Affordable Mass Transit Guidance

Helping you choose the best system for your area

Commission for Integrated Transport Guidance
The laudable aims of Transport 2010, whereby 25 new light rail lines were envisaged by 2010, have not materialised. Currently there are 7 urban centres served by a light rail system, and, according to National Audit Office, 4 of these are running at a loss. The government now considers that the construction of 25 new lines might not be practicable, offer value for money, or be affordable, and it has recently withdrawn final approval for 3 proposed schemes because of escalating costs. What has happened?

The problems of cost escalation, risk and associated premiums, lengthy planning processes and inaccurate patronage forecasting have been well documented by the Parliamentary Select Committee. In particular, the Select Committee notes that local authorities have largely been left to decide whether light rail was appropriate for their areas, and recommends a more proactive role for government.

It is against this background that CfIT commissioned its Affordable Mass Transit study. It is not our intention to single out any one scheme or mode. It is our intention to encourage better analysis to enable early decision making and avoid delay and prevarication. This is a useable, practical guide to delivering the most appropriate mass transit system in a given situation. As such it is aimed primarily at public authorities and those with responsibility for transport in urban areas. The focus is on all mass transit technologies which we consider likely to provide realistic, practical and affordable solutions in the UK context.

Our approach puts forward a rigorous evaluation designed to eliminate the less suitable options from an early stage. In particular, it encourages the continual assessment and monitoring of risk from the initial, strategic assessment phase right through to design and implementation. Most importantly, it provides the option to reappraise at all stages, where key parameters such as system costs or patronage forecasts have changed. As such it is vital that alternatives are genuinely optimised.

The CfIT study is designed to complement existing guidance and provides advice on its application. In so doing, we hope that our work will be of benefit to both local authorities and DfT in their moves to develop and support innovative local plans to tackle congestion, as announced by the Secretary of State in July of this year.

This study has been steered by a working group comprising CfIT membership and local authority, operating company and DfT representation. In addition we have sought input from a wider stakeholder group at key points in the project. I would like to thank all involved for their input and support. Ultimately, we hope that our work will go some way to assisting the delivery of high quality mass transit that provides value for money both in terms of the user and non user benefits of the system.

Peter Hendy
Chair
Commission for Integrated Transport
September 2005
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>4</td>
</tr>
<tr>
<td>The Need for Guidance</td>
<td>4</td>
</tr>
<tr>
<td>Purpose of this Guidance</td>
<td>4</td>
</tr>
<tr>
<td>Users of this Guidance</td>
<td>5</td>
</tr>
<tr>
<td>Approach to this Guidance</td>
<td>5</td>
</tr>
<tr>
<td>Structure</td>
<td>6</td>
</tr>
<tr>
<td>Phase 1</td>
<td>8</td>
</tr>
<tr>
<td>Phase 2</td>
<td>9</td>
</tr>
<tr>
<td>Phase 3</td>
<td>10</td>
</tr>
<tr>
<td>Data</td>
<td>10</td>
</tr>
<tr>
<td>1. Introduction</td>
<td>11</td>
</tr>
<tr>
<td>What is Mass Transit?</td>
<td>11</td>
</tr>
<tr>
<td>What is ‘Affordable’?</td>
<td>11</td>
</tr>
<tr>
<td>What is the guidance for?</td>
<td>12</td>
</tr>
<tr>
<td>Guidance Philosophy</td>
<td>13</td>
</tr>
<tr>
<td>Why do we need this guidance?</td>
<td>14</td>
</tr>
<tr>
<td>Who is the guidance for?</td>
<td>15</td>
</tr>
<tr>
<td>How does it fit with existing guidance?</td>
<td>16</td>
</tr>
<tr>
<td>Structure of the document</td>
<td>16</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2. Phase 1 – Strategic Assessment</td>
<td>17</td>
</tr>
<tr>
<td>Step 1 – Qualitative Assessment – Contextual Criteria</td>
<td>20</td>
</tr>
<tr>
<td>Step 2 - Quantitative Assessment - Affordability</td>
<td>34</td>
</tr>
<tr>
<td>Step 3 – Ranking and Shortlist of Preferred Options</td>
<td>52</td>
</tr>
<tr>
<td>Independent Review of Phase 1</td>
<td>55</td>
</tr>
<tr>
<td>3. Phase 2 – Scheme Identification</td>
<td>56</td>
</tr>
<tr>
<td>Introduction</td>
<td>57</td>
</tr>
<tr>
<td>Existing Framework for Scheme Development and Appraisal</td>
<td>59</td>
</tr>
<tr>
<td>Linking Phase 1 to Phase 2</td>
<td>60</td>
</tr>
<tr>
<td>Application of Major Scheme Appraisal Guidance</td>
<td>60</td>
</tr>
<tr>
<td>Economic Impact Report</td>
<td>67</td>
</tr>
<tr>
<td>Strategic Environmental Assessment</td>
<td>67</td>
</tr>
<tr>
<td>Comparison of Phase 2 and Phase 1 Outputs</td>
<td>67</td>
</tr>
<tr>
<td>4. Phase 3 – Scheme Refinement and Monitoring</td>
<td>68</td>
</tr>
<tr>
<td>Introduction</td>
<td>69</td>
</tr>
<tr>
<td>The Monitoring Process</td>
<td>70</td>
</tr>
<tr>
<td>Decision Making</td>
<td>73</td>
</tr>
<tr>
<td>Post-Implementation Monitoring</td>
<td>74</td>
</tr>
<tr>
<td>5. Data</td>
<td>75</td>
</tr>
<tr>
<td>Supporting Information in Appendices</td>
<td>76</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1: Guidance Overview  
Figure 2: Phase 1 Overview  
Figure 3: Assessing demand  
Figure 4: Strategy development and scheme identification

List of Tables

Table 1: Technology type and implementation timeframe  
Table 2: Width requirements  
Table 3: Gradients accommodated by systems in operation  
Table 4: Example Step 1 AST  
Table 5: Evidence on Patronage Transfer from Car and Public Transport  
Table 6: Average fares for selected UK systems  
Table 7: Example Fare Elasticities  
Table 8: Examples of systems operating costs  
Table 9: Examples of depreciation periods  
Table 10: Examples of out-turn capital costs (2002 prices)  
Table 11: Capital costs assumptions (£ per km at 2002 prices)  
Table 12: Effect of alignment type on overall capital costs for UK light rail schemes  
Table 13: Systems capacity  
Table 14: Applicable capital expenditure optimism bias uplifts  
Table 15: Example Internal Monitoring table  
Table 16: Example External Monitoring table
The need for this guidance has arisen from:

- the **Government’s objectives for transport**, notably the need to reduce reliance upon the private car;
- the **lower than anticipated rate of delivery** of mass transit systems;
- concerns regarding the **affordability and below forecast performance** of some mass transit schemes that have been promoted or delivered in recent years; and
- the consequent **need to achieve improved delivery** of affordable and cost-effective mass transit systems.

Purpose of this Guidance

This guidance document is designed to **assist promoters of mass transit systems to select the most suitable, affordable and cost-effective technology** to meet their needs and objectives, and to do so quickly and at reasonable cost.

