageway resurfacing throughout the length of the system. The stop/start pattern of the BRT (including route geometry, stop spacing and interaction with other traffic) will be similar, if not identical, to the tram, and thus the actions of acceleration and deceleration. Given the resurfacing assumption and the similar operating pattern there is no evidence that the ride quality associated with BRT will be significantly lower than that for the tram. This is broadly supported by the conclusions of 'Bus or Light Rail: Making the Right Choice' (Hass-Klau et al, 2000), which notes that some of the bus based systems which were reviewed managed to achieve good ride quality.

4.13 The capacity of the 'ftr' is given as 100 passengers, with 53 seated and 47 standing. It should be noted that typical UK tram vehicles provide 35% of their capacity as seating (based on an average of the vehicles used in Croydon, Manchester, Nottingham and Sheffield), compared with 53% for the 'ftr'. Thus the 'ftr' (in common with buses generally) will provide a higher proportion of seating than a typical tram vehicle. The lower overall capacity of 'ftr' compared with a tram will require more vehicles to be operated than would be the case with a tram option, with a consequent increase in service frequency (note this is similar to the assumption made about frequency in the original BRT assessment based upon the 'CiViS' vehicle).

4.14 The specific 'tram-like' quality features provided by the 'ftr' vehicle include:

- Tram-like external appearance with covered wheels;
- Separate full width driver's compartment;
- Two passenger entrances with wheelchair access at the front;
- Automated ticketing equipment including smartcard and barcode readers;
- Public address system with 2-way communication;
- CCTV and real time information linked to automatic vehicle location;
- Air-conditioning;
- Double-glazing; and
- High levels of sound-proofing.

CONCLUSIONS

4.15 The revised BRT option provides the same coverage and service patterns as Supertram. BRT will offer the majority of the quality features provided by Supertram and will provide a product that is clearly distinguishable from existing bus services.

It is the promoters' view that there are significant differences in the attributes of BRT as compared to tram which are not adequately reflected in the report.

5. Demand Forecasting and Economic Appraisal

INTRODUCTION

5.1 This section considers:

- Comparative appraisal of the tram and BRT options, using the forecasting and assessment methodology used by Metro;
- The effects of some revisions to costs proposed by DfT and Atkins;
- The reasons for 1) higher patronage and 2) higher benefits calculated for the tram, using Metro's methodology;
- The results of some tests using a different methodology; and,
- Atkins' conclusions on the relative performance of the BRT option compared with the tram

5.2 Firstly, however, a description of the tests undertaken is provided.

TESTS UNDERTAKEN

5.3 In the November 2004 Appraisal Document, demand forecasting was undertaken for the truncated tram option and the BRT option presented. As previously stated, this BRT option covered the entire alignment of the original Supertram proposal, whereas the tram scheme was truncated to the south. The BRT test undertaken in the November 2004 submission will be known as 'BRT Original' in the remainder of this section.

5.4 A total of two further model tests were undertaken as part of the work for the current study. These are detailed below:

- 'Truncated' BRT. This test involved the deferral of part of the southern line from Balm Road down to Tingley as with the 'truncated' tram scheme. For this test it was assumed that there were no BRT services running in south Leeds, beyond Balm Road, with the normal bus services remaining instead of the new services. This is referred to as BRT Option 1 in the remainder of this section; and,
- Full three line BRT, with guideways removed on part of the southern line. This test was undertaken assuming the full BRT system was in operation, as per the submitted case. On the southern section, from Balm Road to Tingley, it was assumed that the extensive guideway sections were not constructed and instead the services run on road in segregated bus lanes instead (it should be noted that the test undertaken did not assume any priority measures on this southern section, with the BRT running at the same speeds as the general bus services assumed in the model. This test will therefore be slightly low in both benefits and costs). This is referred to as BRT Option 2 in the remainder of this section.

5.5 The first of the additional tests is designed to mirror the 'truncated' tram scheme as closely as possible. This will allow a direct comparison to be made between the BRT option and the tram option, as the two alternatives now have exactly the same geographical coverage.

5.6 Analysis of the run time savings compared to the existing bus times, described in section 2, also suggest that the benefits of the guideway section between Balm Road and Tingley are weaker than for the segregation on the other routes. Analysis has shown that journey time savings associated with the tram or BRT are far less in the southern corridor, which could suggest that the BRT option as it is currently envisaged is over-engineered to the south. The second test, therefore, assumes that the BRT concept is introduced to the south, with high quality vehicles and supporting infrastructure, but without the guideways and thus associated costs. It is thought that comparable journey times could be achieved with extensive priority measures on the existing carriageways. It should be noted that the costs of supporting infrastructure for the southern route have not been included in the economic appraisal because it was not possible to ascertain these details in the time available.

COMPARISON OF TRAM AND BRT - DEMAND FORECASTS

5.7 Patronage forecasts for the tram and BRT options were undertaken using bespoke models. Demand was forecast from four main segments: those with a car available; those with no car available; those who would use Park and Ride; and, from users of Leeds City Railway Station, who would use the tram to reach their final destination.

5.8 The demand forecasts for all of the options examined are given in Table 5.1 below. The table shows the annual patronage for the two systems, in millions of passengers, for the forecast year of 2015.

Table 5.1 – Annual Forecast Demand, 2015

Options	Annual demand (millions)
Truncated Tram	19.33
BRT Original	16.33
BRT Option 1	15.12
BRT Option 2	16.28

5.9 The tram can be directly compared with the BRT by examining the BRT Option 1 result, as they offer the same geographical coverage. This shows that, *using Metro's methodology,* the BRT is forecast to carry 15.12 million passengers per annum, compared to 19.33 million forecast for the tram. This equates to the BRT carrying 78% of the forecast tram demand.

5.10 The truncation of the BRT scheme to the south has relatively little impact on overall BRT demand. The addition of the southern line results in an additional 1.21 million passenger per annum, which equates to 8% of the overall BRT demand for the truncated scheme.

5.11 As part of the CfIT study we suggested that there is a great deal of merit in benchmarking the predicted performance of schemes against schemes already in existence. Tables 5.2 and 5.3 below show the forecast 2015 demand for the tram and BRT options (per route kilometre and per stop) in comparison with demand for actual tram systems for 2003/04 (or 2004/5 in the case of Nottingham).

Table 5.2 – Annual passenger demand per kilometre of route

Option	Passenger boardings 2003/04 millions	Length of route (km)	Passenger boardings 2003/04 millions/length of route (km)
Leeds Supertram	19.3	22	0.88
BRT Option 1	15.1	22	0.69
Croydon Tramlink	19.8	28	0.71
Manchester Metrolink	18.9	39	0.48
Sheffield Supertram	12.3	29	0.42
Midland Metro	`5.1	20	0.26
Nottingham NET[1]	8.4	14	0.60

Table 5.3 – Annual passenger demand per tram stop

Option	Passenger boardings 2003/04 millions	Number of stops	Passenger boardings 2003/04 millions/stop
Leeds Supertram	19.33	35	0.55
BRT Option 1	15.12	33	0.46
Croydon Tramlink	19.8	38	0.52
Manchester Metrolink	18.9	37	0.51
Sheffield Supertram	12.3	48	0.26
Midland Metro	5.1	23	0.22
Nottingham NET[2]	8.4	23	0.37

5.12 Table 5.2 shows that 0.88 million passengers are predicted to board the Leeds Supertram per kilometre of route per annum. This differs significantly from the levels recorded for actual implemented light rail systems in the UK. The range for existing systems in Table 5.2 is 0.26 for Midland Metro through to 0.71 for Croydon Tramlink. The Manchester Metrolink and Sheffield Supertram, with 0.48 and 0.42 million boardings per kilometre respectively, are approximately half the predicted figures for Leeds, although the Manchester system is based largely on conversion from heavy

[1] Patronage figures refer to 2004/05
[2] Patronage figures refer to 2004/05

rail and might be expected to yield a lower ratio of patronage to route distance (due to lower stop density). Also, the Leeds figures are forecasts for 2015, so they would be expected to be higher, but the magnitude of the difference does appear high.

5.13 Table 5.3 shows that 0.55 million passengers are predicted to board the Leeds Supertram per stop per annum. This figure is similar to the numbers of passengers who boarded the Manchester Metrolink per stop in 2003/04 (but, as noted above, the Manchester system has a much lower stop density) but approximately double that of Sheffield Supertram.

5.14 The models are all configured for two time periods: a morning peak hour model (0800 to 0900 hours) and an average interpeak hour model. The output matrices from these models have been analysed to determine the level of trip making in the two time periods, along with the mode previously used, to give an indication of the level of transfer from car forecast to be achieved from the two systems.

5.15 Tables 5.4 and 5.5 below show the demand for the truncated tram and truncated BRT system for the morning peak hour and interpeak hour, respectively, for 2007. In these tables it has been assumed that the Park and Ride segment comprises trips that are forecast to transfer from car, whilst the City Centre dispersal trips would have otherwise been walk or bus trips local to the City Centre and focussed on the station.

Table 5.4 - Rapid transit demand: AM peak hour (0800 to 0900 hours): 2007

Previous Mode	Truncated Tram		BRT, Option 1	
	Trips	Percentage	Trips	Percentage
Car (In-Scope)	976	24.6	564	17.2
Car (Park and Ride)	543	13.7	447	13.6
Total Car	***1519***	***38.3***	***1011***	***30.9***
Bus	1837	46.3	1800	54.9
Rail	182	4.6	151	4.6
Bus or Walk Trips in the City Centre	431	10.9	315	9.6
Total	**3969**	**100.0**	**3277**	**100.0**

Table 5.5 - Rapid transit demand: average inter peak hour: 2007

Previous Mode	Truncated Tram		BRT, Option 1	
	Trips	Percentage	Trips	Percentage
Car (In-Scope)	1373	34.9	726	23.2
Car (Park and Ride)	210	5.3	166	5.3
Total Car	***1583***	***40.2***	***892***	***28.4***
Bus	2286	58.0	2178	69.5
Rail	0	0.0	14	0.4
Bus or Walk Trips in the City Centre	70	1.8	52	1.7
Total	**3939**	**100.0**	**3136**	**100.0**

5.16 Atkins has some concerns over the numbers for the truncated tram presented in Tables 5.4 and 5.5, as they do not appear to be typical of existing light rail schemes. In particular, we have concerns over the following areas:

- The levels of demand on both systems are very similar in the morning peak hour and average inter-peak hour;
- There are high levels of transfer forecast from car. This is particularly the case with transfer from car trips in-scope (non Park and Ride); and,
- There are higher levels of transfer forecast from bus (24% more trips) and car in-scope (41% more trips) in the average inter-peak hour than in the morning peak hour.

5.17 In the light of our concerns listed in the paragraph above Metro's consultants have provided an explanation for the forecasts. This explanation is included in this report as Appendix C.

It is the promoters' view that the statements on forecast patronage levels for Supertram are unjustified.

5.18 Despite our concerns over the absolute levels of the demand forecasts, it should be noted that the forecasting methodology has been applied to both the tram and BRT tests. Therefore, if the forecasting model overstates tram demand, it will also overstate BRT demand. However, it has not been the purpose of this study to examine the tram forecasts *per se*. Instead, the relative performance of the two systems can be examined in this document.

5.19 In terms of the relative differences in the tables above, the tram is forecast to attract 20% more passengers than the BRT in the morning peak hour and 26% more in the average inter-peak hour.

5.20 The largest difference between the tram and BRT forecasts is in the amount forecast to transfer from car trips in-scope. In the morning peak hour, the transfer to tram from car trips in-scope is forecast to be 73% higher than that for BRT. The work undertaken by Metro therefore suggests that the tram is likely to be far more successful in attracting passengers out of their cars.

5.21 We consider that the differences in overall attractiveness between the two modes, and particularly that forecast to transfer from car, appear high. The forecasts appear high particularly given that there appears to be very little difference between the two systems in terms of actual journey times offered and the quality of the associated facilities. The reasons for the differences will be explored in the remainder of this section.

COMPARISON OF TRAM AND BRT - ECONOMIC APPRAISAL

The Approach to Calculating Economic Benefits

5.22 Unit benefits for a particular mode are calculated as the reduction in perceived travel cost enjoyed by travellers using that mode. The perceived travel costs, known as “generalised costs”, are usually calculated and expressed in units of time, with time spent in less desirable activities (such as waiting) given a higher weighting to reflect the greater perceived cost of such time. The cost of any fare is expressed in units of time by dividing the money value by the perceived value of time. A perceived “mode constant” reflecting the inherent attractiveness (or otherwise) of one mode over another is also included, in units of time. All these components are summed to give an overall perceived travel cost. The reduction in this value between the without-scheme and with-scheme scenarios gives rise to the unit benefits used in the appraisal.

5.23 The benefits across all modes are summed for the modelled time period, annualised to give a full year of benefits and then used in discounted cash flow analysis making reasonable assumptions about demand growth between modelled years and the growth in the value of time. Such benefits are compared against scheme costs, both capital and operating, again presented in the format of discounted cash flows with due regard to the cost and timing of maintenance, vehicle refurbishment, etc. The ratio of the present value of benefits to the present value of costs is known as the Benefit to Cost Ratio (BCR).

Initial Results from Metro

5.24 The Benefit to Cost Ratios presented by Metro for the truncated tram, and the BRT tests are shown in the Transport Economic Efficiency Summary Table below.

Table 5.6 – New tests: Transport economic efficiency table (Metro)

£m, PV	Truncated Tram	BRT Original	BRT Option 1	BRT Option 2
PT User Benefits	1226	679	563	675
Non-User Benefits	490	335	313	335
Net Revenue Impact	211	142	130	142
Investment Costs	600	435	369	369
Operating Costs	374	362	362	362
PV of Total Benefits	**1499**	**844**	**790**	**838**
PV of Total Costs	**633**	**461**	**394**	**396**
Net Present Value	**866**	**383**	**396**	**442**
Benefit : Cost Ratio	**2.4 : 1**	**1.8 : 1**	**2.0 : 1**	**2.1 : 1**

5.25 The figures in the table above show the results for the truncated tram and the BRT original option from the work undertaken for November 2004 submission. The BCR for the tram has improved slightly from those presented in the November 2004 document, due to a different treatment of capital costs agreed with the Department for Transport in the subsequent discussions that took place.

5.26 The background assumptions used in calculating the values in the two new BRT Options are consistent with the original assumptions made by Metro.

5.27 Table 5.6 above shows that the performance of the BRT, in terms of both benefit to cost ratio and absolute level of benefits, improves with the removal of the southern section of route. The performance of the BRT is still lower than that of tram in benefit to cost ratio terms and significantly lower in terms of absolute level of benefits.

5.28 The reasons for the difference in performance of the tram and BRT will be discussed later in this section. Firstly, however, a number of changes were made to the cost assumptions underlying the original benefit to cost ratio. These are highlighted in the following section.

REVISIONS TO INITIAL TESTS

Vehicle Costs and Optimism Bias

5.29 In the initial tests, the costs for the BRT infrastructure remained the same as for the BRT case submitted by Metro, based on the values used in the November 2004 submission. Subsequent to the November 2004 work, First Group have launched their 'ftr' vehicle, described in section 4. It was assumed earlier in this study that the BRT vehicle should be based upon the First 'ftr' vehicle as an example of a high quality 'tram-like' bus in the UK. This assumption had the impact of reducing vehicle capital costs from £700k per vehicle in the original submission to £315k per vehicle in the current analysis.

5.30 A further change came about with recent revisions to the optimism bias. At the time of the November 2004 submission Government guidance suggested a blanket 44% cost increase to be applied for optimism bias, based on the findings across a range of civil engineering projects. More recent research has been undertaken for DfT, specifically aimed at transport schemes, based upon analysis from a range of schemes in terms of both scale and type of construction. This research recommends a rate of 32% to be applied for BRT systems, as the construction methods involved are similar to those for highway schemes. It is noted that the 32% figure is based upon experience from a wide range of highway schemes, including those requiring complex and large scale construction.

5.31 The results of these revisions on the TEE Summary Table for the BRT Options 1 and 2 are given in Table 5.7 below. They are again compared to the values for the truncated tram.

Table 5.7 –Transport economic efficiency table (Revised cost)

£m, PV	Truncated Tram	BRT Option 1	BRT Option 2
PT User Benefits	1226	563	675
Non-User Benefits	490	313	335
Net Revenue Impact	211	130	142
Investment Costs	600	321	322
Operating Costs	374	362	362
PV of Total Benefits	**1499**	**790**	**838**
PV of Total Costs	**633**	**346**	**349**
Net Present Value	**866**	**444**	**489**
Benefit : Cost Ratio	**2.4 : 1**	**2.3 : 1**	**2.4 : 1**

5.32 The revisions to Metro's initial analysis show that the benefit to cost ratio for a BRT alternative is forecast to be very similar to that of a tram. The Present Value of

Benefits is still forecast to be much lower, however, resulting in a Net Present Value of around half that forecast for tram.

5.33 It should be noted that Metro have some concerns over the revisions made to the analysis. Firstly, they do not accept that a lower optimism bias should be used for the BRT as they contend that the construction would be sufficiently complex to warrant a larger optimism bias being applied. They also have raised doubts over the quality of the 'ftr' type of vehicle being sufficient for it to be considered on the same basis as the 'CiViS' vehicle previously examined.

5.34 The economic analysis for the truncated tram system outlined in Table 5.7 should also be revised to reflect DfT recommendations regarding optimism bias. The original costs for the tram, which were determined as a result of a competitive tendering process, only had an optimism bias of 6% attached. This value is suggested as the optimism bias to apply to costs following a Best And Final Offer (BAFO) stage, a stage beyond the position of the costs for Leeds. DfT have advised, however, that the 6% figure currently applied for optimism was too low and that a more realistic value be used to reflect the status of the costs.

5.35 With the changes outlined above, the benefit to cost ratio for the BRT and tram systems are very similar following these initial tests, but there is still a large gap between the Net Present Value of the two schemes. The costs are obviously significantly lower for the BRT scheme, but this is mirrored by significantly lower benefits.

5.36 In the two directly comparable schemes (tram versus BRT Option 1), the benefits for BRT are only 53% (790 divided by 1499) of those for tram. If the benefits are disaggregated further, into user benefits (benefits accruing to people who use the system), the disparity becomes even greater. The user benefits for BRT are only 46% of those of tram.

5.37 In the discussion on demand earlier in this section (paragraph 5.9) it was shown that the BRT is forecast to attract 78% of the demand of the tram. BRT, therefore, is forecast to attract 78% of the tram users, but only 46% of the benefits that accrue to the users. The benefit per head for BRT users is therefore considerably lower than for tram.

5.38 The difference in levels of forecast benefits between the tram and BRT, discussed above, can be as a result of three factors:

- Differences in generalised journey times between the two modes;
- The Mode Constant applied to the two modes; and,
- The treatment of the two modes within the modelling structure.

5.39 A detailed examination of the differences in absolute journey times forecast between the two modes was undertaken in section 2 of this document. This concluded that whilst the in-vehicle time on tram is slightly lower, any savings that accrue are likely to be offset by the increased frequency, and thus reduced wait time, on the BRT. Given the additional weighting placed on wait time in the derivation of perceived generalised cost, the impact of this increased frequency may even give rise to BRT having a lower generalised cost (excluding mode constant) for the door-to-door journey, once weighting is taken into account. The significant difference in benefit, therefore, is unlikely to be as a result of journey time differences. The two remaining considerations; the mode constant and the modelling structure, are discussed below.

Mode Constant Assumptions

5.40 The mode constant for the tram has been assumed to be 12 minutes with respect to the existing bus, based on stated preference survey results (see EIR Table B4.3). This means that were all other things to be equal, the bus would need to take 12 minutes less for the same journey for it to be perceived equally as attractive as the tram (and consequently capture half of the relevant public transport model demand). In terms of overall magnitude, and based on experience from other public transport studies, such a value appears reasonable.