For the purposes of this guidance mass transit is defined as an urban public transport system which provides a ‘turn-up and go’ service. This requires a maximum headway between vehicles of 10 to 15 minutes or a minimum frequency of 4-6 services per hour over core sections of route, providing a minimum capacity per direction of typically 300 passengers per hour (pph) for bus based systems and 800 pph for rail based systems.
In addition it is assumed that mass transit systems as addressed by this guidance will enjoy a degree of segregation from, and/or priority over, general traffic movements, unless these can be controlled effectively through measures such as road user charging.

Affordability relates to the ability to deliver the system. This includes the ability to obtain adequate funds for the construction and operation of the system (including any requirement for ongoing revenue support), the availability of such funding within an appropriate timescale, and the balance between system costs and the benefits delivered. Where private sector financing is to be used the financial assessment must include the costs and charges associated with such finance.

The process detailed in this guidance is intended to address all potential mass transit technologies that are capable of providing a ‘turn up and go’ service. The focus of the detail of this guidance (in terms of the information supplied) is upon bus based and light rail technologies, as these are most likely to provide realistic, practical and affordable solutions in the UK context.

Users of the Guidance

The **primary audience** for this guidance will be those directly responsible for the promotion of mass transit systems. These will typically be public authorities with responsibility for transport in major urban areas, such as County, City, Regional and Unitary councils, Passenger Transport Authorities and TfL. The guidance should be used by the elected members and officers of these organisations together with those working on their behalf (such as consultancy companies).

The **secondary** users of this guidance will be those organisations associated with, but not directly responsible for, the promotion of mass transit schemes. This will include those providing public sector finance (such as DfT), private sector financial organisations, PFI contractors and public transport operators. This guidance is intended to assist such organisations (and those working on their behalf) to determine whether the work undertaken by the promoting authority is robust and in accordance with best practice and whether the proposed system represents a sound investment.

**Approach to this Guidance**

This guidance is focused upon the UK context and is designed to link closely to existing guidance relating to the promotion of mass transit systems within the UK. In particular, it is presumed that the overall context and objectives for any mass transit system have already been clearly established through the Regional Transport Strategy or Local Transport Plan process, together with identification of the overall planning and transport context within which the system will operate.

The guidance is designed to provide an overall structure for the decision making processes needed to deliver the most appropriate mass transit system for a given situation. It explains the nature of the decisions that should be made and provides information to support the decision making process. This guidance is not prescriptive. It is intended to encourage quick and efficient assessment of a wide range of mass transit systems and technologies and the geographic areas over which these may be applied. In particular, careful consideration should be given to the differences between lower intensity solutions applied on an area-wide basis and higher intensity solutions applied on a corridor basis.
The structure detailed in this guidance uses increasing levels of detail in a step-wise manner to progressively eliminate those options that are not likely to provide an ‘affordable’ solution to the identified need and objectives. Three principal phases of work are identified as shown in Figure 1:

• **Phase 1 – a high level strategic assessment** of the alternative mass transit technology options and geographic areas of treatment;

• **Phase 2 – a detailed appraisal of a shortlist of options** in accordance with the recommendations set out in the Government’s Major Scheme Appraisal Guidance; and

• **Phase 3 – a monitoring process** to be adopted during the detailed design and implementation of the preferred option.

Assessment of risk is an important part of the process throughout all three Phases. Allowance should be made for variability in key parameters (particularly costs and forecast patronage), with higher levels of allowance in the earlier Phases reflecting the less detailed analysis and thus lower levels of definition and certainty. Sensitivity tests are an essential part of the evaluation of risk and are recommended at key points in the process. In addition, optimism bias should be included at all stages in accordance with guidance from DfT.

The focus of the guidance is on Phase 1 – the process of selecting the most appropriate options for detailed analysis from a wide range of mass transit technology options including area-wide or corridor based treatment. Promoters must assess whether their transport objectives can be best met by applying intensive measures to a limited number of corridors (for example via rapid transit measures) or whether more widespread application of lower level measures may be more effective. The key output of this phase should be a clear demonstration that all options have been considered together with robust and transparent evidence as to the reasons for rejection of options. This Phase will help ensure that only the most appropriate options are taken forward for detailed assessment in Phase 2.

Where the more detailed work in Phases 2 or 3 results in significant changes to key system parameters (such as scheme costs or performance), consideration should be given to the need to re-examine the earlier Phase(s), as illustrated in Figure 1. Such iteration will be required where the changes are of a scale that would affect the decisions made in the previous Phase(s). This is most likely to occur as a result of increases in estimated system costs or reductions in forecast patronage.
PHASE 1: STRATEGIC ASSESSMENT

Potential mass transit technologies

• Contextual criteria
• Affordability
• Review of first assessment

AST Style Assessment

Shortlist of technology options

PHASE 2: SCHEME DEVELOPMENT AND APPRAISAL

Shortlist of technology options

• Major Scheme Appraisal

Advice on application of MSA guidance

Full Appraisal of:
- Preferred option
- Low cost alternative
- Next best option

PHASE 3: SCHEME REFINEMENT & MONITORING

- Preferred option
- Low cost alternative
- Next best option

• Monitoring and evaluation of scheme performance during detailed design and procurement

Sensitivity test

Delivered system with known performance and minimised risk

Figure 1: Guidance Overview
The Phase 1 process comprises 3 steps, each of these steps is briefly summarised below:

- **Step 1 – a qualitative assessment** of the performance of each technology option. This is undertaken through identification of:
  - the **Problems** that the mass transit system is intended to address;
  - the **Policy Objectives** to which the mass transit is intended to contribute;
  - the **Context** within which the mass transit system will be implemented and operated; and
  - the **Physical Opportunities and Constraints** that will influence the design of the mass transit system.

  Indicators should be established for each of these areas and the performance of each option assessed qualitatively using a 7-point scale.

  The results of the qualitative assessment should enable elimination of those options that do not provide an effective solution to the identified problems, do not contribute significantly to the policy objectives, or are unlikely to be deliverable.

- **Step 2 – a high-level quantitative assessment of the financial performance** of each technology option. This is undertaken through identification of:
  - likely levels of passenger demand;
  - revenue;
  - operating costs; and
  - capital costs.

  An outline methodology is indicated in the guidance, together with supporting information to assist the estimation of system costs. The detail of the work in Step 2 should be tailored to a level sufficient to distinguish between the options being examined and thus inform the decisions being made. Allowance should be made for risk, with sensitivity tests recommended to establish the impact of variation in key system parameters.
The results of Step 2 should enable rejection of further options where these are unaffordable in the sense that insufficient funding is likely to be available within an appropriate timescale to support the required level of capital expenditure and/or operating subsidy.

- **Step 3 – a value for money assessment** of each technology option based upon the results of Steps 1 and 2. The quantitative work undertaken in Step 2 should enable refinement of the qualitative assessment, in particular a better estimation of the benefits likely to be delivered by each option.

A **Technology Option Appraisal Summary Table (TOAST)** should be assembled to include the key indicators arising from the results of Steps 1 and 2. This Appraisal Summary Table (AST) is based upon the advice given in DfT’s ‘Guidance on the Methodology for Multi-Modal Studies’ (GOMMMS). Emphasis should be given to those indicators that provide distinction between alternative options and will thus contribute to the decision making process. The TOAST should also include an estimate of the risks associated with each of the elements in the table.

On the basis of the TOAST, the remaining options should be ranked on a value-for-money basis. This will require comparison of the benefits, impacts and costs associated with each option. The ‘best’ performing options as assessed by the TOAST process will be taken forward to more detailed analysis in Phase 2.

It is recommended that an **independent review** of the Phase 1 process be undertaken at the end of Step 3. This should be designed to ensure that the full range of options has been considered and that the assessment process has been undertaken in a manner that is both appropriate and robust.

---

### Phase 2

Phase 2 focuses on **scheme development and appraisal**. This area is covered by the DfT’s existing detailed guidance and thus this guidance does not seek to replace, supersede, or duplicate that existing guidance.

Thus Phase 2:

- indicates the **existing guidance framework** for scheme development and appraisal;
- explains the **linkages** between Phase 1 of this guidance and the existing guidance; and
- provides **advice on the application** of the existing guidance.

The results of the Phase 2 activity should be compared against the outputs from Phase 1 to determine the degree to which key system values may have changed during the more detailed assessment process in Phase 2. This review should examine whether the changes in such values (in particular costs and patronage) would be sufficient to alter the conclusions from Phase 1. Where this is the case, the Phase 1 work should be repeated using the more detailed valuations from Phase 2 and, if appropriate, alternative option(s) taken forward to Phase 2.

The output from Phase 2 should be a definition for the preferred scheme option(s), the next best option and a low cost alternative together with their appraisal summary tables. These should be complemented by the results of sensitivity tests to inform the monitoring activity in Phase 3.
Phase 3

The Phase 3 process comprises monitoring of both internal and external changes that may occur during the detailed design and implementation of the preferred system. Internal changes are those occurring as part of the scheme design and refinement process. External changes are those occurring to the external context within which the system will be implemented and operated. An important part of this monitoring process will be to ensure that the conclusions reached in Phase 1 and 2 continue to be valid. Where changes to key system values (in particular system costs and forecast patronage) remove the advantage previously shown for the preferred option, it will be necessary to repeat Phase 2 and, where appropriate, Phase 1 using the revised valuations.

Separate but related detailed monitoring plans are recommended:

• **Internal Changes** – should be recorded as they occur. The nature of each change should be recorded together with its impacts upon system performance and any recommended action; and

• **External Changes** – should be recorded on a periodic basis in a similar manner to internal changes.

It will be important to undertake regular assessments of the cumulative impacts of the changes that have been monitored. It should be noted that the net effect of a series of changes may be greater than the sum of the individual effects for each change. As noted above, particular attention should be given to system costs and forecast patronage.

The results of the monitoring process should lead to decisions regarding the future development of the scheme, these are likely to fall into three categories:

• **changes to scheme design** to accommodate or mitigate the change;

• the promotion of **changes to the external environment** (particularly where these are under the control of the system promoter); and

• in circumstances where changes to key system values have required a return to Phase 2 or Phase 1, **change to an alternative scheme** or technology option.

Data

As part of this guidance, technical data is provided to assist with the quantitative calculations required, particularly those outlined in Step 2 of Phase 1. The appendices to the guidance provide details of capital costs and operating costs for a number of existing and proposed mass transit systems in the UK. Recorded costs vary significantly and are strongly influenced by the context within which an individual scheme is being promoted. There is a general lack of robust data relating to bus-based schemes due to:

• a relative lack of experience of measures such as guided bus;

• a lack of detailed monitoring of enhanced bus based systems; and

• the commercial confidentiality attached to bus-based cost information.

The data sources that have been researched emphasise the need for a systematic approach to mass transit system monitoring and data collection in order to provide information that will enhance the robustness of quantification of costs and performance for mass transit systems. It is recommended that DfT give serious consideration to a programme of data collection and monitoring for mass transit systems (similar to that adopted by the Highways Agency for trunk road schemes), including those using bus based technology. In particular there is a lack of data relating to bus systems that have been subject to intensive investment (such as Crawley ‘Fastway’ and the guided bus systems in Leeds and Bradford) and this is an important area for improved data collection.
1. Introduction

What is Mass Transit?

1.1 For the purposes of this guidance mass transit is defined as an urban public transport system which provides a ‘turn-up and go’ service. This requires a maximum headway between vehicles of 10 to 15 minutes or a minimum frequency of 4-6 services per hour over core sections of route, providing a minimum capacity per direction of typically 300 passengers per hour (pph) for bus based systems and 800 pph for rail based systems. In addition it is assumed that mass transit systems as addressed by this guidance will enjoy a degree of segregation from, and/or priority over, general traffic movements, unless these can be controlled effectively through measures such as road user charging. The process detailed in this guidance is intended to address all potential mass transit technologies that are capable of providing the above levels of service. The focus of the detail of this guidance (in terms of the information supplied) is upon those technologies that are most likely to provide realistic, practical and affordable solutions in the UK context. These are defined as bus based and light rail systems, as detailed in section 2.

What is ‘Affordable’?

1.2 Affordability for a mass transit system is not a simple concept. Affordability for the purposes of this guidance relates to the funding of the delivery and operation of the system, including any requirement for ongoing revenue support. Affordability will depend upon the parties involved in system promotion and funding, the objectives for the system, the capital cost, private sector contributions, the financial operating performance, the benefits delivered by the system and the timescales for system implementation. For the purposes of this guidance, the principal components of the assessment of ‘affordability’ of a particular technology option are:

- the capital cost;
- the degree to which operating costs are covered by revenues and any subsidy requirement; and
- the user and non-user the benefits delivered by the system.
1.3 These components will drive three key decision areas:

- is there sufficient funding available to pay for the capital cost? This question may be addressed at one, or more, of a local, regional or national level (depending upon the context). The assessment of this question will also depend upon the funding arrangements and funding bodies. Where private sector funding is to be sought, will the overall funding arrangements provide appropriate levels of risk for private sector investment and have the costs of private sector finance been fully included?

- does the technology option have a positive operating margin? – i.e. can the service be sustained from passenger fares or other available revenue flows (operating costs should include any requirements for refurbishment or renewal of system assets such as vehicles or fixed infrastructure). If not, can the subsidy be sustained? A long-term subsidy requirement may lead to the rejection of an option given constraints upon public finances. However, short/medium term subsidy may well be acceptable where (for example) a system is being promoted for economic regeneration or to ‘pump prime’ new development though early provision of non-car travel options; and

- does the technology option represent good value for money? This will require an assessment of the relationship between system costs and the benefits delivered by the system. Value for money will not be an absolute measure, but is likely to be determined through comparison with alternative transport projects to enable prioritisation of spending. This may be achieved by determining a unit cost per benefit delivered (for example per unit of mode shift). This comparison may again take place at a local, regional or national level depending upon the scale and nature of the project.

What is the guidance for?

1.4 This guidance document is designed to help promoters of mass transit systems select the most suitable, affordable and cost effective technology to meet their needs. The guidance should also assist those responsible for funding and delivery such as the Department for Transport (DfT), Scottish Executive, financial institutions and PFI contractors. The guidance is non-statutory and should be used as a resource to complement existing information.