5.41 When modelling the BRT option an equivalent mode constant of 9 minutes was assumed, three quarters of that used for the tram, with respect to existing bus.

5.42 If BRT shared all of the same attributes as tram and delivered these attributes to an equal degree, then the BRT and tram options should have the same mode constant. Our review of the evidence on mode constant values documented in TRL593 “The Demand for Public Transport” suggests that an assumption of three quarters of the mode constant of the tram is consistent with all the environmental factors – waiting environment, real time information, seating comfort, etc. – being assumed equal between tram and BRT, with the sole difference being in the perceived ride quality. In the event, the costed assumption in the existing appraisal is that the BRT route is resurfaced throughout, so that even the ride quality differences between BRT and tram are minimised. (More information on the derivation of mode constants is presented in Appendix D)

5.43 Overall we consider that the three quarters assumption is reasonable given that some features (such as level boarding) would be slightly less effective for BRT than tram. The resulting mode constants (with respect to bus) of 12 minutes and 9 minutes appear to be reasonable. The result is that the tram is considered to have a 3 generalised minute advantage over BRT.

5.44 Tests undertaken as part of the original appraisal work suggest that using the same 12 minute mode constant would boost BRT benefits by about 25%. Even then (with reference to paragraph 5.36) the BRT benefits would be less than 60% of those for the tram. The remaining discrepancy in benefits between BRT and tram, therefore, is primarily due to differences in the way the two modes have been treated in the forecasting and appraisal model structure.

Mode Choice Model Structure

5.45 The demand model which estimates the choices travellers make in response to the cost of different mode choice options is a conventional logit choice model (discussed further in Appendix D). The model structure and the sensitivity arising from the choice of model parameters determine: a) the number of travellers forecast to use each mode and; b) the benefits they enjoy.

Modelling BRT as a New Travel Choice - The 'Red Bus/Blue Bus' Problem

5.46 When introducing a new public transport mode within the adopted model structure, the composite cost of public transport travel is calculated to fall. This will result in scheme benefits, even where the measurable time and cost attributes of the new mode are identical to those of existing public transport modes. Any such calculated benefits may be assumed to be directly due to the inherent benefit of having a further new travel choice. Clearly, if the existing service is provided by (say) a red bus and the new service uses (say) a blue bus, the new service will not be perceived as a new choice and any benefit calculations which assume it is a new choice may grossly overestimate the level of benefit.

5.47 On this basis, the assumption underpinning the existing economic appraisal work undertaken by Metro has been that a tram option would be perceived as a new travel choice while a BRT option would be considered as distinct from conventional bus, but not a new travel choice in the same way as tram. This approach was adopted because Metro does not believe that travellers will perceive BRT to the same positive degree as Stated Preference research has suggested they will perceive tram. This stance has resulted in an off-line adjustment being made to the BRT benefit forecast, resulting in the removal of half of the benefits associated with a new choice. Atkins has concerns regarding this methodology which results in tram and BRT being treated differently in the forecasting and appraisal process.

5.48 The latest tests of "Truncated BRT" undertaken for this study indicate that the impact of the method previously used to appraise the BRT is to remove approaching £500 million of benefits compared to the economic appraisal were BRT to be modelled and appraised in the same way as tram, albeit with a lower mode constant.

5.49 The following table demonstrates the scale of the issue by comparing BRT Option 2 with and without treatment as a wholly new mode, with the tram results alongside. In these tests the mode constant for BRT is still assumed at a lower level than that of tram.

Table 5.8 – Transport economic efficiency table (Effect of 'new mode' treatment on BRT Option 2)

£m, PV	Truncated Tram	BRT Existing forecasting/appraisal methodology	BRT modelled as a wholly 'new mode'
PT User Benefits	1226	675	1004
Non-User Benefits	490	335	443
Net Revenue Impact	211	142	184
Investment Costs	600	322	322
Operating Costs	374	362	362
PV of Total Benefits	**1499**	**838**	**1332**
PV of Total Costs	**633**	**349**	**359**
Net Present Value	**866**	**489**	**973**
Benefit : Cost Ratio	**2.4 : 1**	**2.4 : 1**	**3.7 : 1**

5.50 Modelling the BRT as a new travel choice in the same way that tram has been modelled, although with a reduced mode constant for BRT, has the effect of producing a significantly higher BCR than that attributed to the tram. The overall level of benefits for the BRT option is also much closer to that assumed for the tram. The higher level of benefits, coupled with the much lower cost, also results in a Net Present Value of Benefits higher than those associated with the tram system.

5.51 In addition to Metro adjusting the benefits forecast through their decision on travel choice, they also removed some of the demand. If the BRT is regarded as a new choice in line with the appraisal for tram, the demand will also be greater.

5.52 In response to the raising of this issue about the lack of consistent treatment of the two options in the appraisal, an additional test has been undertaken by the promoters in which BRT is modelled and appraised as a new mode, albeit one correlated with 'ordinary bus' within a bus nest, and not as a wholly new multinomial choice, ranking directly alongside car and rail, in the way the tram options have been economically appraised. This is an alternative way of undertaking the forecasting and appraisal and yields a greater BCR than previously reported for the BRT, as shown below. However, it still fails to treat BRT as a new travel choice in the manner that tram is treated and therefore does not fully address Atkins' concerns regarding the difference in treatment between tram and BRT in the forecasting and appraisal process.

Table 5.9 – Transport economic efficiency table (Effect of modelling BRT as a 'New Sub-Mode' of bus, on BRT Option 2)

£m, PV	Existing forecasting/appraisal methodology	Modelled as a wholly 'new sub-mode' of bus
PT User Benefits	675	659
Non-User Benefits	335	420
Net Revenue Impact	142	180
Investment Costs	322	322
Operating Costs	362	362
PV of Total Benefits	**838**	**957**
PV of Total Costs	**349**	**356**
Net Present Value	**489**	**601**
Benefit: Cost Ratio	**2.4 : 1**	**2.7 : 1**

5.53 It can be seen that the BCR resulting from the treatment of BRT as a wholly new sub-mode of bus lies between that using the original appraisal methodology and that assuming the BRT to be a wholly new travel choice at the top nest of the choice model, as shown in Table 5.8. This result is intuitive and provides another marker with which to understand the spread of values.

5.54 The impact of the different approaches of demand and benefits can be seen in the table below.

Table 5.10 – Appraisal results

Test	BCR	PVB	% of tram benefits	NPV	Demand	% of tram demand
Tram	2.4 : 1	1499	100.0	866	19.33	100.0
BRT (treated in the same way as tram)	3.6 : 1	1271	84.8	916	17.72	91.7
BRT (with an adjustment made)	2.3 : 1	790	52.7	444	15.12	78.2
BRT (additional test as a sub mode of bus)	2.7 : 1	957	63.8	601	n/a	n/a

5.55 Finally, it is assumed that if a bus-based system were to be introduced then it is likely that the operator would pay for the cost of new vehicles, rather than them being provided by the public sector. Examining the impact of such a scenario on the benefit to cost ratio can be seen in Table 5.11 below. This table shows the impact of the vehicle purchase on the BRT Option 2, new mode test.

Table 5.11 – Transport economic efficiency table (Vehicle costs picked up by the private sector)

£m, PV	Existing forecasting/appraisal methodology	Modelled as a wholly 'new mode'
PT User Benefits	1004	1004
Non-User Benefits	443	443
Net Revenue Impact	184	184
Investment Costs	322	322
Operating Costs	362	362
PV of Total Benefits	**1332**	**1310**
PV of Total Costs	**359**	**337**
Net Present Value	**973**	**973**
Benefit: Cost Ratio	**3.7 : 1**	**3.9 : 1**

5.56 The impact of the private sector purchasing the vehicles is to further increase the benefit to cost ratio from 3.7:1 to 3.9:1.

Conclusion

5.57 The incremental development of the BRT forecasts and their resulting economic appraisals has been described above. Assuming a truncated BRT network and lower costs as discussed, the resulting BCR values for BRT range from 2.0 to 3.9 depending solely upon how the BRT is assumed to be perceived by travellers.

5.58 The truncated tram BCR has been developed to a value of 2.4. This value will be reduced once the higher level of optimism bias recommended by DfT is adopted.

5.59 The treatment of the BRT as a new travel choice, or not, discussed earlier in this section, has a major impact on the economic performance of the scheme. The modelling work suggests that benefits to the value of nearly 60% of the benefits arising from the measurable attributes of the scheme, such as improved frequency and journey time savings, as well as mode constant, arise from whether or not the system is perceived as being distinct from existing modes of public transport or not.

5.60 It is the view of Atkins that BRT has similar characteristics to Supertram. It has the majority of the physical features of the tram, operates the same service patterns as tram, and achieves similar journey times to tram. It does, however, have some quality features lower than those offered by tram, so it is accepted that the perception of the mode may be lower than that for tram (a fact reflected in the lower mode constant). Given this, Atkins believes that BRT should be assessed in a similar manner to Supertram, albeit with a lower mode constant. Thus Atkins concludes that the economic benefits provided by BRT should lie at the upper end of the range of the economic tests. In this case BRT would result in a similar Net Present Value of benefits to Supertram and offer better value for money with a Benefit to Cost ratio in excess of that of Supertram.

It is the promoters' view that, in the light of a lack of evidence from elsewhere, the most appropriate and realistic view of the forecast levels of demand and economic benefits would be through modelling BRT as a wholly new sub-mode of bus or as a half new mode as reported in the November 2004 Appraisal Document.

6. Wider Appraisal

INTRODUCTION

6.1 An integral part of the appraisal is the fit of the revised BRT option against the wider central Government NATA objectives, as well as the central Government shared priorities and the objectives contained within the provisional West Yorkshire Local Transport Plan 2006-2011 (WYLTP). In accordance with the study brief, a review of the revised BRT was also undertaken against key recommendations set out in:

- Public Accounts Committee (PAC) report – Improving public transport in England through light rail (March 2005);
- Transport Select Committee (TSC) report – Integrated transport: the future of light rail and modern trams in the United Kingdom (March 2005); and,
- National Audit Office (NAO) report – Improving public transport in England through light rail (April 2004).

6.2 For the purposes of this assessment, the key features of the revised BRT option (set out in Section 4) were assumed.

6.3 The assessment of fit with the WYLTP objectives, central Government objectives and central Government shared priorities are indicated with the following notation (this is in accordance with that used by Metro in the November 2004 Appraisal Report for the assessment against central Government and LTP objectives):

- Large beneficial (LB);
- Moderate (Strong) beneficial (MB);
- Slight beneficial (SB);
- Neutral (N)
- Slight adverse (SA);
- Moderate (Strong) adverse (MA);
- Large adverse (LA); and,
- Not applicable.

6.4 The assessment of fit of the revised BRT scheme against the Public Accounts Committee report, the Transport Select Committee report and the National Audit Office report was, by necessity, a subjective exercise. Each of these documents contains recommendations relating to the way in which light rail schemes are delivered in the UK. Therefore, the assessment considered how easy it might be for the revised BRT scheme to meet these recommendations when compared against the truncated tram scheme and the original BRT alternative. The results of these assessments are presented in a simple tabulated format.

6.5 A summary of the review against each policy document is presented below. It should be noted that the assessment presented in this section represents the view of Atkins. Where Metro does not accept this assessment, this has been indicated.

WEST YORKSHIRE PROVISIONAL LOCAL TRANSPORT PLAN (2006 – 2011)/SHARED PRIORITIES FOR TRANSPORT

6.6 In the appraisal document submitted in November 2004, the performance of the truncated tram scheme and the BRT alternative were assessed against the objectives contained within the first West Yorkshire Local Transport Plan. In accordance with central Government requirements, the LTP has since been reviewed and updated and a provisional LTP2 document was submitted to the Department for Transport in July 2005. In line with guidance, this second Local Transport Plan reflects the central Government/LGA shared priorities for transport. A high level review of the performance of the truncated tram scheme, the BRT alternative and the revised BRT scheme has been undertaken against the relevant LTP2 objectives. A summary of this assessment is presented below. Where the qualitative assessment has resulted in different scores, these are then discussed further.

Table 6.1 – Assessment against WYLTP objectives

LTP objectives	Truncated Tram	BRT	Revised BRT
Accessibility			
Obj 1: Improve access to jobs, education and other key services for everyone	LB	MB	MB
Obj 2: Improve accessibility for those people, services and facilities which have poor accessibility	MB	MB	MB
Obj 3: Broaden travel horizons and access to information	MB	MB	MB
Obj 4: Encourage planning for accessibility	N	N	N
A1: Improve physical accessibility by making PT more accessible	LB	MB	MB
A1: Improve the continuity and signage of cycle and walk routes	SA	SA	SA
A4: Maintain and develop PT networks through our bus and rail strategies	LB	LB	LB
A5: Maintain and enhance concessionary fare schemes and address cost barriers for job-seekers	N	N	N
A6: Raise awareness of PT and improve and target information and marketing	MB	MB	MB
Congestion			
Obj 1: Reduce delays to the movement of people and goods	M	SB	SB
Obj 2: Encourage more journeys by public transport, walking and cycling, particularly in congested parts of the network	LB	MB	MB
Obj 3: Improve journey time reliability	LB	MB	MB
Obj 4: Make better use of highway capacity	MB	MB	MB
Obj 5: Reduce the demand for travel by car as a proportion of overall trips	LB	MB	MB
C1: Encourage modal switch to public transport	LB	MB	MB
C2: Manage the demand for travel	N	N	N

LTP objectives	Truncated Tram	BRT	Revised BRT
C3: Manage the existing highway network	MB	MB	MB
C5: Encourage more cycling and walking	SB	SB	SB
Safety			
Obj 1:Improve safety for all highway users	LB	MB	MB
Obj 2: Reduce the number and severity of road casualties	LB	MB	MB
Obj 3: Tackle problems facing vulnerable road users (including those in deprived areas)	MB	MB	MB
S1: Provide an appropriate road environment with facilities for each user group	N	N	N
S5: Improve safety through new technologies that can reduce the risk of injury	N	N	N
Air Quality			
Obj 1: Limit transport emissions of air pollution, greenhouse gases and noise	MB	SB	SB
Obj 2: Mitigate and adapt to the effects of climate change	MB	SB	SB
AQ1: Traffic demand management measures, focusing on commuter journeys (promotion, car parking and network management, re-allocation of road space)	MB	MB	MB
AQ2: Encouraging more sustainable travel (Travel plans, sustainable fuels, alternative vehicles trials)	LB	MB	MB
AQ3: Actions to reduce vehicle emissions (UTMC, speed control, traffic management, cleaner vehicles)	MB	SB	SB
Asset Management			
Obj 1: Improve the condition of the transport infrastructure	MB	MB	MB
Obj 2: Manage the infrastructure more effectively	MB	MB	MB
Obj 3: Meet the needs of current and future transport users	MB	MB	MB
M3: Maintenance and operation of UTMC and CCTV systems (on street and public transport)	MB	MB	MB
M5: Maintenance of bus stations, shelters and stops	MB	MB	MB

Accessibility

- Objective 1 – Improve access to jobs, education and other key services for everyone.

6.7 Although the area served by the BRT option is more extensive than that of the tram scheme, owing to the inclusion of the Southern Corridor, the Economic Impact Report presented as an Appendix to the November 2004 Appraisal document, suggests the increase in accessible jobs will be greater with the tram scheme than with the BRT alternative. To reflect this the tram scheme has been scored higher. A further discussion of the findings of the Economic Impact Report is presented later in this section.

- Sub-Objective A1: Improve physical accessibility by making PT more accessible

6.8 Physical accessibility benefits would be lower for the BRT options, since the cost of docking systems to help deliver the full benefits of level boarding on unguided sections of route have not been included in the specification and hence their cost has not been included in the appraisal.

- Objective 2: Improve accessibility for those people, services and facilities which have poor accessibility

6.9 Metro's assessment of scheme performance against this objective suggests that the truncated tram scheme would perform better than both the BRT alternative and the revised BRT. This is based on the assumption that BRT cannot guarantee access to the mobility impaired. However, it is Atkins' view that this is reflected in the assessment against Sub-Objective A1, which acknowledges that the costs (and thus the benefits) of docking systems on off-guideway sections have not been included in the assessment. Therefore, given that the extent of the truncated tram network and the revised BRT alternative are the same, and that the original BRT alternative includes an additional extension on the southern corridor, a comparable assessment score has been retained.

- Objective 3: Broaden travel horizons and access to information
- Sub-objective A6: Raise awareness of PT and improve and target information and marketing

6.10 For both of these objectives, Metro's assessment suggests that the truncated tram scheme would perform better than both the BRT alternative and the revised BRT. This is based on the assumption that the tram represents a 'step-change' in public transport provision in a way that a BRT system can not. However, Atkins note that the BRT will be promoted and marketed in the same way as the tram scheme, and thus a comparable assessment score has been maintained. Provision of information at stops will be the same for all of the options.

- Sub-objective A4: Maintain and develop PT networks through our bus and rail strategies

6.11 Metro's assessment of scheme performance against this objective suggests that the truncated tram scheme would perform better than both the BRT alternative and the revised BRT. The comparable service pattern and enhanced service frequency of the BRT options, coupled with the flexibility to adapt more easily to future requirements with a bus based system, means that a comparable assessment score has been retained.

Congestion

- Objective 1: Reduce delays to the movement of people and goods

6.12 Metro's assessment of scheme performance against this objective suggests that the truncated tram scheme would perform better than both the BRT alternative and the revised BRT, as the tram incorporates higher capacity, requires fewer vehicles and is more effective in attracting people out of cars. However, it is Atkins' view that although the run times for the truncated tram system are forecast to be shorter than for the BRT options, the increased service frequency and the likely reduction in wait time for BRT users mean that a comparable score has been retained. The increased ability of a tyre-based vehicle to deviate from its route (where not in guideway) means that it will also allow obstructions to be moved from the carriageway more easily in the event of a breakdown.

- Objective 2: Encourage more journeys by public transport, walking and cycling, particularly in congested parts of the network

6.13 Forecast demand for the tram scheme, and thus the overall increase in the number of public transport journeys is higher than the levels of forecast demand for the BRT alternative. Thus the tram scheme is scored as Large Beneficial against Moderate Beneficial for the BRT alternative and the revised BRT.

- Objective 3: Improve journey time reliability

6.14 As currently specified the tram scheme is scored as Large Beneficial compared to a score of Moderate Beneficial for the BRT alternative. This is based on the assumption that the tram scheme has a higher level of self enforcement and is given greater priority at junctions. However, it should be noted that both of these issues could be addressed with the introduction of a formal enforcement scheme alongside the BRT alternative at a cost and increased levels of priority for the BRT vehicles, which would not need to be conceded to other conventional buses.

- Objective 5: Reduce the demand for travel by car as a proportion of overall trips

6.15 Compared with the BRT alternative, a larger proportion of the demand for tram is forecast to come from car, thus representing a greater reduction in the proportion of overall trips on the network which are made by car. Therefore the tram is scored as Large Beneficial and the BRT alternative and the revised BRT is scored as Moderate Beneficial.

- Sub-objective C1: Encourage modal switch to public transport

6.16 Section 2 summarises the levels of mode shift affected by the introduction of the tram scheme and the BRT alternative. This indicates that a higher proportion of the demand for tram is as a result of mode shift away from the private car, compared to the BRT alternative. On this basis the tram is scored as Large Beneficial and the BRT alternative and the revised BRT is scored as Moderate Beneficial.

Safety

- Objective 1:Improve safety for all highway users
- Objective 2: Reduce the number and severity of road casualties

6.17 Both of these indicators are measured as a function of the reduction in vehicle kilometres on the road network. Thus the larger mode shift away from private car, which is forecast for the tram scheme, would result in a larger decrease in vehicle kilometres and thus in the number of forecast accidents. Therefore the tram scheme has been scored as Large Beneficial against a score of Moderate Beneficial for the BRT alternative and the revised BRT.