1.5 The guidance is intended to steer the development of affordable and cost effective mass transit systems, improve the record of system delivery and ensure that delivered systems achieve their forecast performance. The guidance seeks to:

- provide an overall structure for the decision making process;
- indicate the nature of the decisions that should be made;
- indicate the information required to support the decision making processes;
- identify and detail information sources together with advice regarding areas where information is currently unavailable; and
- ensure that the best decisions are made leading to the application of the right technologies in the right places.
Guidance Philosophy

1.6 The guidance is focused upon the UK context in terms of both the recommended process and the information provided to support that process. The process itself is closely linked to existing guidance in the UK and thus the UK transport context. Whilst overseas experience offers a potentially useful source of information, this is rarely directly transferable to the UK for a number of reasons, including:

- urban population densities (particularly in Continental Europe) tend to be much higher, therefore favouring high-capacity modes;
- in many locations urban transport operates in an entirely different planning, development and operational environment; and
- local taxation is frequently used to support urban transport capital and operating costs.

1.7 The guidance presumes that the overall need for a mass transit system has already been established through higher level planning processes such as the Regional Transport Strategy (RTS) and/or Local Transport Plan (LTP). This will ensure that the role of the mass transit system, as part of an integrated transport and land-use strategy, complements and is complemented by other components of the strategy. Thus the overall objectives for the system, i.e. those flowing from the RTS and/or the LTP can be readily identified.

1.8 The guidance has been designed to avoid prescription. The context and criteria relating to a particular transport problem are typically unique and results from one situation are rarely directly applicable to another. Thus the guidance has a degree of flexibility inherent in its approach that enables the decision making framework to reflect the circumstances relating to a particular situation, whilst ensuring that there is a high degree of consistency in the decision making process across different locations.

1.9 The guidance is inclusive; it encourages the consideration of all potential mass transit technology options. Thus it extends from conventional bus based systems through to light rail and metro systems and alternative uses of heavy rail infrastructure. Whilst the focus is upon those technologies already in use in the UK context, it can also include consideration of new types of system and new technologies. It also encourages strategic thinking as to the geographic area(s) to be addressed and the manner and timing of implementation.
Why do we need this Guidance?

1.10 The need for guidance has arisen from:

- central Government transport objectives\(^1\) and (DfT) Public Service Agreements\(^2\) which require the provision of high quality public transport, offered as a positive choice alongside the private car;
- recognition that the current rate of system delivery is insufficient to deliver Government objectives;
- concerns regarding the affordability, cost-effectiveness and appropriateness of a number of schemes that have been promoted in recent years; and
- below forecast performance of a number of LRT systems, leading to lack of delivery of forecast benefits (as assessed by the DfT’s appraisal process for major transport schemes) and requirement for ongoing revenue support as a result of operating costs exceeding revenues.

1.11 An important part of the Government’s transport policy is the reduction in reliance upon the private car through provision of improved mass transit (public transport) facilities. This will assist the delivery of a number of wider objectives including:

- enhancing the economy through reduction of travel costs by reducing road congestion due to car traffic;
- enabling increased travel (and thus economic development etc.) without increasing car traffic;
- improving accessibility, especially for non car users;
- improving air quality and reducing greenhouse gases; and
- improving safety.

1.12 However, encouragement of mode shift and consequent reduction in car use will only be achieved through:

- provision of mass transit services of sufficient quality to attract users from the private car; and/or
- demand management measures, such as reallocation of highway capacity, parking controls and road user charging.

1.13 Thus, much of the emerging regional and local transport policy is based upon a combination of these elements and the provision of high quality mass transit is a high profile component of many transport strategies. However, there may be other objectives driving the promotion of a mass transit system. The most significant of these are likely to relate to land use, where the primary objective for a system may be to regenerate areas of economic decline or to provide access to facilitate new land use development.

1.14 Recent major public transport investment in urban areas has tended to concentrate upon light rail systems. However, the current rate of major mass transit scheme delivery is insufficient to meet the aspirations previously set by Government.

---

\(^1\) As set out in ‘A New Deal for Transport: Better for Everyone’ (1998)

\(^2\) As set out in Annex B of ‘The Future of Transport, A Network for 2030’ (DfT 2004)
The Transport Ten Year Plan 2000 (DETR, 2000) envisaged by 2010 ‘the delivery of up to 25 new rapid transit lines in major cities and conurbations, more than doubling light rail use’. Only 7 urban areas are served by such systems at present and it is highly unlikely that the total of 25 lines will be achieved in the next 5 years.

1.15 This position would appear to be confirmed by the findings of the National Audit Office (NAO), which undertook a study of light rail systems implemented in the UK, and made comparison against experience from overseas. Whilst most systems delivered the anticipated services (in terms of routes, frequencies etc.), there is a significant trend for patronage levels to be lower than forecast. This in turn has reduced the benefits delivered by these systems, reduced the financial case and in some cases has led to the need for ongoing financial subsidy.

1.16 At the same time, a report by DfT ‘The Future of Transport, A Network for 2030’ (2004) emphasised that bus based options are likely to provide the most cost-effective mass transit solution for ‘most corridors’. The report continues to note that ‘Buses are flexible too – they can be deployed quickly in response to changing demand. And unlike rail or metro systems, buses do not require substantial infrastructure so can rapidly boost the supply of public transport’. Despite the findings of these reports, there has been little evidence of increased emphasis upon such bus based systems.

1.17 Thus, an important function of this guidance is to ensure that the information and advice on the appraisal of future systems includes consideration of the full range of affordable mass transit technology options in an equitable manner.

Who is the Guidance for?

1.18 The guidance will be used by a range of audiences including:

- political decision makers, typically responsible for high level policy decisions, local transport policy and scheme development. These are most likely to be elected members of local authorities with responsibility for local transport, including passenger transport authorities and county, metropolitan district and unitary councils;

---

3 Improving public transport in England through light rail (NAO, 2004)

4 WebTAG Units 1.4/3.9
• officers of promoting local authorities (as noted above) responsible for production of technical information, providing advice to the political level and undertaking more detailed decision making;

• organisations working on behalf of promoting authorities (typically transport and engineering consultancy companies);

• transport operators who will have responsibility for the operation of mass transit systems and who may also be investors in such systems;

• potential investors in mass transit systems. These may include the public and private sectors and parties not directly involved in system promotion (such as financial institutions and PFI contractors); and

• organisations working on behalf of funding or investing bodies. These organisations will typically be consultancies undertaking independent audits to determine the robustness of the project.

1.19 The primary users of this guidance will typically be public authorities with responsibility for transport in major urban areas, such as County, City, Regional and Unitary councils, Passenger Transport Authorities and TfL. These organisations, and those working on their behalf (such as consultancy companies), should be responsible for ensuring that the processes identified in this guidance are adopted for the promotion of any mass transit system proposals.

1.20 The secondary users of this guidance will be those organisations associated with, but not directly responsible for, the promotion of mass transit schemes. This will include those providing public sector finance (such as DfT), private sector financial organisations, PFI contractors and public transport operators. As noted above, many of these organisations will employ consultants to undertake audits and reviews of the work undertaken by the promoting authority. This guidance is intended to assist such organisations to determine whether the work undertaken by the promoting authority is robust and in accordance with best practice and whether the proposed scheme represents a sound investment.

How does it fit with existing Guidance?

1.21 The guidance is designed to complement existing advice on the production of Local Transport Plans (LTPs) in particular the suite of major scheme appraisal documents. This guidance seeks to:

• put greater emphasis on strategic comparison of alternative technology options;

• provide information and advice regarding the application of existing guidance; and

• ensure that monitoring and review is carried out during the latter stages of the scheme development process.

Structure of the document

1.22 The remainder of the guidance covers the following areas:

• Section 2: Phase 1 – Strategic Assessment;

• Section 3: Phase 2 – Scheme Development and Appraisal;

• Section 4: Phase 3 – Scheme Refinement and Monitoring; and

• Section 5: Data
2. Phase 1
Strategic Assessment
2.1 The Phase 1 – Strategic Assessment focuses on the need to ‘rule-out’ technology options which are clearly unsuitable or unaffordable at the earliest stage. To help scheme promoters achieve this, a step-by-step process has been identified which highlights a range of issues that must be considered in the selection of an appropriate technology. This will enable promoters to identify those technology options that make little contribution to the objectives, and will provide evidence as to why these options have been rejected.

2.2 Whilst the strategic assessment adopts an inclusive approach, such that all generic mass transit modes can be examined, it is recommended that the following technologies are always included in Phase 1 (it should be noted that alternative degrees of segregation are important for bus-based options as these are likely to have a major effect upon construction requirements and thus costs and impacts, whereas light rail requires construction throughout regardless of degree of segregation):

- Conventional bus with limited segregation, including:
  - Traditional buses and newer vehicles with reduced emissions and increased fuel efficiency and new designs to increase attractiveness and passenger comfort (examples include the use of Hydrogen buses in London and the ‘StreetCar’ vehicle associated with First’s ‘ftr’ concept);
  - Limited segregation measures within the existing highway such as high occupancy vehicle lanes, with flow bus lanes, Red Routes or bus access to pedestrian areas (examples: flagship bus priority routes in London, Edinburgh ‘Greenways’ and West Midlands ‘Showcase’);
- Conventional bus with maximum segregation, including:
  - Buses capable of external guidance running mostly on their own alignment such as bus routes almost entirely using dedicated raised kerb bus lanes or segregated busways (examples: Edinburgh plus current proposals in Cambridgeshire and between Manchester and Leigh); and
- Guided bus with limited segregation, including:
  - Buses capable of external guidance using specially built bus lanes at key locations only with raised kerbs or other forms of guidance (examples: Leeds ‘Superbus’ and Crawley ‘Fastway’);
- Guided bus with maximum segregation, including:
  - Systems using lightweight vehicles operating at lower speeds than trains such as underground metro systems using lightweight vehicles and tramway systems (examples: Tyne and Wear Metro, Docklands Light Railway, Manchester Metrolink, South Yorkshire Supertram, Midland Metro, Croydon Tramlink).
The decision to assess new, and in particular, untried technologies (including other forms of guided bus such as optical5 and wire6 guidance, low cost light rail and personal rapid transit7) should depend upon a rigorous examination of their practicality and a risk assessment. For technologies already used elsewhere (e.g. mainland Europe) but not in the UK, the reasons for this should be examined, as should the applicability of these options given the local context. Heavy rail should also be included in situations where opportunities for enhanced use of the existing rail network exist (including use for light rail) or very high demand levels are anticipated. Demand levels that may justify new heavy rail infrastructure in the urban passenger context are likely to be confined to London and the major metropolitan conurbations.

The guidance is intended to encourage consideration of a wide range of mass transit systems and the geographic areas over which these may be applied. In particular, careful consideration should be given to the differences between lower intensity solutions, for example conventional bus measures, applied on an area-wide basis and higher intensity solutions, for example light rail, provided on a corridor basis.

The process has been designed so as to be transparent, and to encourage realistic appraisal of one technology against another using the best information available.

A three step process has been established to inform the decision making under Phase 1. The flowchart below sets out the content of each step and the relationships between the steps. Each step is discussed in more detail below:

- Step 1 – undertake a qualitative assessment of the performance of each technology option;
- Step 2 – undertake a high-level quantitative assessment of the financial performance of each technology option; and
- Step 3 – re-consider the remaining technology options and undertake a value for money assessment, using the outputs from Steps 1 and 2, to produce a shortlist of technology options for more detailed appraisal in Phase 2.

It is recommended that an independent review of the Phase 1 process be undertaken at the end of Step 3. This should be designed to ensure that the full range of options has been considered and that the assessment process has been undertaken in a manner that is both appropriate and robust.

---

5 Optical guidance systems can be used to guide conventional buses on their route, ensuring that the vehicles pull in accurately at bus stops thus offering level access for passengers. A camera is mounted in front of the bus steering wheel and reads coded markings painted on the road which are then analysed by an image processor which detects and corrects deviations by activating a motor on the steering column.

6 New wire guided systems use underground cables to guide buses or trams on rubber tyres on their routes.

7 Personal rapid transit systems would use a fleet of automatic driverless cabs travelling on their own guideway network.
Step 1 – Qualitative Assessment - Contextual Criteria

2.8 The aim of Step 1 is to carry out a qualitative assessment to clearly identify the local context in which a mass transit system might operate. Scheme promoters will need to undertake a series of tasks to prompt consideration of key issues which could impact upon the ability to deliver a scheme or which could affect its operational viability.

2.9 Working through these tasks promoters should be able to highlight those factors which will have a ‘critical’ influence on the success of their scheme. Thus, a key output from Step 1 is the identification of a number of indicators which can then be used in an Appraisal Summary Table (AST) assessment of the alternative technology options for that scheme, similar to that detailed in the DfT’s ‘Guidance on the Methodology for the Multi-Modal Studies’ (GOMMMS). The key tasks to be undertaken include clear identification of:

- Problems;
- Policy objectives;
- Contextual factors; and
- Physical opportunities and constraints.

2.10 Having undertaken some preliminary investigation under each of these headings (as described further below) the promoter will be in a position to draft a set of AST indicators on which to score the long list of alternative technology options. These indicators are likely to include the degree to which each technology contributes towards Government objectives, as well as the degree to which they are likely to contribute towards regional and local policy objectives. The list of AST indicators must reflect the context for the scheme, as considered in the following sections, and measure the degree to which each technology option:

- addresses the identified problems;
- is compliant with, and contributes to the delivery of current policy objectives;
- is deliverable in terms of technology risk; and
- is politically acceptable.
2.11 In keeping with the GOMMMS type assessment, a 7-point scale (large, moderate and slight beneficial, neutral and large, moderate and slight adverse) is used.

Identification of Problems

2.12 This task is designed to ensure that any mass transit system is being promoted in response to a clearly identified set of problems and not as an end in itself. It is presumed that the need for improved public transport provision has already been established through study of the transport needs for the area as a whole (for example through the RTS and/or the LTP). This will ensure that the role of any mass transit system, as part of an integrated transport and land-use strategy, complements and is complemented by other components of the strategy. Thus the specific problems that the mass transit system is intended to address should already be defined.