Air Quality

- Obj 1: Limit transport emissions of air pollution, greenhouse gases and noise
- Obj 2: Mitigate and adapt to the effects of climate change
- AQ3: Actions to reduce vehicle emissions (UTMC, speed control, traffic management, cleaner vehicles)

6.18 As a percentage change in the overall number of trips within each corridor, the reduction in the number of car users within any of the options is likely to be small. However, the Moderate Beneficial score for the tram scheme reflects the forecast reduction in car users coupled with the emission free tram technology, compared to a Slight Beneficial score for the BRT alternative and the revised BRT.

- AQ2: Encouraging more sustainable travel (Travel plans, sustainable fuels, alternative vehicles trials)

6.19 Again the Large Beneficial score given to tram, compared to the Moderate Beneficial score for both the BRT alternative and the revised BRT option reflect the forecast differences in mode shift away from the private car. However, it should also be noted that promotion of travel planning initiatives could be undertaken equally for both tram and bus based schemes

Summary

6.20 It can be seen that the assessment of the three options (tram, BRT alternative, and the revised BRT scheme) against the Local Transport Plan objectives reveals several differences. Where these occur they mainly result in a higher appraisal score for the tram scheme. However, it should be noted that the many of these assessments relate to the level of forecast mode shift away from private car. Thus the issues discussed in Sections 2 and 5 should be borne in mind when reviewing the wider appraisal of the options.

CENTRAL GOVERNMENT OBJECTIVES

6.21 As with the appraisal against the Local Transport Plan objectives, Table 6.2 below presents the assessment of tram scheme, the BRT alternative and the revised BRT against the central Government NATA objectives. The appraisal of the truncated tram scheme and the BRT alternative contained within the November 2004 report was used as the basis for this assessment. Thus the likely performance of the revised BRT scheme was benchmarked against these scores. Where the revised BRT is shown to score higher than the BRT alternative, this indicates that the original appraisal was considered to introduce too much distinction between the tram and the BRT alternative.

Table 6.2 – Assessment against Central Government objectives

Appraisal document objectives	Truncated tram	BRT	Revised BRT
Environment			
Noise	N	N	N
Local air quality	MB	SB	SB
Greenhouse gases	MB	SB	SB
Landscape and townscape	SA	SA	SA
Heritage of historic resources	SA	N	N
Biodiversity	N	N	N
Water environment	N	N	N
Physical fitness	SB	SB	SB
Journey ambience	LB	MB	MB
Safety			
Accidents	LB	MB	MB
Security	LB	LB	LB
Economy			
Economic appraisal: Benefit to Cost Ratio (BCR)	2.4:1	1.8:1	2.3:1 - 3.7:1
Reliability	LB	MB	MB
Wider economic impacts	LB	MB	MB
Accessibility			
Options values	MB	MB	LB
Severance	SB	N	N
Access to the transport system	LB	MB	MB
Integration			
Transport interchange	LB	MB	LB
Land use policy	LB	MB	LB
Other Government policies	MB	MB	MB

Local Air Quality

6.22 Although the original November 2004 appraisal report scored the performance of tram and BRT equally for the Local Air Quality indicator, the Moderate Beneficial score shown here reflects the larger mode shift away from car which is forecast for the truncated tram scheme, and thus a reduction in local emissions.

Greenhouse Gases

6.23 The larger mode shift away from car which is forecast for the truncated tram scheme gives rise to a score of Moderate Beneficial, when compared to both the BRT alternative and the revised BRT which are scored as Slight Beneficial.

Heritage of Historic Resources

6.24 Both BRT options are scored as Neutral for their potential impacts on Historic Resources. This compares with a Slight Adverse score for the truncated tram, due to the additional impact of visual intrusion associated with overhead wires and masts.

Journey ambience

6.25 The original appraisal of the truncated tram scheme against the BRT alternative scored the tram as Large/Strong Beneficial compared to Moderate Beneficial for the BRT alternative. The commentary for the original appraisal highlights the difference in ride quality that is expected to occur between the tram and BRT vehicle. Whilst it is accepted that the ride quality offered by the tram is likely to be superior to that offered with a bus-based system, the assessment does not refer to the other components which can contribute to journey ambience. These include the use of modern high quality vehicles, high quality provision of information and excellent waiting facilities, all of which could be delivered in a comparable manner for the BRT alternative as for the tram. Thus, whilst the appraisal of the revised BRT is also scored as Moderate Beneficial, it should be noted that the difference between the two is unlikely to be as large as this scoring would suggest.

Economic Appraisal: BCR

6.26 A full discussion of the BCRs for each option, along with the results of relevant sensitivity tests, is presented in Section 5 of this report.

Reliability

6.27 As currently specified, the tram scheme is scored as Large Beneficial compared to a score of Moderate Beneficial for the BRT alternative. This is based on the assumption that the tram scheme has a higher level of self enforcement, and is given greater priority at junctions. However, it should be noted that both of these issues could be addressed with the introduction of a formal enforcement scheme alongside the BRT alternative at a cost, and increased levels of priority for the BRT vehicles, which would not need to be conceded to other conventional buses.

Wider economic impacts

6.28 Appendix C to the November 2004 appraisal report (Economic Impact Report) presents the economic impact of the tram scheme and the BRT alternative.

6.29 The main function of an Economic Impact Report is to assess the effect of the proposed transport scheme on employment characteristics for those designated Regeneration Areas (RAs) affected by the proposals. The two key indicators are an assessment of the impact on:

- The number of jobs accessible to residents of Regeneration Areas; and
- The change in employment levels amongst residents of Regeneration Areas.

6.30 Changes in access to jobs for residents of the RAs is a function of the changes to the generalised time between a given pair of zones following the introduction of the scheme being tested. Thus a reduction in the generalised time between zones leads to an increase in accessible jobs and workforce.

6.31 Table 8.1 in the EIR (reproduced below) shows the change in the number of accessible jobs available to residents of the RAs and illustrating that the tram (Option 1) will have a larger impact than BRT (Option 2) in provide access to an increased number of job opportunities.

Table 6.3 - (Table 8.1 EIR) Changes in numbers of jobs accessible to residents of the RAs, 2011

Regeneration Areas	Accessible jobs with no tram	Additional accessible jobs			
		Option 1	Option 2	Option 3 (city wide)	Option 4
East Line					
East Bank	51816	14294	10346	5655	18313
		28%	20%	11%	35%
Harehills	144720	9195	5942	8551	12501
		6%	4%	6%	9%
Seacroft	100914	9700	7644	8354	9996
		10%	8%	8%	10%
Gipton	139051	15453	12155	8361	16491
		11%	9%	6%	12%
Swarcliffe	64417	5845	4705	6849	12720
		9%	7%	11%	20%
South Line					
Beeston & Holbeck	193759	5891	3054	10963	6267
		3%	2%	6%	3%
Hunslet	184499	9763	9327	7056	13708
		5%	5%	4%	7%
North Line					
Little London	202147	6748	5030	6265	7346
		3%	2%	3%	4%

6.32 The information presented in Table 6.3 reflects the larger time savings forecast for the truncated tram scheme when compared with the BRT alternative.

6.33 Table 8.2 in the EIR (reproduced below) shows that the BRT (Option 2) would have a greater impact on the number of additional jobs in Leeds city centre compared to the tram (Option 1), reflecting the higher assumed frequency of the BRT option and the extension to Middleton.

Table 6.4 - (Table 8.2 EIR) Jobs in Leeds city centre after five years and ten years operating

Year	Jobs with no tram	Additional Jobs			
		Option 1	Option 2	Option 3 (city wide)	Option 4
2016	101,587	222	280	243	404
2021	100,589	1,612	1,916	1,493	2,759

6.34 Table 7.5 in the EIR (reproduced below) presents information on the increase in additional accessible workforce with the truncated tram (Option 1) and BRT (Option 2) alternative options in place. This shows a comparable percentage increase in patterns of accessible workforce between BRT (Option 2) and tram (Option 1) for 3 out of the 5 RAs on the East Line, better performance of the tram on the Northern Line, and equal or better percentage increases for BRT on the southern line.

Table 6.5 - (Table 7.5 EIR) Patterns of accessible workforce, 2011

Regeneration areas	No tram	Option 1	Option 2	Option 3 (city wide)	Option 4
East Line					
East Bank	102,401	110,427	109,461	108,489	110,323
Harehills	154,738	159,634	158,615	160,005	159,648
Seacroft	124,124	130,183	130,489	131,317	130,657
Gipton	153,504	158,508	157,384	160,704	159,204
Swarcliffe	107,381	112,221	110,046	112,728	112,370
South Line					
Beeston & Holbeck	87,958	89,260	89,764	94,101	89,523
Hunslet	107,915	111,860	111,903	114,403	112,370
North Line					
Little London	137,454	143,800	142,792	144,486	144,274
East Line					
East Bank	-	8,025	7,060	6,088	7,922
	-	8%	7%	6%	8%
Harehills		7,896	6,877	8,267	7,910
	-	5%	5%	5%	5%
Seacroft	-	6,059	6,365	7,193	6,532
	-	5%	5%	6%	5%
Gipton	-	5,004	3,880	7,200	5,700
	-	3%	3%	5%	4%
Swarcliffe	-	4,840	2,665	5,347	4,989
	-	5%	3%	5%	5%
South Line					
Beeston & Holbeck	-	1,302	1,806	6,143	1,565
	-	1%	2%	7%	2%
Hunslet	-	3945	3988	6488	4824
	-	4%	4%	6%	4%
North Line					
Little London	-	6,346	5,338	7,033	6,820
	-	5%	4%	5%	5%

6.35 Table 7.11 (shown below) in the EIR provides a summary of impact on jobs and employment within the RAs. It shows the average forecast increase in accessible jobs in a RA, 10,000 for tram (Option 1), and 7,000 for BRT (Option 2). It also illustrates the forecast change in unemployment. The tram (Option 1) is forecast to deliver a greater reduction in unemployment than the BRT (Option 2), although the absolute reduction in numbers of unemployed is relatively small.

Table 6.6 – (Table 7.11 EIR) Summary of Impact on Jobs and Unemployment

	Option 1	Option 2	Option 3 (city-wide)	Option 4
Increase in accessible jobs (rounded average for an RA) – 2011	10,000	7,000	8,000	12,000
Extra jobs in City Centre – 2016	222	280	243	404
Reduction in unemployment in RAs – 2016	94	72	21	143
Approximate additional operational jobs	400	400	0	400
RA residents into operational jobs	46	46	21	46
Total reduction in unemployment in RAs - 2016	140 (4.9%)	118 (4.1%)	21 (0.7%)	189 (6.6%)

Access to the transport system

6.36 The extent of the BRT network provides the same level of coverage as the tram, thus the differential in score is attributable to the ease of physical access for users. Physical accessibility benefits would be lower for the BRT options, since the cost of docking systems to help deliver the full benefits of level boarding on unguided sections of route have not been included in the specification and hence their cost has not been included in the appraisal.

Transport interchange

6.37 The original appraisal for this indicator considered the level of improvements to interchange which would be delivered in terms of the waiting environment, integration with other services (P&R, bus, and rail) and provision of information. The frequency and service pattern associated with the BRT alternative, and the links to other modes, is the same (and in terms of frequency, better than) that for tram. The original appraisal indicated that a reduced lack of 'presence' in the city centre would result in a lower score for the BRT alternative. By providing the same standard of infrastructure at stops, along with the same levels of promotion and marketing for the BRT alternative as for the tram, it is suggested that a similar appraisal score would be appropriate.

6.38 If the options are considered in terms of their ability to facilitate future enhancements to the transport network, the BRT alternative may provide a more flexible system which could more readily be reconfigured to accommodate new interchange requirements.

PAC REPORT/TSC REPORT/NAO REPORT

6.39 The assessment of fit with each of the Public Accounts Committee, Transport Select Committee and National Audit Office reports on light rail identified those recommendations most relevant to the application of a scheme within the Leeds context. The section below introduces relevant recommendations from each report and shows how the truncated tram, BRT alternative and optimised BRT scheme would contribute to their implementation.

6.40 Recommendations from the Transport Select Committee, 'Integrated transport: the future of light rail and modern trams in the United Kingdom' report[3] are described below.

- *Light rail needs to be part of an integrated transport system.*

  The BRT and revised BRT could be easier to integrate to the existing public transport, cycling and pedestrian networks as they will potentially reduce the need for physical infrastructure/engineering and the risk of segregation. All options should have similar level of integration with the existing rail network.

- *It is no longer possible to transfer revenue risk to the private sector without increasing costs dramatically, whether or not those risks materialise. Some contracts have attempted to claw back funds if risks do not materialise, but they cannot completely remove the premium the private sector charges for assuming risk, and it would be invidious for them to do so. It is true that if the public sector takes on a risk it may find itself facing charges in future (although the risk may equally not materialise). However, whilst this means that risks should be carefully assessed, it does not mean that the public sector should not consider taking these on board.*

  Consortia delivering tram schemes are well equipped to bear the burden of construction risks but not to take full revenue risk on as this means that their business is dependent on public policies over which they have no or little influence, such as fares, parking restrictions, traffic management or planning consents along their route. The tram proposal could avoid the risk of bid prices being inflated by using an alternative procurement framework. For the BRT and improved BRT options, the risk would be lower as construction and operation would be separated[4] and experienced bus operators would bid to run services under a quality partnership or contract.

6.41 Recommendations from the Public Accounts Committee, 'Improving Transport in England through Light Rail' report[5] are described below.

- *Potential problems with design and delivery should not be allowed to escalate as the residual risk of such schemes if an operation fails is likely to fall on taxpayers.*

  Risk of problems with design and delivery of the BRT and improved BRT should be lower as these systems will require lower levels of construction, as unlike the tram, they will not require construction throughout the entire system length. In

[3] Published in March 2005
[4] See section 8 Delivery
[5] Published in March 2005

particular, Supertram would require more complex construction along existing highways with associated diversion of utilities.

- *Diverting utilities such as water and gas mains, and installing new infrastructure, also drives up costs. Promoters should demonstrate that utilities need to be diverted when such diversions are planned and show how these costs are to be contained.*

  There should be less physical infrastructure/engineering with the BRT and improved BRT options. The need for utilities diversions should be lower with the bus based options. However, it is noted that not diverting utilities may increase the risk of service disruption in the future.

- *The financial viability of light rail systems should be rigorously tested through a range of potential outcome scenarios.*

  The original untruncated tram proposal was subject to a PFI bidding process with financial proposals submitted by two interested Consortia. All options have been submitted to a financial viability test.

6.42 Relevant recommendations from the National Audit Office report, 'Improving Public Transport in England through Light Rail'[6] are listed below.

- *To ensure the realisation of more benefits for passengers light rail scheme need to be complemented with integrated schemes such as park and ride schemes. Light rail schemes also need to secure speedy and punctual services by, for example, giving priority to light rail vehicles over road vehicles at key junctions.*

  All options could potentially link with existing or future Park and Ride sites. All options could make use of segregated tracks/lanes, existing public highways and UTC systems providing priority at junctions to improve speed and punctuality. However, it is noted that the additional vehicles required with the BRT option mean that it may not be possible to provide the same level of priority at junctions as with tram.

- *The costs of implementing light rail need to be reduced through systems standardisation, managing the risks associated with the cost of diverting utilities and their long term maintenance, examining the potential for heavy rail conversion and track sharing.*

  As the BRT vehicle technology is based on conventional bus and the construction elements are more akin to highway than light or heavy rail, the costs and the risks associated with the delivery of the infrastructure are likely to be lower. This is reflected in the lower capital cost of the original BRT option.

- *Promoters need to develop sources of funding other than the taxpayer through the use of Local Authorities' powers under the Transport Act 2000 (congestion charging, workplace parking levy) or developers' contributions.*

  Under the Transport Act 2000, local authorities can develop congestion charging schemes to help support the delivery of their Local Transport Plans. Light rail and bus options could all be supported through congestion charging or the

[6] Published in April 2004

introduction of a workplace parking levy scheme. Investment from developers could also be secured for the tram, BRT or improved BRT options.

6.43 The recommendations from these three reports were mainly addressed to DfT. However, some recommendations have direct implications for the proposed Leeds scheme. Although the tram, BRT and improved BRT options could meet most of the requirements set by the NAO and the Committees, the bus options would contribute to reducing scheme costs as they would not require extensive utilities diversion and design and delivery issues should be less important. The bus options might also be easier to integrate to the existing public transport, cycling and pedestrian networks as they will require less physical infrastructure/engineering.

It is the promoters' view that the report does not recognise that BRT would not deliver on regeneration, connectivity, social inclusion accessibility and improvements in air quality (environmental impacts) to the same extent as the tram would.

7. Stakeholder Consultation

BUS OPERATORS

7.1 As part of the study, Atkins met with representatives of the key bus companies (FirstGroup and Arriva) operating within the Leeds area.

7.2 The operators provided general comments on the operation of services within the Leeds area, as well as specific issues relating to each of the three corridors included within the tram/BRT proposals. Both of the operators noted continuing year on year growth in patronage on services in Leeds.

7.3 It should be noted that FirstGroup are already working with Metro to introduce operation of the 'ftr' vehicle in Leeds. FirstGroup has identified ten corridors (including those served by the Supertram routes) where they feel it may be possible to introduce the 'ftr', along with associated bus priority measures. In the first instance FirstGroup are working with Metro to introduce the 'ftr' vehicle on a single corridor.

General

7.4 Both of the operators identified a need to make improvements to the level of priority currently given to buses on the network. They identified a particular need to tackle 'congestion hot-spots' (identified in conjunction with Metro as part of the Yorkshire Bus Initiative work) and to provide greater priority for buses at these locations. This was felt to be a key issue in making bus travel more attractive. Other key features which the operators identified as necessary to improve the perception of bus travel were:

- Improvements to vehicles;
- Introduction of restraint on the use of the private car for travel into the city centre;
- Ability to offer direct services on key corridors;
- High frequency services;
- Enhanced technology e.g. real time information; and
- Ability to deliver improved reliability.

7.5 Both operators expressed the view that high levels of physical segregation are not always necessary, and that much could be achieved with the introduction of 24hr bus lanes and better enforcement activity.

7.6 Both operators also noted that the capital investment required for the Supertram proposal is high and that a high level of bus priority measures could be achieved across the city if the equivalent level of spend were committed.

7.7 It is interesting to note that one of the operators perceived that the patronage growth experienced on the existing Leeds 'super-routes' (guided busways) was attributable in the main to the intensive marketing campaign undertaken before the construction of the guideway.

Northern Corridor

7.8 A high frequency bus service (approximately every 2 minutes) is already in operation on this corridor. It is the operator's view that one of the key congestion problems (Headingley Lane) will not be addressed with either of the tram or BRT proposals as in both cases the vehicles will be running on street mixed with other traffic.

7.9 It was the operators' view that it is counter-intuitive to route the public transport service around the back of the Arndale Centre in Headingley. Instead, it was suggested that the alignment of the Headingley bypass be used to remove general traffic away from the shopping area, leaving direct access for public transport through the main shopping area.

Eastern Corridor

7.10 The operator noted that the proposed outbound section of guideway on Easterly Road is unlikely to be required.

Southern corridor

7.11 Bus services currently operating on the southern BRT alternative corridor, south of Balm Road, do not currently experience delays. Thus, there was no perceived need for the levels of segregation proposed with the BRT alternative.

7.12 It was noted that the routing for the BRT alternative, providing access to the Armouries/Clarence Dock area would be a welcome addition. Access to this area is currently precluded owing to the layout of the one-way system.

7.13 Proposals have already been developed for the operation of an 'express' Park and Ride service from the Stourton site. It was suggested that this site would be likely to capture trips both from the east and the south. Shorter journey times and the ability to run express services (which would mean that users were travelling with other 'car-drivers') would make this site more attractive.