Issues which may prompt a feasibility study for a mass transit system include:

- High levels of current or forecast demand between identified origins and destinations, or on key corridors;
- Severely congested sections of the highway network, resulting in unreliable journey times or large delays;
- Need to encourage mode shift and reduce car use;
- Need to encourage regeneration or redevelopment;
- Need to cater for development pressures in a sustainable way;
- Congestion of rail infrastructure;
- Identification of air quality problems;
- Identification of accessibility problems; and
- Need to make more effective use of existing railway routes.
2.13 Promoters should be clear whether the mass transit system will be expected to cater for current levels of demand, or whether a system is being promoted in response to forecast demand, say, that associated with new development, or alternatively if mass transit is being promoted as a catalyst for regeneration. In any of these three scenarios, it is important to identify the nature and scale of the problem.

Imbalance in Supply and Demand

2.14 An imbalance in supply and travel demand can be identified as a problem both on the current transport network (likely to be exacerbated in the future) or one which will occur as a result of background traffic growth, or alternatively as a direct result of growth associated with new development. All of these problems are likely to be characterised by symptoms of congestion and delay on the highway network, and may also manifest themselves in overcrowding on the existing public transport network.

2.15 It is important to establish the scale and nature of the problem. Are the problems confined to a single corridor or to a number of discrete corridors, or are problems being experienced across the network, either in a particular sector or on an area-wide level? This will help to determine the way in which the various technology options are assessed, and whether the assumption is that the technology should be applied to the area as a whole, or only to selected corridors. This will enable promoters to test area-wide bus-based measures, assessing the cumulative effect of small scale impacts across a large area, compared say to the testing of corridor specific light rail or guided bus schemes, assessing the effects of a larger impact in a smaller area.

2.16 It will also be necessary to review trip making patterns, focusing on origins and destinations at the strategic level. The aim should be to develop an initial quantification of the scale of travel demand. For example, the mass transit system must cater for approximately 1000 trips in the a.m. peak period between locations X and Y, or a system is needed which can accommodate 300 trips on each of three separate corridors.
Absence of Supply

2.17 Another problem which may give rise to a feasibility study into mass transit may be an identified absence of supply, for example ‘gaps’ in the existing public transport network as a result of lack of appropriate infrastructure (e.g. river crossings). This may manifest itself in problems of accessibility, and may be closely linked to issues of social exclusion, and car availability.

Regeneration

2.18 Often a key catalyst cited for the development of a mass transit system is the need for economic regeneration. However, where mass transit systems have been implemented, the degree to which regeneration has been achieved and the extent to which the mass transit system itself is responsible, remains a subject of debate. In part this is because such areas are also often targeted with investment to stimulate growth in employment and industry and thus it is not possible to separate out the effects of the mass transit system alone.

Identification of Policy Objectives

2.19 In order to properly appraise the different mass transit technologies available, it is very important to identify the policy objectives against which the performance of the system will be measured. This follows the approach adopted by central government for the appraisal of all major transport schemes, and adds transparency and equality to the decision making process.

2.20 The hierarchical structure of transport policy development and delivery in the UK means that all policy objectives must essentially ‘nest’ within the framework of central government transport objectives, driven by the New Deal for Transport, the Ten Year Plan, and the shared priorities. Along with relevant planning policy guidelines, these documents set the scene for the development of Regional Spatial Strategies and Regional Transport Strategies, and it is within this context that LTPs and newly emerging Local Development Frameworks must sit. Thus, for a major transport scheme to receive public funding it must also stand scrutiny against the objectives which flow from this planning structure, from the national level down to the local level.

Key objectives arising from the identification of problems might include:

- Reduction of public transport travel time to and from the city centre;
- Increased highway journey time reliability; or,
- Improved accessibility to the city centre.
2.21 Therefore, the policy objectives which are likely to have the most significant impact on delivery of mass transit are those contained within the LTP and the Local Development Framework. However, it is also recognised that the process of identifying policy objectives is likely to result in the setting of scheme specific objectives which could include operating characteristics and system specifications. This is encouraged as an additional tool in the appraisal process.

2.22 Promoters must also consider the implementation timeframe, i.e. whether the scheme needs to be delivered in the short, medium or long-term, or whether the ability to deliver it incrementally is a controlling factor. Key drivers in this decision may include the need for new infrastructure in order to bring forward particular development proposals. Table 1 shows the typical implementation timeframe associated with different types of technology (n.b. ‘P’ indicates possible depending on nature of system).

Key ‘scheme specific’ objectives could focus on a range of issues, examples might include:
- Reduce average public transport journey time by X% in the corridor/area;
- Achieve mode shift of X% in corridor/area;
- Provide capacity of X pph in corridor/area;
- Improve accessibility in area X;
- Result in an overall reduction in air quality pollutants;
- Provide a maximum 10 minute headway on all corridors;
- Allow for system variability and functionality e.g. accommodate feeder services and Park and Ride;
- Ensure scheme flexibility to cater for changing demand patterns; and
- Ensure implementation in the short-term.

Table 1: Technology type and implementation timeframe

<table>
<thead>
<tr>
<th>Technology</th>
<th>Short-Term</th>
<th>Medium-Term</th>
<th>Long-Term</th>
<th>Incremental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Bus</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Guided Bus</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Light Rail</td>
<td>X</td>
<td>✔</td>
<td>✔</td>
<td>P</td>
</tr>
<tr>
<td>Heavy Rail</td>
<td>X</td>
<td>P</td>
<td>✔</td>
<td>P</td>
</tr>
<tr>
<td>Innovative</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>
2.23 This task prompts promoters to consider contextual issues that are pertinent to their area and which may influence, either directly or indirectly, the way in which a mass transit system can be implemented and/or operated. Areas for consideration may include, but should not be limited to:

- Policy context (as distinct from the policy objectives);
- Competition environment (degree of regulation and integration, noting that the majority of patronage for new mass transit systems is typically drawn from existing public transport);
- Public/political acceptability;
- Impact of topography on catchments; and
- Ability/need to upgrade the system/infrastructure.

2.24 As part of this task promoters should also give consideration to the various risk elements associated with scheme promotion. Risks may be technology specific or they may be contextual, e.g. linked to the political or policy climate. As a baseline, consideration should be given to:

- Variation in capital costs;
- Technology risk;
- Variation in forecast demand;
- Change in policy context; and
- Altered political priorities.

2.25 The policy context in which the mass transit system will be expected to operate is distinct from the objectives which are likely to have been identified earlier in Phase 1. Whilst the objectives focus on what the system will be expected to deliver, and what targets may need to be met, the policy context refers more to the environment in which it must perform in terms of influences upon travel demand and competing transport modes. This includes both the political climate, as well as the formal policies which have been adopted by the relevant local authorities. The mass transit system is likely to be promoted as part of a ‘package’ of measures designed to address transport problems and needs in an area. Thus it is important to understand how the performance of different mass transit technology options may be affected by the other measures being proposed for the area, particularly those measures that may change the balance between journey ‘costs’ (including travel times) for car users and public transport users. Policy options/measures that may be considered as part of this task include:

- Demand management;
- Allocation of road space;
- Decriminalised Parking Enforcement;
- Parking policies, including pricing and availability;
- Quality contracts/partnerships; and,
- Subsidies/incentive regimes.