BUSINESS COMMUNITY

7.14 Atkins held consultation discussions with representatives from:

- Chamber of Commerce;
- Yorkshire Forward; and
- Property Forum.

7.15 Through these discussions a number of key issues were identified.

Need for improvements

7.16 Whilst the consultees generally expressed a strong level of support for the Supertram proposals, there was also support for any improvements that would speed up the movement of people and provide better access to the city centre. Consultees felt strongly that if the Supertram proposals are rejected, alternative provision must be made and that if it is a choice between a bus-based system or no public transport improvements, then a bus based system would be welcomed.

Perception of tram versus bus

7.17 The consultees expressed the perception that a tram is better than a bus. Thus it was noted that any bus based alternative would need to be branded so as to be clearly identified as different to conventional bus, i.e. it should not be called a 'bus'.

7.18 Concerns were also expressed about the level of emissions associated with conventional bus.

Level of funding

7.19 There were general concerns regarding levels of transport and 'civic' expenditure within the Leeds area. Comparisons were drawn both with other cities in the region and also with London. There is a perception that Leeds has lost out in investment terms in recent years and that it is in danger of 'stagnating' or being overtaken by other cities.

7.20 It was very important to the consultees that the DfT take a positive approach to the current review process, such that funding for some form of public transport improvements is forthcoming. There was a general feeling that if the Supertram proposals are rejected, then the same level of investment in public transport and associated infrastructure improvements is still required in the Leeds area. Consultees noted that a more comprehensive geographical coverage could be achieved with bus, for the same level of investment currently required for Supertram.

Other infrastructure

7.21 It was noted that a more integrated approach to transport and land-use planning is required, such that maximum benefit is derived from any proposed Park and Ride facility. It was suggested that the Park and Ride sites should be developed as 'hubs', providing direct and immediate links between employment, residential and retail activity.

7.22 As well as public transport improvements, consultees identified the need for an improved 'ring-road' (in particular on the north side of the city) which would help to remove traffic from the centre.

ECONOMIC IMPACT REPORT

7.23 As part of the Economic Impact Report, consultation was undertaken with developers and inward investors.

7.24 One of the overall conclusions of the EIR was that with the tram in place, 'Inward investors will be more easily and quickly found: developers have found that inclusion of the tram in marketing material has had a useful impact on the rate of take up experienced, and a recent pteg study has identified that UK light rail schemes have brought confidence to businesses making investment decisions'

7.25 However, Section 6 of the EIR also acknowledges the uncertainty which exists when trying to measure the perception of one mode against another. Paragraph 6.83 notes that 'The position of a Bus Rapid Transit system between a tram system and a Yorkshire Bus Initiative Standard system seems flexible. The marketing of a BRT is thus vitally important to how developers would respond to it. When described as a 'tram on rubber tyres requiring permanent infrastructure' it was suggested that their response would be little different to that of the tram. The key factors in difference are: sense of permanence, perception by white-collar workers, and service quality (speed, comfort and reliability)'.

7.26 Paragraph 6.85 goes on to note 'The impact of Option 2, BRT, is strongly related to how this mode is sold to developers as this will affect the permanence they perceive in the system'.

8. Delivery

8.1 The Department for Transport has been consulted about possible delivery options and the following is a summary of their findings. A longer note from the Department is at Appendix E. Nothing in either this summary or the Appendix is to be taken as pre-judging any decision the Secretary of State may be called upon to take with regard to whether or not he should make any Order under the Transport and Works Act 1992 ("TWA Order") or approve any quality contracts ("QC") scheme relating to this project.

8.2 To establish a guided busway system including new segregated trackway the PTE will need powers to acquire land, to execute works and to operate (or procure operation of) the system.

8.3 Powers to acquire land and execute works (both new track and modification of existing highway) can be obtained through a TWA Order, assuming the guideway is of a "prescribed mode" for the purpose of that Act (a side guidance system is a prescribed mode, but an optical guidance system is not). Alternatively these powers could be obtained under the Highways Act 1980, in which case the resulting busway (apart from any stretch within an existing highway) would need to become a highway designated as a special road, restricted to use by guided buses. Restriction of access to busway within an existing highway could be achieved by Traffic Regulation Orders.

8.4 A TWA Order could also make any necessary provisions for the operation of the busway sections of the route, including the application of other enactments (such as the Transport Acts 1985 and 2000) with or without modification.

8.5 A TWA Order could not directly regulate bus services or other traffic on stretches of the proposed route that did not involve a separate track or lane for guided buses ("the non-guided sections"). But the effect of provisions in the Order might in practice extend to the route as a whole.

8.6 Specifically, a TWA Order could allow the PTE to determine which operator(s) was permitted to use the busway but could not regulate the use of the non-guided sections by other bus operators. In some cases, particularly in the central area of Leeds, it would be necessary and desirable for other operators (serving other corridors) to use that road space.

8.7 It would be possible to supplement the operational provisions in a TWA Order with a statutory quality partnership scheme (under the Transport Act 2000) specifying minimum standards of service from all operators using the non-guided sections of the routes. Such a scheme could (if compatible with the TWA Order) also cover the guided sections. By combining the TWA and statutory quality partnership ("SQP") scheme powers there appears to be scope for some creative thinking, over and above what a SQP on its own could provide, as illustrated by the current busway proposal from Cambridgeshire County Council. The report of the public inquiry is currently under consideration by the Department of Transport. A decision, when taken, whatever its outcome, could well provide further evidence of the Secretary of State's views as to the scope of these combined powers. Alternatively, non-statutory quality partnership agreements could be made with operators, but at the risk that these would give no power to exclude, or impose the same standards on, any operator refusing to make an agreement, including new entrants.

8.8 Another possibility (if the criteria can be met - see paragraph 8.10 below) would be a quality contracts (QC) scheme under the Transport Act 2000. In practical terms it would not be possible to separate a quality contract for the guided and unguided sections of the same services. If a QC scheme were to cover the sections of busway provided under the TWA Order, that Order would need to be appropriately drafted to ensure that the QC provisions in the Transport Act 2000 applied to the busway. Alternatively a QC scheme could cover all bus services in the area(s) served by the busway system apart from the services using the busway itself, which would be regulated under the TWA Order.

8.9 The main advantages of a QC scheme would be that it could regulate normal bus services feeding into the busway system, or potentially competing with the busway services, as well as services using the busway itself. The main disadvantage, apart from the need to satisfy the criteria in the 2000 Act, is that a quality contract cannot be let for more than 5 years, and the scheme itself has a maximum life of 10 years.

8.10 Before approving a QC scheme the Secretary of State must be satisfied that it is the "only practicable way" of implementing policies in the PTA's bus strategy, will do so in a way that is economic, efficient and effective, and will be in the interests of the public. A QC scheme is unlikely to be the only practicable way of procuring services on the busway itself (because of the availability of powers through the TWA), though it might be the only practicable way of integrating the busway services with other local bus services in the area.

8.11 Whatever legislative path is followed, the methods for providing access to the busway (whether by tendering, or by imposing service standards under a quality partnership scheme or agreement) must be compatible with the law on competition and with EU restrictions on State aids. Besides existing UK and EU law, the likely effect of the Commission's proposed Public Service Requirement (PSR) Regulation needs to be taken into account (though the Regulation as currently drafted may well be substantially amended). In theory the same strictures would apply to procurement of a light rail system but the implications of a bus-based system may differ somewhat in practice.

8.12 A simplified presentation of the legislative attributes of each of the implementation options is shown in Table 8.1.

Table 8.1 – Bus operation powers summary

Legislative attributes	Order under the Transport and Works Act 1992 (TWA)	Statutory quality partnership	Quality contracts scheme
Description of bus operation legislation	Order making power similar to light rail schemes. Order made by Secretary of State on application by passenger transport authority.	Made jointly by PTA and City Council (as traffic authority assuming that at least one TRO is needed)	Made by the PTA, having been approved by the Secretary of State. Secretary of State satisfied that public interest to make the scheme.
Scheme availability	PTA could regulate all aspects of operation but only on guideway section	Any operator who wanted to participate. Penalties are applied if use facilities without participating and fail to meet required standards	Competitive tender on the basis of best value. Winner gets exclusive right to operate the relevant services.
Minimum length	-	5 years	-
Maximum length	-	No limit	10 years duration of scheme (Maximum contract length 5 years)
Infrastructure in place at outset/Guaranteed Infrastructure Provision	✓	✓	×
Limited Geographically to a route	✓ (Guideway section)	✓	×
Only regulates bus way	✓	×	×
Scheme on similar regulatory footing to light rail	✓	×	×
Regulate frequency or timing of Services	✓	×	✓
Regulate fares	✓	×	✓
Ability to regulate quality of services	**NA**	✓	✓
Exclusive right for operator to operate on the corridor.	✓	×	✓
Open access (if agree to participate).	✓	✓	×
More than one operator able to operate	✓	✓	×
Need to justify restriction in competition	**NA**	✓	×
Allow regulation of competition on parallel routes.	×	×	✓
Assurance on other operators standards	**NA**	✓	✓
Ability to implement a holistic approach to infrastructure and bus branding	×	✓	✓

Legislative attributes	Order under the Transport and Works Act 1992 (TWA)	Statutory quality partnership	Quality contracts scheme
Commercial incentive to develop market	**NA**	✓	×
Could stimulate greater competition for market on lucrative corridors	**NA**	✓	✓
Likely to be preferred option of bus operator	×	✓	×
Operator guaranteed revenue	×	×	✓
Combine with Statutory Quality Partnership	✓	**NA**	×
Ensures Network Stability	✓	×	✓
Limits over bussing	**NA**	×	✓
Taxpayer see benefits of patronage growth	**NA**	×	✓
PTA has ability to design services to meet wider policy objectives	**NA**	×	✓
Need for stringent monitoring of performance standards	×	×	✓

TIMESCALE IMPLICATIONS

8.13 The timescale required for the various options is also a consideration. Further discussion of the 'time-line' for each of the statutory procedures is included at Appendix F. On the assumption that a TWA Order will be needed at least to authorise the acquisition of land and construction of the off-road guided sections, the question is how much additional time, if any, the other options would add to the overall timescale for the project. While the time taken to process a TWA Order can vary considerably according to the length and complexity of the inquiry, the Department for Transport advises that typically 2 years should be allowed from the submission of the application to the Secretary of State's decision. The works affected by the Order cannot proceed until the Order has been made. The overall time allocation would not significantly differ if Highways Act procedures were used - again the critical issue would be the length and complexity of the public inquiry.

8.14 The statutory procedure for making a quality partnership scheme is fairly streamlined, involving publication in the local press, and consultation with operators, the police, etc. but no formal approval is needed. At least 3 months must elapse between making the scheme (in its final form following consultation) and its coming into force. The date of coming into force should not be before all the facilities covered by the scheme (primarily the guided busway) are provided and ready for use. It should probably possible to carry out all the statutory stages in the period between a TWA Order being approved and the works being completed, though it is strongly advisable to initiate informal discussions with operators at a much earlier stage.

8.15 The statutory procedure for making a QC scheme is similar at the outset, but once consultation has taken place, the scheme must be submitted to the Secretary of State for approval. The Secretary of State may receive representations from anyone who participated in the consultation process. The Department may require further information about the scheme as part of the appraisal process. The Secretary of State may approve the scheme with or without modification, and if it is significantly modified, may require at least a partial reconsultation with those parties affected by the modifications. The time needed to approve a scheme is difficult to predict given that this is so far an untried procedure. If the scheme is approved, the PTE must make it within six months of the date of approval (and must publish a notice within 14 days of its approval). At least 6 months must elapse between the date of making and its coming into operation, though for a complex scheme, and in all cases where there is a requirement to publish a notice of tender invitations in the Official Journal of the European Communities, considerably longer than 6 months may in fact be needed.

8.16 This is therefore a considerably more lengthy process than the making of a statutory quality partnership scheme and, to avoid delaying the start of the busway services, would need to be initiated at roughly the same time as the TWA process. So far as a QC scheme depends on the making of a TWA Order (i.e. is not purely concerned with the provision of bus services away from the guideway itself) it would appear to be desirable for the two decisions to be taken at the same time, to minimise the risk of one prejudicing the other - however there is no hard and fast rule and much will depend on the circumstances of the case. It should be borne in mind that each instrument, the TWA Order and the QC scheme, must be considered on its own merits in terms of the respective legislation - approval of one does not imply approval of the other - hence there is a risk of abortive work if only one of the two is approved and cannot be implemented independently of the other.

It is the promoters' view that there are a number of unresolved issues about how to implement a very high quality bus based system and ensure the delivery of the quality attributes over a period comparable to a tram concession. It should also be recognised that Metro and Leeds City Council do not have the powers to acquire land or construct guided systems for a bus based system, and that there are risks associated with any potential future application for such powers.

9. Conclusions

INTRODUCTION

9.1 This study has been concerned with examining a Bus Rapid Transit (BRT) solution for the three Leeds Supertram corridors, with the aim of considering whether buses can deliver a better solution than light rail when all possible existing levers are used in an imaginative and cost effective way. In line with the work already undertaken by Metro, this examination of a high quality bus based scheme has used the existing BRT proposals, which included elements of both guidance and segregation, as its foundation.

9.2 The assessment undertaken by Atkins has been based upon the modelling, costing and economic analysis tools and systems developed by Metro and its consultants. Atkins has not undertaken a detailed review or audit of these tools and systems.

SCHEME

BRT Option

9.3 As discussed in the earlier sections of this report, Metro and Leeds City Council considered a BRT option, designed to replicate the tram as closely as possible, in their November 2004 Appraisal Report submission to Government. We regard the design work undertaken as being very thorough and a good basis for considering a high quality bus alternative in the current study.

9.4 Atkins considers that the BRT option developed by Metro/Leeds CC could be refined further, but that this task is beyond the scope of the current high-level study. In particular, the scheme would benefit from a detailed value engineering exercise to see if there is scope to reduce the costs further and improve value for money. Additional work could also examine the potential for different guidance mechanisms (for example optical guidance at stops), different service patterns, and the ability to extend the network, although care would have to be taken not to compromise the quality of the system proposed or outcomes achieved.

9.5 The BRT system, as set out in the November 2004 appraisal report, was anticipated to cost £208.5m including a 15% allowance for contingencies, but excluding allowances for QRA and optimism bias. It is understood that the 15% contingency allowance applied to the BRT costs is similar in percentage terms to the risk allowance included in the truncated tram costs. However, owing to the commercially sensitive nature of the information, the cost of the truncated tram option has not been made available, although it is our understanding that this would be approximately twice the cost of the BRT system. Atkins has made some adjustments to these costs. The costs of segregation on the southern route were removed and lower vehicle costs were used (see section 2). On this basis, the capital cost of the BRT option would be £163.2m including the vehicles, and £151.2 million excluding the vehicles. It is most likely that under a BRT option the bus operators would pay for the vehicles. These revised cost figures also include a contingency allowance, but exclude optimism bias. The application of optimism bias is discussed in paragraph 9.27.

Services

9.6 The high quality BRT option (Option 2, as defined in section 5.3) which Atkins has considered is designed to replicate the services that would be offered by the truncated Supertram option, with which it has been compared. Thus, BRT would serve the same routes and stops as the proposed Supertram scheme, with services assumed to operate over the same time periods. The BRT vehicles would be smaller and of lower overall capacity than those assumed for Supertram. Therefore, to deliver 80-90% of the capacity of the tram, the BRT services have been assumed to require twice the number of vehicles, the cost of which has been taken account of in the economic appraisal. The BRT option would also result in more people being seated than the tram. Thus BRT would provide the same service patterns as Supertram, but at an increased frequency.

Physical Features

9.7 In terms of fixed physical infrastructure comparable to Supertram, the BRT option would offer:

- Dedicated stops;
- High quality shelters;
- Real time information;
- Off-board ticket machines;
- Lighting at all stops;
- CCTV;
- UTC system providing priority at junctions; and,
- Similar lengths of segregated track.

9.8 Atkins has assumed that the vehicle characteristics for the BRT option would be similar to those of the 'ftr' vehicle recently launched by First Group. This is described as a bus with tram-like appearance and offers most of the features of the Supertram vehicle, including:

- Automated ticketing equipment;
- Public address system with two-way communication;
- Real time information;
- Air-conditioning;
- Double-glazing;
- High levels of sound proofing; and,
- Similar quality of vehicle interior.

9.9 Although for the purposes of this study, the appraisal has been based on the vehicle characteristics of the 'ftr', it is noted that other vehicles are available, some of which are more expensive. The range is approximately £200k for a modern high quality single-deck articulated vehicle to £700k for a CiViS type vehicle with guidance and electric transmission. The analysis undertaken as part of this study assumes a vehicle cost of £315k.

9.10 The BRT vehicle is likely to have some features of lower quality than a tram vehicle, notably;

- Level boarding which may be limited to the front door (but which could be provided both on-guideway and off-guideway if docking stops are provided on the latter);
- The floor may not be level throughout;
- Diesel powered vehicles will result in higher levels of local emissions; and
- The ride quality is likely to be slightly lower (although the costs assume 100% resurfacing of the BRT route).

9.11 Ride quality is a function of a combination of factors (discussed further in section 2), of which surfacing is one, but which also include driver behaviour, vehicle acceleration and braking, and seating arrangements. Within a given vehicle there are likely to be more seated passengers on a BRT vehicle than on a tram. Whilst it is noted that there are several factors influencing ride quality, it is Atkins' conclusion that the differences between the BRT system and the tram are likely to be small.

9.12 Thus Atkins concludes that the BRT system would offer the majority of the physical features provided by Supertram. However, it should be noted that some of the quality features associated with the vehicle, such as ride quality and level boarding may be provided at a lower level. Atkins notes that Metro considers that some of these differences could have a significant effect on the attractiveness of BRT compared to tram.

Travel Times

9.13 The journey times forecast for BRT have been discussed in detail in section 2 of this report. When compared on an end-to-end basis, in-vehicle journey times for BRT are forecast to be approximately 10% (equating to 2 or 3 minutes) slower than the equivalent Supertram times. It should be noted that in both of these cases, this represents a significant reduction when compared to existing bus journey times for the same corridors. Within the run-time model used to forecast BRT and Supertram journey times, Atkins has identified three principal factors which contribute to the slower BRT journey times:

- The increased frequency of BRT vehicles is assumed to reduce the degree of priority that can be given at junctions. (It is generally more difficult to give priority to larger numbers of vehicles, but in practice the BRT priority will depend upon service frequency and signal timings);
- There is assumed to be greater abuse of priority measures for BRT than tram (in the BRT option, abuse could be reduced through greater enforcement, but at a cost); and,
- Engineering constraints in certain locations result in lower BRT speeds compared with Supertram.

9.14 Other journey time elements, such as the walk to and from the stop, will be the same for BRT as for tram.

9.15 The increased frequency for BRT compared with Supertram would result in reduced waiting times. The reduction in waiting time is likely to offset the increased in-vehicle time leading to similar overall journey times for BRT and Supertram.

Reliability

9.16 Bus journey times are likely to be less reliable than tram journey times because of the lower level of priority at junctions and the risk of greater abuse of priority measures by other traffic. Although generally, given the priority afforded to the bus in the BRT option, the variation in travel time should be relatively small. Delays on a tram system are therefore likely to be less frequent than on a bus based system.

9.17 Associated with reliability is the issue of 'bunching' (several vehicles travelling in convoy) which sometimes occurs with conventional bus services. However, this should be avoidable through the use of automatic vehicle location.

'Non-quantifiable factors'

9.18 Within the scheme appraisal process it is generally acknowledged that there are some factors that may influence scheme performance, but the impact of which cannot be quantified. These mainly relate to perception, both of users and non-users, and their attitudes towards vehicle quality, reliability, and associations of 'permanence' made about different modes. For example, it is often noted that the infrastructure associated with a tram (fixed track and overhead line equipment) may give rise to a perception of permanence which has implications about the future of the system. Conversely, the presence of fixed track and overhead line equipment may also be perceived as an unwelcome visual intrusion.