2.26 The use of demand management techniques (e.g. parking charges/controls and road user charging), or indeed the political will to introduce such measures in the future, can have a significant role to play in the success of a mass transit system. Used in conjunction with other initiatives, these tools have been shown to make a positive contribution to encouraging mode shift away from the private car. Similarly re-allocation of road space to aid the performance of a mass transit system may discourage car use and encourage mode shift.
For example, road user charging and
decriminalised parking enforcement can
both provide an additional revenue stream to
support other transportation initiatives, as well
as demonstrating a local authority’s political
will to exercise control over parking activity.
The advent of the Transport Innovation Fund
is likely to further the need to complement
proposals for mass transit systems with
appropriate demand management measures.

2.27 Use of partnership working with public
transport operators including, where
appropriate, the use of Quality Partnership
Scheme powers is a good indication of the
climate in which the mass transit system will be
operating. As yet, no Quality Contracts have
been implemented.

Interaction with other Modes

2.28 Interaction with other modes or operators
is particularly important when developing
proposals for a mass transit system. Scheme
promoters should give consideration to a
number of issues, and their potential to affect
the viability or successful operation of the
proposals. Issues which should be considered
include:
• Firstly, do other modes or alternative services
exist, either on the same corridor, or on
competing corridors?
• Are these modes or services likely to be
adversely affected by the introduction of the
proposed mass transit technology?
• Can the likely response of operators of other
services be predicted, and if so, can it be/does
it need to be controlled? and,
• What effect might there be on revenue support
requirements for existing services?

2.29 The answers to these questions will contribute
to the assessment of risk associated with the
proposals. This issue is discussed further
below.

2.30 Where possible early engagement of existing
PT operators will improve the understanding of
the likely environment within which the system
is likely to operate and thus the choices that
will be presented to the potential passenger.
In particular it should enable identification of
the opportunities for partnership arrangements
(although these will be subject to control
under the Competition Act) and thus increase
certainty regarding fares, patronage and
revenues.

Public/political acceptability

2.31 In order to be deliverable, technology
options must be capable of being accepted
by the public and politicians. There will be a
number of factors that will need consideration
including:
• image of alternative technologies;
• physical impact of system construction;
• impacts upon non-users of the system;
• environmental impacts, and
• economic impacts on local businesses, during
and after construction.
Topography

2.32 Whilst topography is an important consideration in terms of appropriate mass transit technology, consideration should also be given to the impacts of topography on the potential catchments for the mass transit system.

Upgradeability

2.33 Promoters must consider how important it is for their scheme to be able to cater for changes in forecast demand. For example, demand associated with major development proposals (identified for future implementation), and which is likely to significantly increase patronage of the system.

2.34 Will the forecast increase in demand result in a need for different technology/infrastructure? Can this be provided? In the same way, consideration should be given to the required design life for the system, either as initially built or as ultimately upgraded if different.

Risk

2.35 As part of Step 1, promoters should also consider a number of high level risk elements associated with each technology being assessed at this point. This should include the potential effects of issues such as:

- Variation in capital costs – could this be supported, and to what extent?
- Technology risk – is it new, has it been proven elsewhere?
- Variation in forecast demand – could this be supported, and to what extent?
- Change in policy context – is the success of the scheme dependent on/or particularly sensitive to, the continuation of existing policies?
- Altered political priorities – is the scheme likely to survive a change in local or national government?
- Interaction with other public transport modes - how will these respond, and how will this impact upon fares and patronage?

2.36 Obviously some of these issues will have greater relevance in different places. For example, in London this would need to reflect the presence of a single operator, whilst recognising that available modes may still be ‘competing’ with one another.

Key AST indicators that might be identified following consideration of Contextual Factors might include:

- Fit of technology option with existing and proposed demand management measures;
- Impact during construction;
- System image;
- Likely abstraction of patronage from existing public transport services; and
- Degree to which technology option is proven.
2.37 Opportunities and constraints in the built and natural environment are inextricably linked to the way in which mass transit systems can operate, and are likely to be a controlling factor in the design of a given solution. Consideration of these issues will also help to identify any potential ‘show-stoppers’ at an early stage. Whilst there appear to be only a few issues which fall into this category, they have the ability to immediately rule out a particular technology type. Table 2 shows typical system widths and suggests conditions in which different technologies perform best.

2.38 Although it is not possible to set out specific circumstances in which a particular technology would be inappropriate, Table 2 permits some conclusions to be drawn.

### Table 2: Width requirements

<table>
<thead>
<tr>
<th>Technology</th>
<th>System width requirements</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Bus (bus-lanes)</td>
<td>6 - 8m (two-way)</td>
<td>For bus-based systems with on-line stops, maximum frequency is likely to be determined by dwell times at stops, although the resulting capacity limitations can be overcome with the provision of split stops.</td>
</tr>
<tr>
<td></td>
<td>3 - 4.25m (one-way)</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Standard Bus (bus-ways)</td>
<td>8 - 13*m (two-way)</td>
<td>Minimum carriageway width is 6.8m e.g. Runcorn Busway</td>
</tr>
<tr>
<td></td>
<td>*busways in Pittsburgh and Ottawa have 2.5m for standing lanes on both sides</td>
<td></td>
</tr>
<tr>
<td>Guided Bus</td>
<td>5.8 - 6.2*m (two-way)</td>
<td>To perform best, segregation/right of way at ‘pinch-points’ e.g. congested junctions is essential. Kerb guidance may not be effective in busy residential or shopping streets with frequent side roads, main road junctions, pedestrian crossings and bus stops</td>
</tr>
<tr>
<td></td>
<td>*Leeds guideway requires 1 m security strip on each side</td>
<td></td>
</tr>
<tr>
<td>Tram/Light Rail</td>
<td>5.3 - 6.5m (two-way)</td>
<td>Sufficient highway capacity to allow full priority where the alignment is shared with other traffic. Suitable on-street access to the town or city centre being served.</td>
</tr>
<tr>
<td></td>
<td>3.0 – 3.3m (one-way))</td>
<td></td>
</tr>
</tbody>
</table>

Segregation

2.39 Segregation can be identified as one of the key factors in the success of a mass transit system. For instance, guideways and busways are likely to be inappropriate in high density retail and residential areas due to the impracticality of functioning with other modes, unless full or majority segregation can be provided. Thus, the most suitable locations for guided bus infrastructure have been identified as:

- Former railway corridors;
- Undeveloped river plains;
- Relatively straight road medians, with few road intersections;
- Where new tunnel or elevated construction is considered; and
- To allow shared use of underused LRT or tram tracks.

2.40 Promoters must establish how important segregation will be to the success of their system. Is it necessary? Whilst a fully segregated system may be perceived as the ideal, it may not always be essential, and the need for segregation is likely to be dictated by flows and delays on the existing highway network. The need for segregation will be determined through examination of the degree of travel time and reliability advantage that needs to be offered over other modes, especially the private car.