9.19 In the BRT option there will be twice as many vehicles (compared to the number of trams) operating in the city centre. This is likely to have a negative impact on environmental considerations when compared with the tram. However, the presence of more BRT vehicles in the city centre could also serve to raise the profile of the system, and may equally have positive impacts on public perception. However, evidence referring to these factors is often anecdotal and as such no clear conclusions can be drawn.

EXPERIENCE FROM ELSEWHERE

9.20 An extensive literature review of the performance of BRT and tram systems was undertaken as part of the project. This review pointed to a general lack of evidence relating to the performance of high quality bus systems. In particular, there appears to have been very little detailed monitoring undertaken of existing schemes, relating to levels and source of patronage.

9.21 Research by Hass-Klau et al and Brand & Preston shows that the quality bus systems that have been delivered, have been of lower cost, with greater flexibility than tram systems, but they are generally considered to be of lower quality. These systems, however, have generally been '*congestion-busters*', with priority measures focussed on key congested locations (Brand & Preston). Such systems have typically been afforded much lower levels of priority than equivalent tram schemes. Brand & Preston note that '*we do not compare like with like, as bus priority and* *guideway sections often signify only a small percentage of the total service line whereas, for example, light rail benefits are a result of the performance of the entire line/service*'. Thus there is little evidence available as to the performance of bus based systems delivered in a similar manner to a light rail system and over a network of routes. Indeed research in the U.S. (see section 3) has suggested that the most successful examples of quality bus have been those that closely replicate tram systems.

9.22 There is mixed experience associated with recent tram systems in the UK, as documented in the NAO report (see section 3). Whilst these systems have generally delivered the anticipated services and features, this has not always been matched by the expected patronage levels. The reasons for this are complex and are discussed further in section 3. It is not possible to draw firm conclusions, but the experience to date suggests that the preference for tram over bus may be lower than previously anticipated.

9.23 Whilst bus usage in England outside London is in decline in overall terms, there are a number of examples of UK bus systems that have shown high levels of patronage increase in response to investment (such as in Brighton and Hove). However, there has only been one example of a bus system in the UK, Crawley Fastway, which has been delivered in a systematic manner more akin to a tram system. The Crawley Fastway system has many of the attributes of a tram system (such as highly visible branding, dedicated stops, level or near level boarding, real time information, unique vehicles, high frequency) but is of lower quality that the BRT proposal for Leeds. The Crawley system has been more successful to date than anticipated, with patronage some 40% higher than forecast. The Fastway system serves Crawley and Gatwick, with the airport accounting for some 35% of patronage. There has been no detailed monitoring of the Fastway system, so all that can be concluded is that the system has proved more attractive than originally anticipated. Experience of bus investment in the UK indicates that the largest increases in bus patronage appear to have occurred where there has been a systematic approach to improvements, including high quality vehicles, priority measures, simplified fare systems and associated marketing.

9.24 There is little comparative research examining bus and rail based systems, largely due to the lack of systematic bus based systems noted above. There is one research paper from the U.S. (Ben-Akiva, 2002) where detailed analysis has been undertaken using two separate data sets to test whether there is a preference for rail based travel over bus based. This research concluded '*that there is no evident preference for rail travel over bus when quantifiable service characteristics such as travel time and cost are equal*'. The findings of the study also recommended that '*a bus service with 'Metro-like' attributes should be analysed using the same alternative specific constant used for a comparable rail service*'.

9.25 On the basis of the available literature, Atkins conclude that there is no clear evidence that a bus based system providing most of the attributes of a tram system would not attract similar levels of patronage and deliver similar levels of benefit. It is recognised that a significant difference between the systems is the fixed infrastructure associated with a tram, which may give a perception of greater permanence compared with a bus system. However, there are few bus systems that have been delivered in a systematic manner comparable with a tram and thus it is not possible to establish the significance of this perception.

DEMAND FORECASTING AND APPRAISAL

9.26 The patronage forecasts and economic appraisal of the BRT option have been predicted by the model developed by Metro's consultants for the Supertram project. Atkins has some concerns over the patronage levels forecast for Supertram, based upon comparisons with existing UK tram systems. It should be stressed it was beyond the scope of the brief to undertake a detailed audit of the model. The study has, therefore, focused on the relative performance of the two modes, rather than the use of the model as an appropriate tool to determine absolute patronage levels for BRT and Supertram.

9.27 In examining the appraisal of BRT two factors have altered since the Metro appraisal in November 2004. Both of these changes impact on the cost of the BRT system and both have been adopted by Atkins in this study:

- A lower vehicle cost of £315k (compared with £700k in the original BRT option) based upon the recently launched 'ftr' vehicle, as an example of a high quality bus produced in the UK; and
- Application of optimism bias at 32% on top of QRA/contingency (compared with 44% in the original BRT assessment) in accordance with latest DfT research. This is explained in section 4.

9.28 During this study it became clear that a critical factor in comparing the benefits of BRT and tram is how potential passengers, and especially car users, would perceive BRT and whether it would attract significant modal shift. There is a lack of firm evidence on this, given that no BRT system of the type envisaged here currently exists in the UK. In the demand forecasting and economic appraisal work undertaken, this degree of attractiveness is manifested in two key factors which impact on the level of demand and benefits forecast. These factors are the 'mode constant' associated with BRT, and the independence of the BRT from other modes, which affects the elasticity of choice between them.

9.29 The first of these factors, the 'mode constant', is a measure of the degree to which, all other things being equal, the mode would be preferred to conventional bus. Metro's appraisal for BRT assumes that the BRT system is less attractive to potential passengers than Supertram. The assumption in the modelling work undertaken is effectively that BRT has 75% of the advantage held by Supertram over existing bus services. Atkins considers that this, in terms of the use of a lower value, and the scale of the lower value, is reasonable given recognition of:

- The lower level of achievement of some quality attributes referred to above;
- The potential for a lower level of travel time reliability; and
- The belief that bus based systems may be perceived less favourably than tram based systems.

9.30 The second factor is the measure of how far the BRT can be considered as a new travel choice, distinct from existing travel choices. Metro's forecast models were set up to project demand for a tram system as a fully distinct new choice. This results in significant transfer to the tram from other modes including car. The modelling for the BRT option then substituted BRT for tram. Metro, however, consider that BRT would not be considered to be a fully distinct new travel choice in the same manner that tram would be, rather it would be a choice more similar to an existing bus. They consider that this is particularly the case in Leeds as there are already guided busways in existence. This decision resulted in an off-line adjustment being made to the BRT demand and benefit forecast, removing half of the benefits attributed to it being a new choice. Metro state this was a pragmatic approach in the light of any alternative research being available.

9.31 The results of the demand forecasting and economic appraisal of the BRT system are shown in Table 9.1 below, along with a comparison with the tram. BRT results are presented with BRT treated in exactly the same way as the tram (second row) and with Metro's adjustment (third row). For both BRT tests, the mode constant used for BRT was lower than that for the tram.

9.32 In addition, during this study Metro re-examined the approach they had previously adopted for the calculation of benefits and set up the model so that BRT could be modelled as a true sub-mode of bus, rather than making an off-line adjustment to achieve a similar effect. This test was undertaken on a slightly different option to those listed in the table above, but is still valid to give an indication of scheme performance. The results are shown in the fourth row of the table.

Table 9.1 – Appraisal results

Test	BCR	PVB	% of tram benefits	NPV	Demand	% of tram demand
Tram	2.4 : 1	1499	100.0	866	19.33	100.0
BRT (treated in the same way as tram)	3.6 : 1	1271	84.8	916	17.72	91.7
BRT (with an adjustment made)	2.3 : 1	790	52.7	444	15.12	78.2
BRT (additional test as a sub mode of bus)	2.7 : 1	957	63.8	601	n/a	n/a

9.33 The assumption about whether BRT is a new travel choice, in the same way that tram is considered to be, is critical in assessing the performance of the scheme. The effect of this decision is worth approximately £500 million and reduces the BRT benefits from approximately £1.3 billion to £800 million. If BRT is considered as a new mode then it is forecast to carry 92% of the demand of tram, with 85% of the benefits. If it is not considered as a new mode, however, it is forecast to carry 78% of the demand, but achieve only 53% of the benefits.

9.34 The forecasting work undertaken gives a range of benefits associated with the BRT, depending on the approach favoured. All approaches examined assume that BRT has a mode constant of 75% of that of tram, as discussed in paragraph 9.29. Net Present Values of benefits of BRT range from £444 million through to £916 million. These compare with an NPV for tram forecast to be £866 million. Given the lower costs of the BRT, these benefits translate into a range of Benefit to Cost ratios of 2.3:1 through to 3.6:1 for BRT, compared to 2.4:1 for the tram. It should be noted that DfT have advised that the level of optimism bias applied to the appraisal of the tram scheme (6%) is considered to be lower than it should be at this stage in the approval process. Application of a higher optimism bias would result in a Benefit to Cost Ratio lower than 2.4:1.

9.35 It is the view of Atkins that BRT has similar characteristics to Supertram. It has the majority of the physical features of the tram, operates the same service patterns as tram and achieves similar journey times to tram. It does, however, have some quality features lower than those offered by tram, so it is accepted that the perception of the mode may be lower than that for tram (a fact reflected in the lower mode constant). Given this, Atkins believes that BRT should be assessed in a similar manner to Supertram, albeit with a lower mode constant. Thus Atkins concludes that the economic benefits provided by BRT should lie at the upper end of the range of the economic tests. In this case BRT would result in a similar Net Present Value of benefits to Supertram and offer better value for money with a Benefit to Cost ratio in excess of that of Supertram.

9.36 It is Metro's view that BRT will not be viewed as a distinct mode in the same way that tram will be. In this instance, the model suggests that the Net Present Value of benefits for the BRT will be at a lower level (between one-half and two-thirds from the two methodologies employed). The fact that the cost of the BRT is approximately half that of tram, will result in a benefit to cost ratio of BRT similar to that of tram.

WIDER APPRAISAL ISSUES

9.37 In addition to the economic performance of the BRT scheme, the performance relative to the wider Central Government NATA/GOMMMS objectives, as well as the Central Government Shared Priorities, and the objectives contained within the provisional West Yorkshire Local Transport Plan, 2006 to 2011, was also examined.

9.38 The objectives from these three sources include a wide variety of aims, including improving accessibility (to services and jobs), reducing congestion (including mode shift) and improving safety. For those areas, where the likely performance of the BRT scheme has been assessed as lower than that of the tram, this is predominantly driven by the differences in demand and the forecast levels of patronage for each mode. As the tram is forecast to carry more passengers, this has led to a lower assessment of performance for the BRT against objectives relating to:

- Accessibility to education, employment and services – although the extent of the BRT network and services is the same as that of the tram, in absolute terms, more passengers are forecast to be carried on the tram;
- Encouraging mode shift, sustainable travel, and journeys by public transport and non-motorised modes – in absolute terms, more passengers are forecast to be carried on the tram;

9.39 The higher demand forecast for tram gives rise to a higher reduction in the number of private car users compared to that forecast for BRT and thus influences the lower assessment of performance of BRT against objectives relating to:

- Improving safety and reducing road casualties – this assessment is based on the reduction in vehicle kilometres and the tram is forecast to attract more passengers away from the private car; and
- Improving local air quality and reducing emissions – this assessment is based both on the reduction in private car use and the higher number of diesel buses compared to electric trams which would have lower local emissions.

9.40 Journey time reliability for BRT is forecast to be lower than that for the tram resulting in a lower assessment of performance against objectives relating to journey time reliability and reductions in delay.

9.41 The other area where the likely performance of the BRT scheme is assessed as lower than that of tram relates to physical accessibility at stops. The costs of docking stops on off-guideway sections have not been included within the economic appraisal. There is no reason, however, why this could not be introduced.

9.42 Although there are areas where BRT has a lower assessment of performance compared to tram, the schemes are also indistinguishable in a number of key areas including the extent of the network, comparable (if not better) service frequencies and the provision of the majority of the physical and quality features associated with the tram scheme.

9.43 Many of the differences, in the assessment of the wider appraisal issues for the BRT option and the tram, are driven by forecast levels of patronage and mode switch. It should be noted, therefore, that the magnitude of the difference is closely linked to the modelling treatment described in paragraphs 9.28-9.30. Thus, the magnitude of the difference is dependent on the determination of BRT as a new mode, such that if it is treated as a new mode it is forecast to deliver 92% of the tram demand; if it is not, and Metro's adjustment is applied, the forecast level of demand is reduced to 78% of that of tram. Thus, taken as a whole, Atkins concludes that the BRT scheme would deliver many of the wider benefits associated with the tram.

DELIVERY

9.44 The review of delivery options in section 8 shows that there are a number of options available, including Quality Partnerships, Quality Contracts and the Transport and Works Order Act. Whilst none of these options are entirely risk free, and will need more work, there is enough evidence to suggest that potential problems in delivery are not insurmountable. Using current regulatory regimes (in particular the TWA route) systems could be devised to deal with potential problem areas such as:

- Service levels including periods of operation, frequencies and run times, including longer term certainty;
- Ticketing arrangements (which would affect dwell time at stops);
- Priority measures, including enforcement; and
- Quality regime.

9.45 If a BRT option is to be pursued, further work would need to be undertaken to address the way in which these risks, and other issues relating to integration and competition with other modes and services, can be minimised. Further detailed consideration would need to be given to identify the most appropriate delivery mechanism for developing a BRT system in Leeds or elsewhere in the UK outside London, and it is likely that delivery would have to be undertaken through a combination of mechanisms (with their attendant risks), rather than a single source.

9.46 Atkins concludes that whilst a bus based system **could** be delivered, because the proposed measures have not been introduced in a systematic way elsewhere, it has not been able to provide a clear demonstration that mitigation of the risks associated with the delivery of all of the BRT features recommended for such a system can be guaranteed, nor that these could be guaranteed for the life of the scheme. Thus, there is a risk associated with system delivery that could affect the performance of a high quality bus based system.

9.47 There are also risks associated with timescale implications for scheme delivery, changing from an existing scheme which has statutory powers to a new scheme which may require them. In the case of the proposed BRT scheme, TWA powers would be needed for the segregated sections, giving rise to the attendant risks associated with progressing the order through the public inquiry process.

9.48 Metro considers that none of the above approaches are without fundamental problems and significant risks. Metro's preferred approach would be a TWA Order (which would be required in conjunction with any option) that superseded the 1968 and 1985 Transport Acts through the inclusion of ancillary matters covering all routes using sections constructed through TWA Order powers. This approach would also, if drafted in such a way, facilitate a subsequent mode upgrade should demand justify it, and funding be available in the future.

CONCLUSIONS

9.49 The BRT option has the potential to offer a lower cost and better value for money alternative to the Supertram proposal. Atkins considers that a BRT system would offer many of the attributes of the Supertram system, including:

- Similar stop and service patterns with a higher frequency service;
- Similar overall journey times (including waiting time);
- The majority of the physical features;
- In the region of 90% of the forecast patronage for Supertram;
- Most of the wider appraisal benefits attributable to Supertram; and
- These would be delivered at around 50% of the capital cost of the tram.

9.50 Some attributes of BRT would be offered at a lower level than Supertram:

- Journey time reliability may be reduced through a lower level of self-enforcement;
- Ride quality may be slightly lower;
- Level boarding may only be available at the front door of the vehicle, however, use of docking stops should ensure this is achieved consistently;
- The vehicle floor may not be level throughout; and
- Emissions at the point of delivery (within the corridors) would be higher.

9.51 The BRT system as proposed is much closer in characteristics to the Supertram system than existing bus services. On the balance of the information and evidence reported in the preceding sections of this report, Atkins considers that BRT would be much closer to a new travel choice in perception and performance than the existing bus services. Atkins does, however, accept that there is an element of risk in this assumption, as a comprehensive bus system has not been delivered in this manner before in the UK, therefore the forecast patronage and benefit levels cannot be guaranteed.

9.52 Section 5 of this report has presented a range of economic performance for BRT. When BRT is assessed economically as a new travel choice, in the same way that tram is, it delivers similar values of benefits to those forecast for Supertram and has a much higher benefit to cost ratio. When BRT is not assessed as a new travel choice it has a similar BCR to Supertram but a much lower present value of benefits. Given the greater similarity of BRT to Supertram than existing bus, Atkins considers that the assessment of BRT should lie at the upper end of this range. On this basis, it is concluded that BRT would offer a substantially higher BCR than Supertram, delivering the majority of the benefits of Supertram at half the cost.

9.53 As noted above, changing from a scheme which has already been granted statutory powers to one which (as proposed) will require a TWA order for the segregated sections is likely to introduce risks associated with the timetable for delivery.

9.54 The above conclusions assume that the BRT system and all its features can be delivered. It is considered that this is the greatest area of risk and uncertainty. Whilst a BRT system could be delivered, it is not clear that the delivery of all of the quality features can be guaranteed. It is also less clear that delivery of all the quality attributes can be guaranteed for the life of the scheme, as it can with a tram, as the tram contract would contain a long term operating concession. If a BRT option is to be pursued, further work would need to be undertaken to address the way in which these risks, and other issues relating to integration and competition with other modes and services, can be minimised.

Appendix A - Run Time Comparisons

JOURNEY TIME COMPARISONS

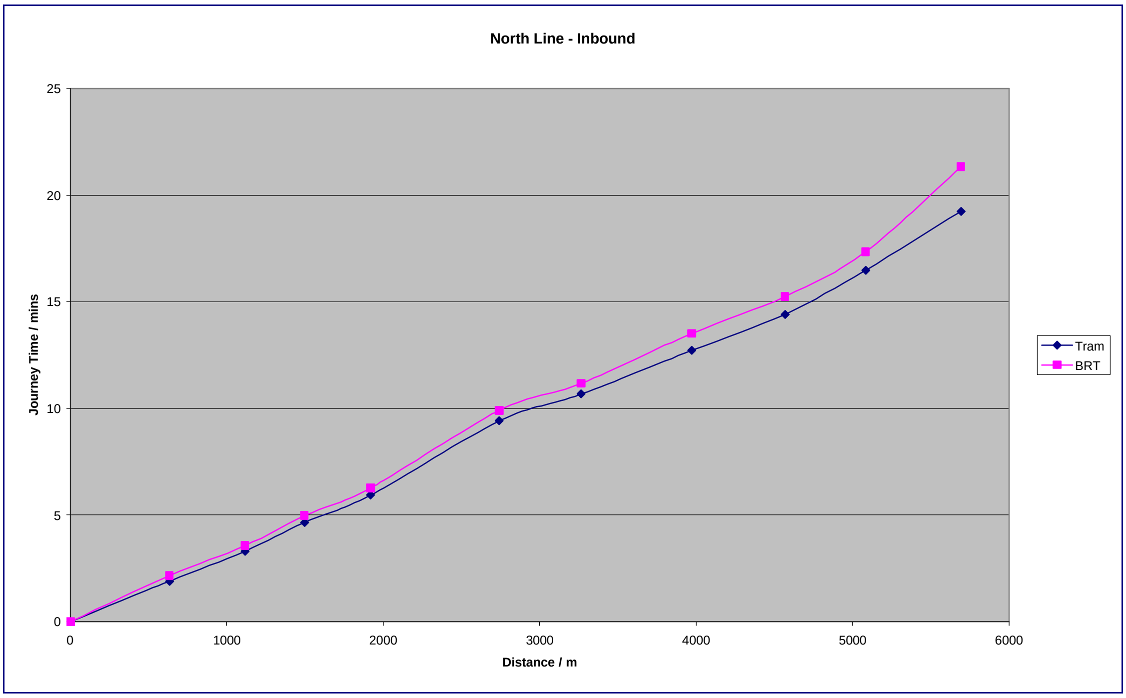

Figure A.1 - North Line Journey Time Comparison – Boddington to City Centre

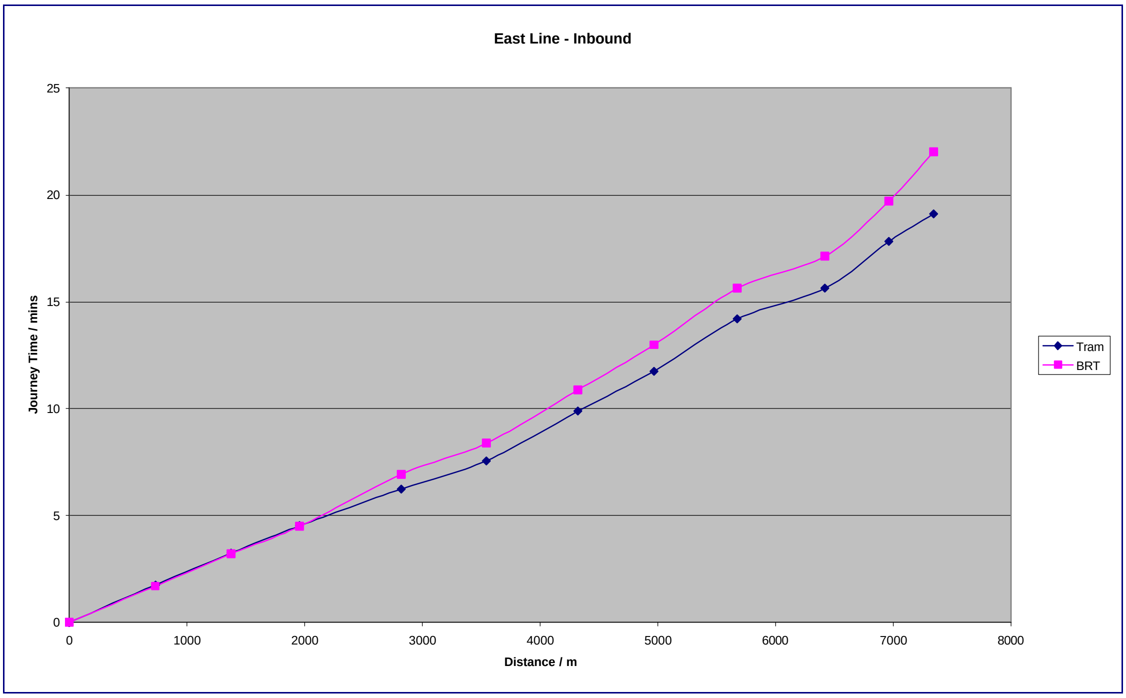

Figure A.2 - East Line Journey Time Comparison – Seacroft to City Centre

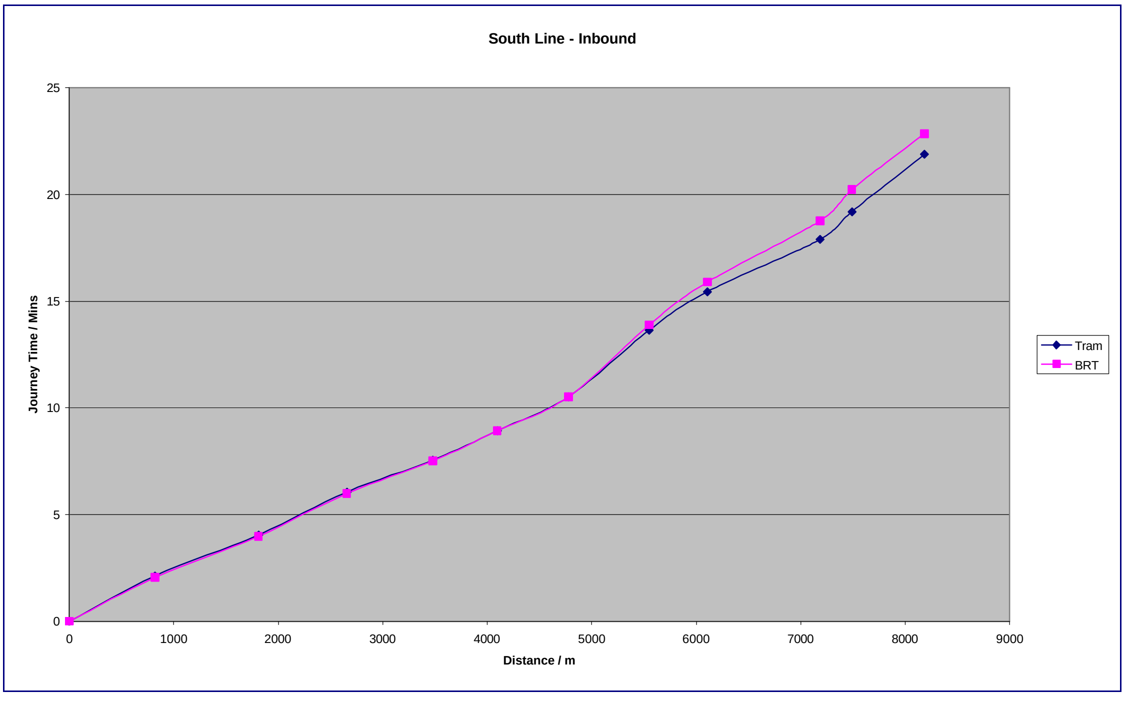

Figure A.3 - South Line Journey Time Comparison – Middleton to City Centre

LOST TIME COMPARISONS

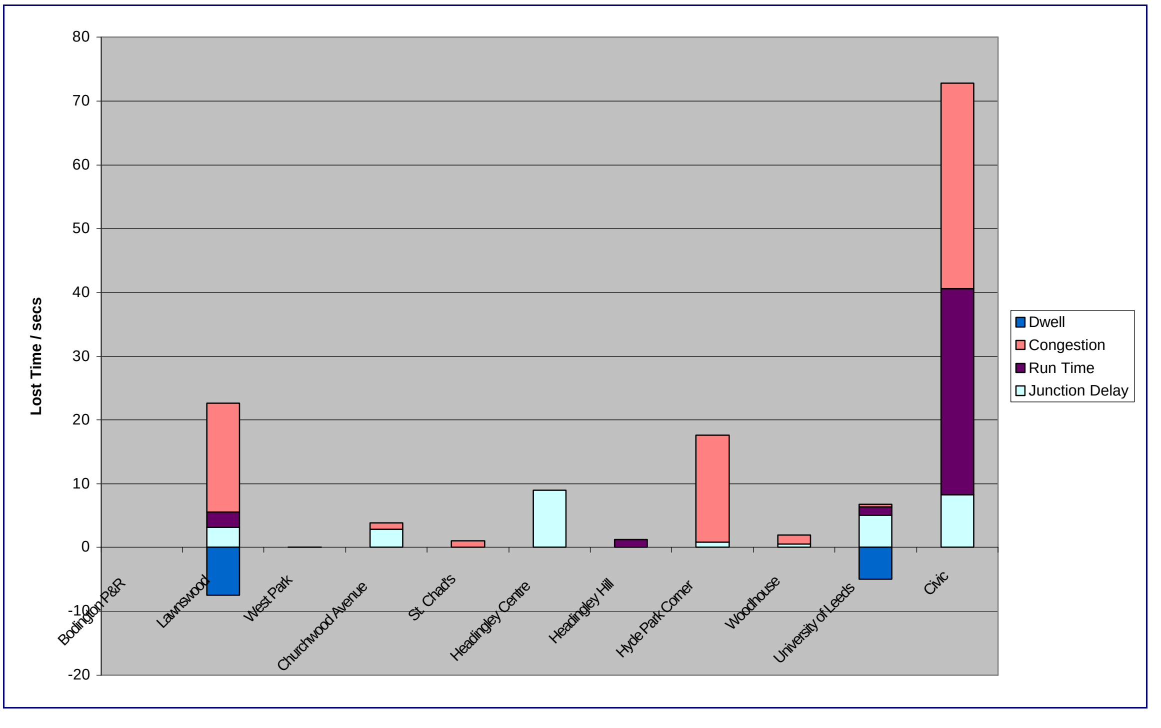

Figure A.4 - Lost Time Comparison – North Line

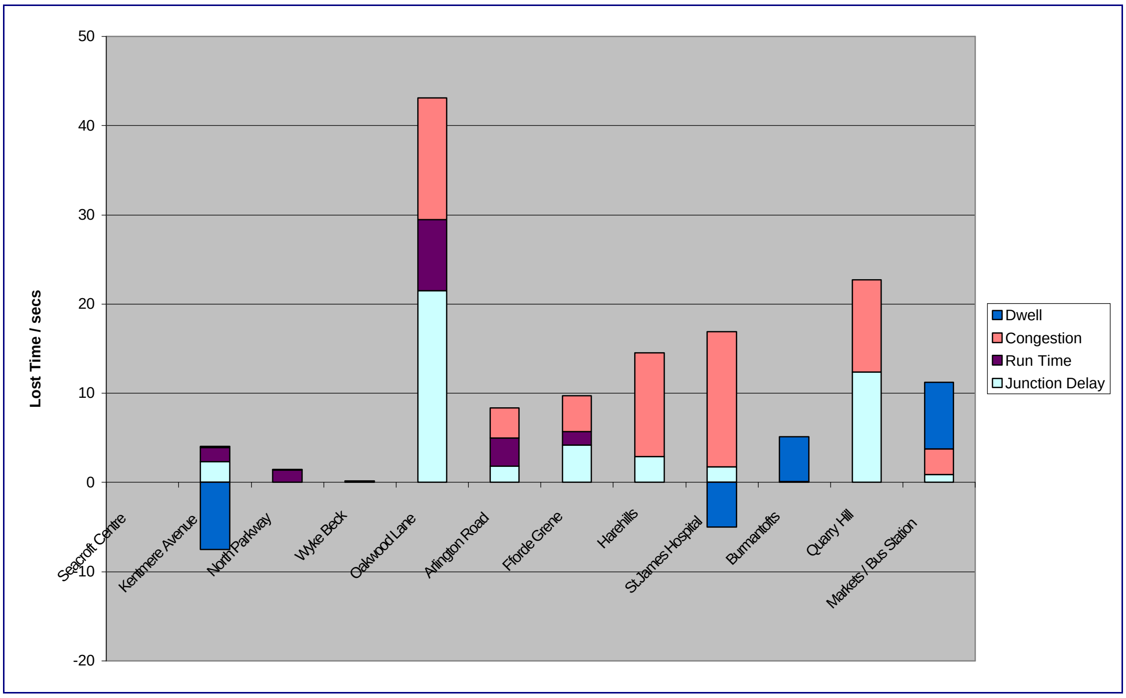

Figure A.5 - Lost Time Comparison – East Line

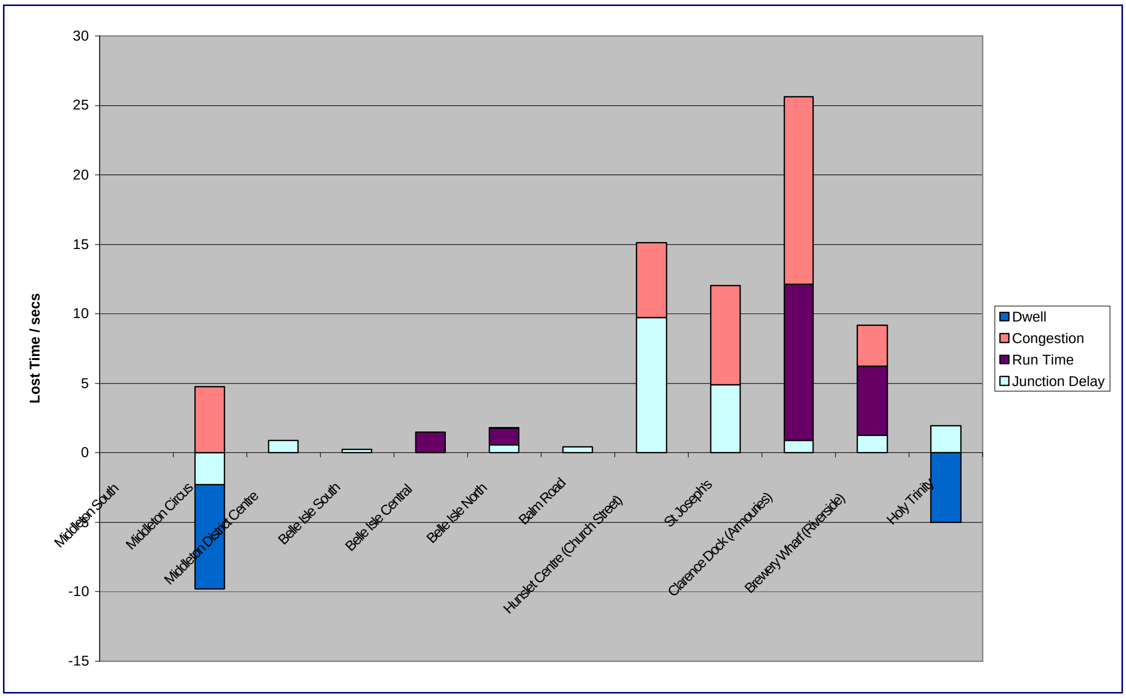

Figure A.6 - Lost Time Comparison – South Line

Appendix B - Reference Sources

Document Title	Web Link	Modes Covered			Issues Discussed										
		Light Rail	Bus Lanes / Bus Priority	Busways / Guided Bus	Capital Costs	Operating Costs	Revenue	Patronage	Impact on Modal Shift	Journey Times	Journey Time Reliability	Environmental Impact	Impact on Congestion	Impact on Regeneration	Optimisation / Enhancement
Ben-Akiva, M and Morikawa, T (2002). ***Comparing Ridership Attraction***. Transport Policy, 9 (2002), pp107-116.		■	■	■				■	■	■	■		■		
Brand, C and Preston, J (2003). ***Which Technology for Urban Transport? A Review of System Performance, Costs and Impacts***. Proceedings of the Institute of Civil Engineers – Transport, November 2003, Issue TR4, pp1-10.	**http://www.tsu.ox.ac.uk/test/index.html**	■	■	■	■	■		■	■	■	■	■	■	■	
Confederation of Passenger Transport UK (February 2003). ***Buses and Coaches: the Transport Solution***. [online] CPT, London.	http://www.cpt-uk.org/documents/E&R0.1Buses%20and%20Coaches%20the%20Transport%20Solution%20_full%20version_.pdf		■									■			
Department for Transport (2004). ***Bus Priority: the way ahead – Overview (Resource Pack – Edition 2)***. Department for Transport, London.	**http://www.buspriority.org/Resource%20Pack%2012-04.pdf**		■	■	■			■		■	■		■		■
Federal Transit Administration and the United States Department of Transportation. ***Characteristics of Bus Rapid Transit for Decision Making***. Federal Transit Administration, USA.	http://www.fta.dot.gov/documents/CBRT.pdf		■	■	■	■		■	■	■	■				■

Document Title	Web Link	Modes Covered			Issues Discussed											
		Light Rail	Bus Lanes / Bus Priority	Busways / Guided Bus	Capital Costs	Operating Costs	Revenue	Patronage	Impact on Modal Shift	Journey Times	Journey Time Reliability	Environmental Impact	Impact on Congestion	Impact on Regeneration	Optimisation / Enhancement
Hass Klau, C and Crampton, G (2002). ***Future of Urban Transport: Learning from Success and Weakness – Light Rail****.* Environmental and Transport Planning, Brighton.															
Hass Klau, C. Crampton, G. Weidauer, M. and Deutsch, V (2000). ***Bus or Light Rail: Making the Right Choice****.* Environmental and Transport Planning, Brighton.															
Litman, T (2004). ***Evaluating Public Transport Benefits and Costs: Best Practices Guidebook***. Victoria Transport Policy Institute, Canada.	http://www.vtpi.org/tranben.pdf														
National Audit Office (2004). ***Improving Public Transport in England through Light Rail***. The Stationery Office, London.	http://www.nao.org.uk/publications/nao_reports/03-04/0304518.pdf														
Steer Davies Gleave (2005). ***What Light Rail Can Do For Cities: a review of the evidence***. Passenger Transport Executive Group.	http://www.pteg.net/LightRailCentre/01-Whatlightrailcandoforcities.htm														
Transportation Research Board (2003). ***Implementation Guidelines for Bus Rapid Transit Systems****.* Transportation Research Board, Washington, USA.	http://trb.org/news/blurb_detail.asp?id=1698														

Document Title	Web Link	Modes Covered			Issues Discussed										
		Light Rail	Bus Lanes / Bus Priority	Busways / Guided Bus	Capital Costs	Operating Costs	Revenue	Patronage	Impact on Modal Shift	Journey Times	Journey Time Reliability	Environmental Impact	Impact on Congestion	Impact on Regeneration	Optimisation / Enhancement
TRL (2004). ***The Demand for Public Transport: a Practical Guide***. Report TRL593.	http://www.demandforpublictransport.co.uk/TRL593.pdf														
United States General Accounting Office (2001). ***Bus Rapid Transport Shows Promise***. United States General Accounting Office.	http://www.altfuels.com/PDFs/GAOBRTstudy.pdf														

Appendix C - Commentary on Supertram and BRT Patronage Forecasts

steer davies gleave

note for file

Date	**23 September 2005**		
Circulation	**Steering Group**		
Project Name	**Study of High Quality Buses in Leeds.**	Project/Ref no.	**206466**
Subject	**Commentary on Supertram and BRT Patronage Forecasts**		

Atkins's report for this study includes tables of patronage forecasts at the level of modelled periods. Some commentary has been requested on the forecasts for Leeds Supertram and the hypothetical Bus Rapid Transit option.

The Leeds Supertram forecasts were produced over 3 years ago and have been reviewed by the DfT at several junctures. They have only been subject to revision as a result of minor variations and then truncation of the scheme specification. Any previous commentary on these forecast is therefore broadly still relevant. A benchmarking exercise has been undertaken previously (in 2003) comparing patronage forecasts in different cities and this has been shared with the DfT at that time. It puts the forecasts of patronage for Leeds Supertram in context and gives some insights into the relative proportions of car transfer for the different cities.

In the morning peak, 3969 trips are forecast for the truncated tram network, of which 976 are transferring from car and 543 are taking advantage of the park and ride facilities. Non-park and ride transfer from car amongst represents about 25% of the total forecast while park and ride demand represents a further 14%. These proportions of car transfer are consistent with the nature of the Leeds travel market on which the Supertram demand forecasts are based, with car use being relatively high in the face of increasing congestion (traffic into the centre of Leeds has grown by 10% between 1994 and 2004) and high prices for city centre parking, reflecting its limited availability. The increase in congestion results from growth forecasts which are lower than DfTs TEMPRO forecasts. In terms of tram schemes in English cities, the city with most similar characteristics to Leeds is Nottingham. Nottingham Express Transit is now carrying more passengers than were originally forecast and a high proportion of users previously used car – indeed, over 20% use the Park & Ride sites alone. It is reasonable to expect that the proportion of car transfer in Leeds could match or indeed exceed that in Nottingham given the road traffic conditions and large scale provision of Park & Ride.

In the Inter-peak period, which is the average hour between 9:30 and 15:00, the number of Supertram trips forecast is 3939, which is a similar figure in total to the peak hour. Clearly this represents flows in two directions summing to a total, which is reached from a largely uni-directional flow in the morning peak period. For comparison, de-annualising METRO-area bus trips with the annualisation factors used for the Supertram forecasts implies bus patronage for the inter-peak average hour of about 80% that in the morning peak hour (by reference to March 2002 ITN Documentation "Demand and revenue Forecasts, Assumptions and Methodology" report). Relatively, the higher significance of inter-peak travel for the Supertram is because the scheme directly links the key drivers of inter-peak demand in Leeds: the University, St James Hospital, the City Centre and secondary centres such as Headingley and Seacroft. This is an important positive attribute of the Supertram alignment. In the inter-peak, car transfer represents a slightly greater proportion of total patronage than in the peak. This reflects the base market size, with buses being proportionately more preferred over cars during busy commuter times than during the inter-peak. During the inter-peak period, a greater proportion of car users are forecast to be attracted by the convenience of the Supertram than are forced to Supertram by the congestion and parking charges affecting their alternative car journey.

By way of comparison, usage of Manchester Metrolink in an average inter-peak hour is also 80% of that of an average morning peak hour, based on analysis of the surveys undertaken of all users for Concessionary Fares monitoring purposes by GMPTE.

The BRT forecasts have been undertaken during summer 2004 and then further in summer 2005 using the same forecasting tools but using adjusted modelling parameters; specifically a lower modal constant advantage of BRT over bus than was used for Tram. Other external adjustments were also made, however. In forecasting the economic user benefits of BRT, it was felt that BRT would not be perceived by the public as an entirely new mode in the same way that Supertram would be. Consequently, an exercise was carried out to determine the scale of benefits resulting purely from modelling the BRT as a new mode and half of these were deducted. Since it was felt that patronage from the car availability segment at least would tend to respond to the level of benefit gained per trip, the same treatment was applied to the patronage forecast by the model for the Car Available demand segment. This led to a reduction in the forecast of patronage for the BRT option.

Appendix D - Modelling and Appraisal Issues

Mode Constant Derivation

The following table, based on material in section 8 of TRL593, provides valuations of the various journey attributes which contribute to the derivation of the mode constant. Note that strictly these are *not* additive.

Table D.2 - Mode Constant Characteristics (TRL593)

Attribute of Journey	Value in Pence	Price Base
Waiting Environment	Max 26.1	
Ride Quality		
stops close to kerb	5.8	1996
rough vehicle motion	-10.5	1996
roomy seats	3.0	1996
two sets of doors	4.2	1996
electronic display	3.9	1999
wide entry – non steps	8.0	1999
ride – very smooth	27.0	1999
ride – generally smooth	16.0	1999

The perceived value of a "generally smooth ride" is shown as 16p (1999 prices) while that of a "very smooth ride" is 27p. Using the value of time for public transport users assumed in the appraisal, this equates to a difference of about 3 minutes of generalised time – consistent with the choice of 12 minute and 9 minute mode constants for tram and BRT, respectively, as introduced in Section 5 of this report.

It could be argued that the difference in ride quality should be even smaller, given that the current appraisal of BRT assumes that all relevant road surfaces will be resurfaced as part of the BRT scheme. This would increase the value of the BRT mode constant and yield further benefits for BRT users.

Use of Composite Costs

It is important to note that an approach based on composite costs will *always* yield user benefits when a new mode is introduced, irrespective of how good or poor the new offering is. This is not entirely intuitive but does reflect the logit forecasting approach, implicit within which is the positive valuation of choice *per se*.

The use of a composite generalised cost with which to appraise benefits to public transport users is not uncommon in studies such as this. By aggregating forecast demand and costs across public transport modes the ability to apportion user benefits to the users of individual modes is lost. However, the key benefit is that the method avoids complications due to the absence of a cost for tram or BRT in the Do-Minimum scenario.

To address the problem of “missing” Do-Minimum data for the new mode, pragmatic work-arounds have been applied on other studies, to facilitate economic appraisal. However, such methods are not straightforward. Consequently, in cases where the apportionment of user benefits to individual transport modes is not essential, the use of composite costs is common.

Appendix E - Note by DfT on the Legislative and Institutional Framework

NB This paper has been prepared to inform the study of high quality buses in Leeds being undertaken by WSAtkins for the Department of Transport and West Yorkshire Passenger Transport Executive. While every effort has been made to ensure factual and legal accuracy, it has not been possible, in the time available, to obtain a definitive legal view on all the issues raised.

The views expressed in this paper, including the conclusions, are without prejudice to any decision the Secretary of State may be called on to take with regard to the making of a Transport and Works Order or the approval of a Quality Contracts scheme in relation to a busway or similar system in Leeds.

INTRODUCTION

A number of legislative options are available to authorise and regulate the provision of a high quality bus system involving guided vehicles and segregated lanes or trackway. It is assumed for the purpose of this paper that the system will use a road-based side guidance mode[7] similar to those used elsewhere in West Yorkshire, and its routes will closely follow the truncated tram option, hence will include:

- sections of newly constructed guided busway;
- sections of guided busway within existing highways;
- sections of normal street running where the buses will not be segregated from other traffic.

This may not in fact be the optimal design for a guided bus system, since it was developed with trams in mind, but forms the best direct comparison to a tram-based system.

CONSTRUCTION AND LAND ACQUISITION POWERS

The PTE will need to obtain powers to construct the new busway sections away from existing highways and acquire the necessary land. It is assumed that the powers obtained for tramway purposes are not transferable to a busway scheme.[8] These powers could be obtained:

- under the Highways Act 1980, if it is intended that the busway be a highway; or
- under the Transport and Works Act 1992 ("TWA") if it provides a guided system covered by that Act.

[7] See Articles 2(g) and 3(1) of the Transport and Works (Guided Transport Modes) Order 1992 (SI 1992/3231).

[8] The Leeds Supertram Act 1993 provides for a rail or cable guided bus system as an alternative to a tramway, but not for a side-guidance system.

If constructed under Highways Act powers, the busway would have to be designated as a special road, restricted to a single class of traffic (a bus equipped with a guidance system). It is assumed that, if constructed under the TWA it would not be dedicated as a highway, and the question then arises whether it would fall within the definition of "road" for the purpose of the Road Traffic Act 1988, the Road Traffic Regulation Act 1984 and the Public Passenger Vehicles Act 1981. The working assumption should be that it would not fall within that definition. It would be possible, however, for the TWA order specifically to apply provisions of those, and related, Acts as if the busway were a road.

The construction of guided busways within existing highways could be done under Highways Act powers and would also require traffic regulation orders ("TROs") to prevent use by other classes of traffic. Alternatively, it could be done under the TWA. However, works or other powers (e.g. to authorise traffic regulation measures or land acquisition) relating to sections of normal street running in unguided mode would fall outside the scope of a TWA order if those powers were not properly "ancillary" to the construction or operation of the guided busway itself.

It should be noted that, whilst a side guidance bus system can be authorised under the TWA, an optical guidance system at present cannot. To bring this within the scope of the TWA would require an Order under section 2 of the TWA prescribing optical guidance as a further mode for which TWA orders can be made. An order under section 2 would need to be approved by affirmative resolution in Parliament, so to make one would be quite a lengthy process, and this would have to be done before the busway order was applied for.

BUS OPERATION POWERS

Again a number of options are available. The choice will depend partly on whether the PTE are looking for a single franchised operator or for an open access system.

The minimum requirement for a licensed public service vehicle operator to run the service would be simply to register the particulars (route, timetable etc) with the traffic commissioner at least 56 days before the start of operation. However, it is assumed that the PTE would wish for further assurance that the service will be operated to a high standard over an extended period. Possible mechanisms would be:

- a non-statutory (voluntary) quality partnership agreement between one or more operators and the PTE (separate agreements for each operator);
- a statutory quality partnership scheme made by the PTA and (assuming at least one TRO is needed) the city council;
- a quality contracts scheme made by the PTA;
- an order under the TWA.

Non-statutory quality partnership agreement

It is assumed that this option, taken on its own, would not go far enough to satisfy the PTE, so it is not discussed in detail here. But a non-statutory agreement is a flexible tool and can be used in conjunction with a statutory scheme or, possibly, with an order under the TWA. (It is assumed that it could not be used in conjunction with a quality contracts scheme because of the nature of such schemes). Such an agreement would not be limited to the matters that can be covered by a statutory quality partnership scheme. Possible uses if this option in combination with others are discussed in paragraphs 38-40 below.

Statutory quality partnership scheme

A statutory quality partnership (SQP) scheme is likely to be the preferred option of bus operators considering using the busway system since it would give them considerable commercial freedom while ensuring high standards and therefore protecting them (to some extent) from competition from lower quality operators using the facilities. It would also guarantee the provision and maintenance of facilities (not just the busways but any other traffic management measures and infrastructure such as bus shelters and bus stations that might be included in the scheme). Bus operators see this as an equal partnership in which both sides have made considerable investments and work together to ensure a high quality (and commercially attractive) service.

Essentially, a SQP scheme would be made jointly by the PTA and the City Council and would come into force once all the facilities were in place and operational. The minimum duration for a scheme is 5 years - there is no upper limit but it is advised that an end-date should be specified. A scheme would require operators to provide services to a certain standard and in particular could specify DDA compliant vehicles with high emissions standards. Any operator able and willing to meet those standards would need to give an undertaking to that effect to the traffic commissioner and be subject to financial or licence penalties if they failed to meet the standards.[9] Operators not willing to participate would be prohibited from using the facilities and would be subject to similar penalties if they used them without authorisation.

A SQP scheme would require open access to all operators meeting the required standards - it cannot confer an exclusive right (though in practice there may only be one operator willing to participate). This means that there could be variations in standard, fares etc between operators which would not occur in a more regulated regime. However, open access does provide some benefits - if, for example, one operator fails to provide the required service or withdraws, other operators can take its place relatively easily.

A SQP scheme cannot be used to regulate frequencies or the timing of services. However, non-statutory agreements on these matters could be made provided they were not incompatible with the prohibitions in the Competition Act 1998. Such agreements would need to be bilateral (i.e. with one operator only) and could stipulate a minimum frequency (but not a maximum).

SQP schemes are subject to the Competition Test in Schedule 10 to the Transport Act 2000, which is policed by the Office of Fair Trading, who have issued guidance on its application, and will give informal advice on request. Broadly, if a scheme has the effect of significantly restricting competition, such restriction must be justified in terms of (a) securing improvements in the quality of vehicles or facilities, (b) securing other improvements in local services of substantial benefit to the users, or (c)

[9] For the financial penalty, see section 155 of the Transport Act 2000, for the licensing sanctions, see section 26 of the Transport Act 1985 (as amended by Schedule 11 to the Transport Act 2000).

reducing or limiting traffic congestion, noise or air pollution. Restrictions on competition must be proportionate to achieving those objectives. It is considered that a well-designed busway scheme would stand a good chance of meeting those criteria.

A SQP scheme leaves operators with the responsibility of providing the required standard of vehicles and of operating the service without subsidy. The only financial burden falling on the PTE therefore is the cost of providing the infrastructure.

A SQP scheme could apply to the whole of the system (or separate schemes for each corridor if preferred), whether street running, segregated lane, or off-highway (provided the latter were a "road", or were deemed to be for this purpose).

The SQP option has a further advantage that, provided operators, the PTA and the City Council are broadly in agreement, it can be made and implemented fairly quickly. Other parties need to be consulted (e.g. traffic commissioner, police) but there is no need for a public inquiry or approval by the Secretary of State.

Quality contracts scheme

This is the option which would give the PTE maximum control over the operation of buses in the scheme and, if desired, for some way beyond the limits of the scheme. However, this control comes at a price in a number of respects.

A quality contracts (QC) scheme is, essentially, a procedure whereby, after competitive tender, an operator is given exclusive right to operate services in a specified area. The PTA has the right to determine the network, fares, frequencies and timings, though contracts can, if desired, allow the operator a degree of discretion over these matters.

It is assumed for comparative purposes that a QC scheme relating to the busway will cover a relatively small area, centred on the three corridors themselves but including possible feeder routes and also nearby roads that might allow bus operators to offer services in competition with the busway services. It could thus be considerably wider in scope than a SQP scheme which would only control the use of facilities provided as part of the scheme (essentially those on the corridors themselves).

The PTA could, of course, promote a QC scheme over a wider area, including the whole PTA area, and indeed could do so irrespective of whether it was also promoting a bus guideway system or tramway system. Consideration of that option is beyond the scope of this study.

QC schemes need to be approved by the Secretary of State after undergoing a local consultation procedure. To satisfy the criteria in the Transport Act 2000, a scheme must provide the "only practicable way" of implementing one or more policies in the PTA's bus strategy. This does not mean the "only feasible way", since other options may be technically possible but expensive or risky. It is nevertheless an exacting test to meet. The scheme must also implement these policies in a way that is "economic, efficient and effective" and the Secretary of State must be satisfied that it is in the interests of the public to make the scheme.

The question of whether a QC scheme is likely to be approved depends therefore on the feasibility of the other options being discussed here, and whether those other options can deliver everything the PTA needs in order to implement its bus policies (having regard also to the wider policies in the Local Transport Plan).

A QC scheme cannot be made for a longer period than 10 years, and individual contracts within the scheme cannot exceed 5 years. In that respect, if no other, it is more restrictive than a SQP scheme.

To date, no local transport authority has pursued the QC option to the point of submitting a scheme for approval by the Secretary of State. It is therefore difficult to estimate the likely time it would take to process a scheme. However, it is considered that, even for a relatively small scheme, a minimum of 2 years should be allowed for from the “drawing board” stage to implementation.

Since the QC procedure is as yet untried (there are close parallels in the London franchising system, but this was not imposed on a previously deregulated market) certain risks attach to its use, including the risk of a legal challenge by operators (as has been credibly threatened by certain key players). It also poses a financial risk to operators because of the 5 year limit on contract length, which means they are likely to bid on the high side. Almost inevitably it would require the subsidisation of services which, in the deregulated market, would be provided entirely without subsidy (if not necessarily at such a high frequency or at such a low fare).

A QC scheme in itself does not commit the PTA or City Council to provide infrastructure in the way that a SQP scheme does, but nevertheless it would have to be provided. The Orders necessary to acquire the land and construct the guideways would need to be processed in parallel with the QC scheme, and either or both could suffer delays or worse. In the event of the guideway not being built, the QC scheme could still proceed, at least in theory, though its effect would be very different; alternatively it could be terminated (or postponed).

One effect of a QC scheme is that the services covered by the scheme do not need to be registered with the traffic commissioner (and no other service may be registered within the area of the scheme unless excluded from the scheme). This means that any enforcement of service standards would lie with the PTA rather than the traffic commissioner and VOSA. That would allow a greater degree of control by the PTA but would need to be resourced.

Order under the Transport and Works Act 1992 (TWA)

As noted in paragraph 2 above, an Order the TWA would be one way of authorising the construction of the guided busway, both off and within existing highways and the acquisition of land for those purposes. The same Order could make provision for the operation of the guided sections of busway (including those within the boundaries of a highway). It would be made under the same primary legislation as tramway orders, and, so far as relevant, could cover the same issues. While the precise extent of the vires of the order-making powers in relation to guided busway schemes is somewhat uncertain, and apparently very wide, there are useful precedents in existing guided busway Orders[10] as well as in existing tramway Orders. It should, however, be noted that the provisions included in any draft TWA Order have to be justified in the circumstances of the particular case, even if precedented in a previously made Order.

A TWA Order would not be able to regulate the use of non-guided sections of the busway route, except so far as the provisions were ancillary to the operation of the guided sections. Some traffic management measures relating to entering or leaving the guided sections might be ancillary in this sense; others would need to be regulated by TROs.

As noted above (paragraph 5), the TWA process is not currently available for an optically guided system.

A TWA order needs to be prepared and consulted on by the PTE and submitted for making by the Secretary of State following consultation. In the light of representations received, it is normally necessary to hold a public inquiry. The process can be extensive - much depending on the number of objections received and the length of any public inquiry - and at least 18 months to 2 years should be allowed from the date of application. However, this process can embrace all the statutory powers necessary for constructing and operating the system (apart from those relating to the non-guided sections).

A TWA order may give the PTE the exclusive right to operate the busway and to permit others to do so on such terms as it sees fit[11]. In fact, the PTE has no power to carry passengers by road in its own right (that power was removed by an order under the Transport Act 1985) and in practice would need to contract out the operation to a licensed PSV operator. (Even if, arguably, the new busways are not regarded as “roads”, the system as a whole undeniably does involve carriage of passengers by road). Obviously it would be open to the PTE to allow more than one operator to use the busway but it could still use the power to exclude operators who did not meet the required standards or were otherwise unsuitable.

The right to operate a system, and the contractual relationship with the actual operator, includes the right to set frequencies and fares. Minimum headways would be needed for operational safety purposes (since the guidance system, like a tramway, would not allow overtaking) and minimum frequencies to ensure that the system is sufficiently exploited to provide the required level or service. The TWA order could empower the PTE to specify, or set an upper limit on, the fares which a contracted operator could charge.[12] All these controls would, technically, apply only to the guided sections, but would almost inevitably feed through to the operation and fare structure of the system as a whole.

[10] The Greater Manchester (Leigh Busway) Order 2005 (SI 2005/1918), the Chester Guided Busway Order 2002 (SI 2002/412) and the South Hampshire Rapid Transit Order 2001 (SI 2001/3627) which includes both tramway and guided busway.
[11] See Art 32 of SI 2005/1918,
[12] See Art 33 of SI 2005/1918, Art 26 of SI 2002/412).

Other measures that could be dealt with in a TWA order include: clarification that the guided sections of the service are regarded as part of a "local service" for the purpose of registration and Bus Service Operators Grant,[13]

- clarification that mandatory concessionary fares provisions apply to the guided sections of the service,
- disapplication of the rules regarding tendering in section 89 of the Transport Act 1985,[14]
- (possibly) disapplying the exclusion of frequencies and timings from a statutory quality partnership scheme under the Transport Act 2000 (some control over the interval between successive services may be necessary on safety grounds).[15]

Unlike a quality contracts scheme, a TWA order could not make provision for feeder services, or regulate competition on parallel roads. Nor could it regulate competition from ordinary buses on the street-running sections of the route. It should be observed, however, that exactly the same limitations apply to tramway orders. Some of the street running sections - particularly the central area of Leeds - will in any case be required for other bus services serving different areas of the conurbation (and beyond) and not competing for custom with the busway system.

Provided that the time and comfort benefits of the busway system are sufficiently attractive (and that the frequency and capacity are appropriate to passenger demand) the fact that operators are able to compete on the unmodified road network should not be a major problem. Those operators could only compete by offering services at much lower cost (which might not be commercially viable over an extended period) or by offering substantially different services, using only part of the busway route and then serving other areas (in which case they would be partially fulfilling the function of "feeder services"). Very similar considerations would apply in the case of a tram-based system which would not be protected from competition from bus services, though it would enjoy a distinct competitive advantage.

Combination of the above options

It should be observed that not all the above options are mutually exclusive. In particular:

- a SQP scheme could be combined with a non-statutory quality partnership agreement;
- a TWA Order could be combined with an SQP scheme and/or a non-statutory quality partnership agreement (in particular to deal with the non-guided sections);
- a TWA Order could be combined with a QC scheme for feeder services and to regulate competition in parallel or adjoining corridors.

[13] The provision in Art 35 of SI 2005/1918 that the busway shall be a "road" within the meaning of s2 of the Transport Act 1985 (definition of local service) appears to deal with these points.
[14] See Art 34 of SI 2005/1918.
[15] The Cambridgeshire Guided Busway promoters are proposing such a provision in their Order. DfT are currently considering the inspector's report on the public inquiry into this scheme.

A non-statutory quality partnership agreement (QPA) for example could include an undertaking that an operator would provide a service to a minimum frequency, though it would not (for Competition Act reasons) allow two operators to share the market in an agreed manner. Such an agreement could also include undertakings by either party as to the time period preceding the commencement of the statutory scheme (which cannot be until the facilities are operational).

A QPA or SQP scheme (or possibly both) could supplement a TWA Order to ensure that the high quality services were delivered on the non-guided sections of the route as well as the guided ones (since a TWA order cannot directly cover the non-guided sections). A SQP scheme could for example provide dedicated bus stops in the non-guided areas that were available only for services using the guided busway. It may be worth noting that the promoters of the Cambridgeshire Guided Bus project are considering the use of either statutory or non-statutory quality partnerships to underpin their scheme.

The combination of a QC scheme with a TWA Order would probably give the PTE/PTA the maximum control over the guided network, and its integration with other local transport. It may be significant that that some other PTEs are considering the combination of a QC scheme with (existing) tramway systems and the potential benefits to WYPTE would not be greatly different whether the "new mode" were a busway or a tramway. The light rail/QC combination was briefly mentioned in the *Future of Transport* White Paper (paragraph 4.29).

Any such QC scheme would of course need to satisfy the requirements of the Transport Act 2000. In particular the reference in section 124 of the Act to a "bus strategy" strongly suggests that a QC scheme must, overall, promote travel by bus and provide a benefit to bus users (rather than to divert them to another mode, or to reduce the number of bus services to improve the financial position of the light rail operator), hence it might be easier to justify a QC scheme supporting guided bus (which is a form of bus transport) than one supporting light rail. Nevertheless it would be difficult to approve a scheme whose primary effect was to prevent bus operators from competing with the guided bus rather than to improve the overall bus network. Such a scheme would have to be carefully devised to ensure that on balance it did deploy the available vehicles and drivers to better advantage for the travelling public.

Because the procedures for a QC scheme and a TWA Order are separate, and both rather lengthy, they would need to be processed in parallel with no guarantee that either would succeed.

PROCUREMENT ISSUES

Procurement of infrastructure

The infrastructure required to provide a guided bus system is considerably less extensive than that required for a tramway system and different in nature. Current expectations would suggest that the infrastructure could comprise the creation of physical guideways in or near the existing highway. This would not be expected to comprise significant complexity of operation (i.e. no "moving parts") and have a relatively low ongoing maintenance requirement in comparison with the tram option. Furthermore the nature of the works required to maintain the infrastructure should not be materially different from that for the rest of the highway and not be of sufficient scale to justify a separate maintenance organisation.

It is worth considering whether the infrastructure could be delivered and maintained under a long-term concession structure either including or excluding the operations of the services. In order for such a procurement route to deliver value for money it would need to have the potential to demonstrate benefits such as efficient whole life costing, improved performance through the use of incentive arrangements, scope for innovation in design and maintenance, and other benefits through appropriate risk transfer. The contractual arrangements would also need to be capable of being effectively defined and issues such as interfaces with third parties such as Highway Authorities and Statutory undertakers clearly set out.

For the factors noted at paragraph 43 above, an initial assessment would be that there is not a self-evident case for an infrastructure concession to deliver better value for money than more best practice conventional procurement of the infrastructure.

The legislative option under which the services are authorised would influence the ability to include the operations in such a concession. Quality Contract options would set maximum contract lengths of 5 years, which would be significantly less than the useful economic life of the infrastructure and so undermine the ability to provide efficient whole life costing. Further the European Commission's proposed Public Service Requirements Regulation[16] would set a maximum contract length at 12 years[17] which would be less than that contract length expected to offer best value for money.

One significant issue may be that of depots. For a rail-borne system the provision of depots for the vehicles is necessarily an integral part of the scheme. For a guided bus system this is not necessarily the case. Guided buses are essentially buses with the addition of specialist equipment. They can be kept in a normal bus depot along with unmodified buses. If the service is operated by an operator who already has a presence in the area, there may be no need for additional garaging - though some expansion may be necessary because of the extra number and size of the vehicles used on the system.

There may however be benefits in the promoter providing a depot since this would increase the opportunity for participation by operators without a current presence in the area. This would be applicable under any option that involved the award of a contract by competitive tender (TWA or QC). It would be more difficult to justify the cost of providing a depot in the case of an open access system and this could also raise State aid issues if the services provided conferred an ancillary benefit on the operators' businesses (see paragraphs 53-63 below).

[16] Revised proposal for a Regulation of the European Parliament and of the Council on public passenger transport services by rail and by road, COM(2005)319 final.

[17] Art.4.5 of the Revised Proposal mentioned in footnote 10 sets a limit of 8 years for bus service contracts, but Art 4.6 provides for this to be extended by a maximum of 50% "if the operator provides the assets needed to carry out the transport services covered by the public service contract and are linked exclusively to the transport services covered by the contract" - hence a maximum of 12 years if that extension were fully used.

Procurement of vehicles

The basis of a SQP (or QPA) based system would be that the operators themselves provide vehicles that comply with the standards set under the scheme, or agreement. Those standards could be quite exacting, as long as they were not unreasonably restricting competition (e.g. by stipulating a particular make or model, or a performance specification that only one manufacturer could meet).

The same would appear to be broadly true of the other options since PTEs do not currently have powers to procure vehicles for the carriage of passengers by road. A proposed Regulatory Reform Order will, if enacted, give them a power to purchase and let vehicles for hire, but only to operators contracted to provide services in connection with a service subsidy agreement under section 9A(4) of the Transport Act 1968.[18] These are, essentially, socially necessary services which the commercial market would not otherwise provide. PTEs have proposed (in response to consultation) that the power ought to extend to services provided under quality contracts and it is still open to the Department to amend the proposal (if Ministers agree) before submitting it to Parliament for approval. However, the Government gave an undertaking to Parliament that the Regulatory Reform Act procedure would not be used to process controversial legislation, and given the considerable controversy surrounding all aspects of quality contracts, the preliminary view of the Department is that to add a proposal of this kind could place the whole Order in jeopardy.

The working assumption must therefore be that PTEs could not procure vehicles themselves, even under the QC or TWA options, but could specify quite closely the type of vehicle they would require the successful tenderer to provide under contract.

The net effect of this is that the purchase of vehicles would fall on the operator rather than the PTE, though the cost would no doubt be reflected in the cost of the contract.

STATE AID

General principles

In the award of any public sector contract care needs to be taken either that the award does not constitute "State aid" (as determined under Community law) or has been specifically authorised by the Commission. This applies regardless of whether the contract relates to a rail-borne or guided bus system. Recent judgments of the European Court, notably the Altmark judgment, have clarified the application of the State aid rules to the transport sector.

The basic principle is that member States should not confer special favours on particular private companies in a way that could distort competition and trade between member States (including "over-compensation" by paying them more than a reasonable market price for a particular service). In principle, the award of a contract following open competitive tender, so that the successful tenderer receives no more than a fair market price for the service provided, would not normally constitute unlawful State aid. A contractual arrangement which "overcompensates" a private

[18] Inserted by section 57(2) of the Transport Act 1985.

company (pays the company substantially more than the market rate) could however amount to unlawful State aid - this is unlikely to occur (at least deliberately) where there has been a fair competitive process for the award of the contract. The ramifications of this principle can, nevertheless, become highly complicated.

Even where no contractual arrangement exists, public expenditure could constitute a State aid if it confers a special benefit on a particular operator (or class of operator).

In considering whether competition may be distorted as a result of public expenditure, the effect on transport operators other than buses (if there are any providing similar services) also needs to be taken into account. This principle also means that there could be State aid issues if the provision of a tramway system resulted in a benefit to the tram operator as opposed to the local bus operators and prejudiced the competitive interests of bus operators.

One can never entirely avoid the risk of an aggrieved operator lodging a complaint with the Commission that an unlawful State aid has been provided. While the following advice deals with general principles, the Commission will review the facts on the ground, as they have developed. The PTE, with its closer local knowledge, will need to satisfy itself that all potential issues of anti-competitiveness, including State aid (the two are not identical) have been addressed to the best of its ability. This general caveat applies equally whether the facilities relate to a tramway system or a guided bus system, and need to be addressed whatever legislative or procurement method is adopted. The following analysis therefore needs to be treated with caution.

Analysis

The provision of the infrastructure in question (the guided busway so far as it involves new facilities) could potentially be State aid if it were provided for the benefit of a particular operator without the need for that operator to compete for that benefit. This could arise, for example, if the PTE negotiated an arrangement with an operator that each of them would contribute a proportion of the cost, and the operator would then be owner, or co-owner with the PTE, of the system and could prevent other operators from using it.

The risk of a State aid problem would appear to be greatly reduced if the infrastructure were to be provided by the PTE either:

- for open access to any licensed PSV operator;
- for open access to any such operator who could provide the standard of service required under a SQP scheme - provided the standard were one that potential operators could reasonably meet and was not an indirect method of securing access for one operator;
- for the use of the successful tenderer for a QC or for a contract in pursuance of a TWA Order (particularly since the contract would be time-limited - as it must be for a QC - and would be subject to further competitive processes before being re-let).

Regarding the procurement of vehicles, it appears from the discussion in paragraphs 49-52 above that this question would not arise since it would fall to the operator rather than the PTE to provide the vehicles.[19]

However, if a public authority which was not prohibited by statute from procuring vehicles (e.g. Leeds City Council) were to do so for the purpose of the busway, the same basic principles would apply. To minimise the risk of a State aid issue, the vehicles should be provided for the use of an operator who has won a contract to provide the service by competitive tender, and leased to that operator on the same basis that would have been offered to any other successful tenderer. However, care would still need to be taken to ensure that this would not distort competition with commercial vehicle leasing companies, or with bus operators on other corridors who would have to make their own arrangements to acquire buses.

The risk of a State aid arising would be reduced either if the public authority offered the vehicles for a lease *at a commercial rate* to any operator of an open-access guidance system, which would be one way of guaranteeing high standard vehicles without inhibiting competition between operators.

In the case of a QC or a contract under a TWA Order, a State aid issue may arise from the fact that operators will be offered payment for a service which they would be capable of providing commercially without subsidy. It appears that the three corridors proposed to be served by the busway are currently all commercially viable, and that purpose of the busway is to provide a faster and more reliable service rather than a service that could not be provided without subsidy and for which a "public service obligation" could legitimately arise. Risks of this nature would be greatly reduced by offering the contracts through competitive tender, but not necessarily eliminated altogether.

PERFORMANCE INCENTIVES

The PTE have indicated that they would wish any operator of the guided bus system to be subject to a performance incentive regime of the kind used in London by Transport for London. This would involve both bonus payments for especially good performance and penalties for unsatisfactory performance.

Although legal advice on this is still awaited, it would appear simple enough to attach such a regime to either a quality contract or a contract in pursuance of a TWA Order, or indeed a service subsidy agreement under section 9A(4) of the Transport Act 1968. This is not conceptually different from what is established practice in London. More problematic is the combination of a regime of this kind with a statutory quality partnership scheme, where there is no contract to provide a service in the first place. The question here is whether it would be lawful for the PTE and an operator to draw up a non-statutory agreement allowing such rewards and penalties. This is mainly a question of the extent of the PTE's own statutory powers.

[19] One of the reasons for the limited scope of the amendment in the proposed Regulatory Reform Order, as described in paragraph 48 above, was to avoid creating a situation where the procurement and leasing of vehicles by a PTE could lead to an unlawful State aid.

A supplementary question is whether such an agreement would fall within the scope of section 89 of the Transport Act 1985. At first sight a performance incentive payment would not appear to be "an agreement providing for service subsidies under which a local service is to be provided", since the local service would be provided irrespective of the performance incentive payment. This matter may however require further investigation.

In considering the matter of performance incentives, it may be worth noting that two senior representatives in the bus industry have recently, and apparently independently, proposed a system of rewards or penalties for *local authorities* who perform particularly well, or badly, in terms of managing traffic for the benefit of bus users. One has proposed that an authority that successfully reduces journey bus times should be rewarded, whilst another had proposed that authorities which fail to achieve an agreed minimum journey time should be penalised. This is mentioned simply as a warning that operators could respond quite robustly to a proposal that measures, rewards and punishes only their own performance and not the performance of the authorities that provide the infrastructure, and that a voluntary agreement would be difficult to negotiate unless it were in some way reciprocal.

Even under a contractual arrangement there would need to be clear rules regarding whether factors causing poor performance were or were not within the operator's control, with scope for disagreement and even litigation if the facts were disputed.

CONCLUSION

It is clear from the above analysis that a number of alternative options are available for the provision of services on a guided bus system. Each carries certain risks and benefits, and some can be used in combination. At one end of the spectrum, it is possible under the Transport and Works Act to establish a regime that is very similar to that of a tramway system, with the (partial) exception of the sections of normal street running. At the other end could be an open access system relying on voluntary agreements on level and standards of services. A number of intermediate options are available.

Although an alternative is available, the obvious and logical means of obtaining the power to construct the new guided sections would be a TWA Order. Since the procedure for obtaining this order can be quite protracted (though broadly similar to the procedures under Highways Act powers) it would seem sensible to include within the order as many relevant provisions as possible, since that would not significantly delay the process and would pose less of a risk than seeking those powers by separate means. Hence, the order should also be used to authorise modifications to the highway sections to accommodate the guided busway, and to regulate operation on all the guided sections, on and off highway, to the extent (if any) that such regulation was considered necessary or desirable.

If it is desired to award a contract to a single franchisee, taking all due care to avoid infringement of competition or State aid rules, this could also be conveniently done under TWA powers, thus avoiding the 5 year time limit applying to a quality contract. The PTE could, if it wished, regulate fares and frequencies as part of the contract and impose a performance incentive regime. Although, strictly speaking, those provisions would only apply to the guided sections, the regime imposed - particularly regarding frequencies and performance incentives - would inevitably affect the operating standards of the street-running sections as well. If there were concern about operating standards on those sections not being sufficiently enforceable, a statutory quality partnership scheme, or a voluntary agreement, could cover those sections. A statutory scheme could also help to raise the standards of other operators using those sections.

A TWA Order would also be compatible with an "open access" system (as proposed for Cambridgeshire). Indeed, it appears to offer a degree of flexibility between the two approaches. For example, once the period of an initial contact expired, the system could be opened up to the general market (subject to quality controls by SQP). Conversely, powers could be taken so that if "open access" failed to deliver the required standard of service the PTE would reserve the right to restrict access to a single contractor (following competitive tender) without the need to go through a new authorisation process.

So long as the possibility of a TWA Order is available, it would be difficult to sustain an argument that a QC scheme was the only practicable way of achieving the objectives (including that of a performance incentive regime).

There are of course circumstances under which a TWA Order would not be available or suitable, e.g.:

- If on further analysis it was decided that a satisfactory bus alternative could be provided without constructing any new track. Although it would still be possible to authorise the alteration of the highway by TWA order this might no longer be the simplest or most efficient option.
- If the most attractive form of guided bus proved to be one using optical guidance, the TWA procedure would not currently be available and there is no immediate prospect of its becoming so.
- However, since an important feature of any bus option is that it should have the characteristics of a new mode of transport (like a tram) it seems most likely that the preferred system will be one which uses new track and side guidance and could therefore be provided under a TWA order.

The only significant matter which a QC scheme could deliver, and a TWA Order could not, is the regulation of feeder bus services and other bus services in the same corridors. Similarly a tramway TWA Order could not deal with those matters. There might therefore be a case for a QC scheme in *addition* to a TWA Order, though the need to process the QC scheme separately through the Department would be an added complication. As discussed above, the prospect of such a scheme satisfying the requirements of the legislation might be slightly more favourable in conjunction with a busway than in conjunction with a tramway. The imposition of a franchised system on these previously deregulated services could nevertheless lead to distortion of the market and the loss of business for unsuccessful tenderers. While this is inherent in any QC scheme, the effect might be particularly severe - and liable to challenge - where it involved only the peripheral services, the core routes covered by the guided system having been disposed of in a separate tendering exercise.

In the light of that, it might be tempting to argue that a QC scheme should be used to regulate all aspects of the guided bus system. However, this would have the distinct disadvantage that the contract could not be let for longer than 5 years at a time (and also that it could not authorise construction or land acquisition).

If minded to pursue the option of a guided bus system, the PTE should seriously investigate all the various legislative options. Our view, on the basis of the above analysis, is that a TWA Order could well be the most practicable way forward, with or without the addition of a statutory quality partnership scheme relating to the non-guided sections of the system. This view is expressed without prejudice to the consideration on its merits which the Department would need to give to any application for a TWA Order, or, as the case may be, a QC scheme, relating to a Leeds Guided Busway proposal. Under any legislative option care would need to be taken to avoid measures that could be challenged as anti-competitive or constituting unlawful State aid. The PTE must obtain its own advice and satisfy itself on those matters.

Appendix F - Time-line for Statutory Procedures

LAND ACQUISITION AND CONSTRUCTION POWERS

Processing a TWA Order for a significant construction scheme normally involves a public inquiry. The length of the process, from application to the Secretary of State to the decision will depend, in particular, on the number of objections received and the length and complexity of the inquiry. Two years is suggested as an indicative figure, though some Orders are processed more rapidly and others could take longer. This is additional to the time needed to draft the Order prior to application and prepare other documents such as the environmental statement. The works cannot proceed until the Order has been made - so the total time required to implement the busway system will depend on the time needed to acquire land and execute works after the decision has been made.

OPERATIONAL PROVISIONS

Powers included in TWA Order

Those powers taken in the TWA Order will be processed alongside the land acquisition powers, though if there are complex or unusual powers, the time taken to draft the Order, and the complexity of the inquiry, could increase. Essentially, though, the inclusion of such provisions does not add to the time requirement.

Statutory Quality partnership scheme

The statutory procedure for making a quality partnership scheme is fairly streamlined, involving publication in the local press, and consultation with operators, the police, etc. The scheme may need to be modified in the light of consultation responses. However this is less likely if the scheme has been designed in consultation with the main operators and other stakeholders.

There is no statutory control over the time to be allowed for consultation nor is there a statutory requirement to re-consult where a scheme is being modified, though that is good administrative practice where modifications are significant. The only statutory time limit affecting the total timescale is that at least 3 months must elapse between making the scheme (in its final form following consultation) and its coming into force.

The date of coming into force should not be before all the facilities covered by the scheme are provided and ready for use ("facility" in this case being the guided busway and anything ancillary to it, possibly also any new or recent bus lanes etc in the unguided sections). Hence the statutory consultation is best carried out once the Order has been approved (this will be essential if it covers guided sections and relies on powers contained in the Order) and can continue while the works are under construction, though preparatory work including informal consultation with operators can begin much earlier to avoid problems later on.

Quality contracts scheme

Again the statutory procedure involves publication in the local press and consultation with operators, the police etc. There is no statutory guidance as to the length of consultation. If, following consultation, the PTE wishes the scheme to proceed, with or without modification, the PTE will need to make a formal application to the Secretary of State for its approval. The Secretary of State may receive representations from anyone who participated in the consultation process.

Officials will need to advise the Secretary of State whether the scheme complies with the requirements of the Transport Act 2000 and this may require them to obtain further details from the PTE as to the proposed operation of the scheme and as to the feasibility or otherwise of alternative ways of implementing their relevant bus policies. The Secretary of State, if he decides to approve the scheme, will also have to be satisfied that it is in the public interest. The Secretary of State may approve the scheme with or without modification, and if it is significantly modified, may require at least a partial reconsultation with those parties affected by the modifications. The time needed to approve a scheme is difficult to predict given that this is so far an untried procedure.

If the scheme is approved, the PTE must make it within six months of the date of approval (and must publish a notice within 14 days of its approval). The minimum time that must elapse between the date of making and its coming into operation is now 6 months (see SI 2005/75), though for a complex scheme, and in view of the need to publish notice in the OJ, considerably longer than 6 months may in fact be needed.

The total process (including preparatory work prior to consultation) up to implementation is estimated to take around 2½ to 3 years. The extent to which the statutory part of this process should relate to the process for the TWA Order is somewhat uncertain and will depend, among other things, on the extent of detail in the scheme. If the scheme relates to matters outside the busways themselves, e.g. the provision and regulation of feeder services and competing bus services, there may be less interrelation between the processing of the quality contracts scheme and the TWA Order though there is always a risk that there will be no point in proceeding with the scheme, if the Order itself is not approved. If the Order and the QC scheme are interdependent, it would be desirable if not essential, and follow normal practice, for the decisions on both to be taken at the same time.