2.41 If it is established that segregation is necessary, it then becomes important to determine how it can be provided. Are the preferred routes such that it can be provided within the existing carriageway, or in the central reserve?

Alternatively could the mass transit infrastructure be accommodated within the existing highway boundary (promoters could consider scope for innovative applications, for example, introducing offside lane bus priorities)? If neither of these options is possible, can segregation be provided on the preferred alignment outside the highway boundary? Consideration must then be given to issues of compulsory purchase for additional land-take, and potential demolition requirements.

2.42 In some circumstances an alternative alignment may be available in the form of a dis-used heavy rail corridor, or the presence of an underutilised operational heavy rail corridor.

Built Environment

2.43 A number of constraints may exist within the built environment that may influence or restrict the type of technology selected. Do the preferred routes or corridors pass through environmentally sensitive areas or pedestrian zones? For example, does the mass transit system need to serve an historic town centre? Consideration should be given to the requirements of conservation areas, Air Quality Management Areas (AQMAs), and the presence of listed buildings or scheduled ancient monuments. Visual intrusion needs to be considered for any electrically powered system which requires overhead power supply.

---

Diversion of Utilities

2.44 Any systems requiring construction of fixed tracks within the highway will probably involve relocation of statutory undertakers’ equipment (pipes, cables, junction boxes etc.) within the swept path of alignment. This element usually carries high costs, and is associated with high levels of risk. In some cases the need for utilities diversion may influence the choice of detailed track location or route options.

Physical Constraints

2.45 Physical constraints relating to street geometry and topography may also have a role to play in the type of technology chosen. On narrow routes, particularly in older towns and cities, consideration should be given to the restrictions of horizontal and vertical clearance as well as curve radii and swept paths, all of which may preclude particular types of technology if these obstacles cannot be eliminated. However, it is likely that a sufficiently narrow route would exclude all types of mass transit technology unless other vehicles were also prohibited.

2.46 Technology is also available to overcome most gradients. Table 3 illustrates the typical maximum gradient accommodated by systems already in operation. However, it should be noted that the impact of the gradient will vary according to the type of technology, and will have the potential to affect speeds and breaking distances etc.

### Table 3: Gradients accommodated by systems in operation

<table>
<thead>
<tr>
<th>Technology</th>
<th>Maximum Gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Bus</td>
<td>13%</td>
</tr>
<tr>
<td>Guided Bus</td>
<td>13%</td>
</tr>
<tr>
<td>Guided Light Transit</td>
<td>13%</td>
</tr>
<tr>
<td>Tram/Light Rail</td>
<td>10%</td>
</tr>
<tr>
<td>Heavy Rail</td>
<td>3%</td>
</tr>
</tbody>
</table>
Constructability

2.47 The physical construction of mass transit systems in dense urban areas can present major difficulties. Consideration should be given to the physical requirements of system construction and whether the scale of construction is likely to be possible without generating unacceptable levels of cost or disruption.

Severance

2.48 The infrastructure associated with different types of technology can result in varying degrees of severance depending on location. For example, a guideway with high kerbs could have a significant adverse effect on pedestrian movements in a busy shopping district. Consideration should be given as to whether the corridors or routes proposed for the application of the mass transit technology are likely to be particularly sensitive to this issue, linked perhaps to population densities or demographics.

2.49 The Step 1 process is designed to help promoters identify the controlling criteria against which potential technology options will be assessed. AST criteria might include:

- Identification of problems;
  - Provide congestion relief to corridor X;
  - Encourage mode shift away from private car;

- Policy objectives;
  - Cater for demand at proposed new settlement;
  - Services must be fast, frequent (e.g. max headway 10 mins) and punctual;
  - Ability to cater for flexible service patterns including feeder services;
  - Deliverable in 5 year horizon;

- Identification of supply opportunities and constraints;
  - Must be segregated from existing congestion;
  - Utilise potential of dis-used rail line;
  - Protect historic city centre; and

- Contextual factors;
  - Demand management in urban centre e.g. parking controls;
  - Quality partnerships with bus operators.

Key AST objectives that might be identified following consideration of supply opportunities and constraints might include:

- Ability to implement within existing highway boundary;
- Must be fully segregated along corridors X and Y; or
- System must serve historic city centre with minimal disruption to built environment.
2.50 At this point each of the technologies should be reviewed against the criteria and against one another. This may enable a particular technology to be eliminated at this stage. The remaining technologies should then be taken forward for consideration under Step 2.

2.51 As the local context is the driving factor behind the compilation of the Step 1 AST, it is difficult to present a meaningful example. However, Table 4 shows the type of output which could be expected from Step 1. This example assumes that the bus-based measures would be applied on an area-wide basis, with guided bus measures on selected corridors, and light rail measures on a further reduced set of ‘key’ corridors. As indicated in paragraph 2.11, the AST uses a seven-point scale as follows, reflecting the advice in GOMMMS:

- LB – large beneficial;
- MB – moderate beneficial;
- SB – slight beneficial;
- N – neutral;
- SA – slight adverse;
- MA – moderate adverse; and
- LA – large adverse.
Table 4: Example Step 1 AST

<table>
<thead>
<tr>
<th>Objective/Indicator</th>
<th>Conventional bus (limited segregation)</th>
<th>Conventional bus (maximum segregation)</th>
<th>Guided bus (limited segregation)</th>
<th>Guided bus (maximum segregation)</th>
<th>Light rail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem Identification</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of public transport travel time to and from the city centre</td>
<td>SB</td>
<td>MB</td>
<td>SB</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>Increased highway journey time reliability</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>SB</td>
<td>SB</td>
</tr>
<tr>
<td>Improved accessibility to the city centre</td>
<td>LB</td>
<td>LB</td>
<td>LB</td>
<td>LB</td>
<td>MB</td>
</tr>
<tr>
<td><strong>Policy/Scheme Objectives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce average public transport journey time by X% in the corridor/area</td>
<td>N</td>
<td>MB</td>
<td>N</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>Achieve mode shift of X% in corridor/area</td>
<td>SB</td>
<td>MB</td>
<td>SB</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>Provide capacity of X pph in corridor/area</td>
<td>SB</td>
<td>MB</td>
<td>SB</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>Improve accessibility in area X</td>
<td>SB</td>
<td>MB</td>
<td>SB</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>Result in an overall reduction in air quality pollutants</td>
<td>N</td>
<td>SB</td>
<td>N</td>
<td>SB</td>
<td>SB</td>
</tr>
<tr>
<td>Provide a maximum 10 minute headway on all corridors</td>
<td>SB</td>
<td>MB</td>
<td>SB</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>Allow for system variability and functionality e.g., accommodate feeder services and Park and Ride</td>
<td>LB</td>
<td>LB</td>
<td>LB</td>
<td>MB</td>
<td>SA</td>
</tr>
<tr>
<td>Ensure scheme flexibility to cater for changing demand patterns</td>
<td>LB</td>
<td>LB</td>
<td>LB</td>
<td>MB</td>
<td>SA</td>
</tr>
<tr>
<td>Ensure implementation in the short-term</td>
<td>LB</td>
<td>LB</td>
<td>SB</td>
<td>SA</td>
<td>LA</td>
</tr>
<tr>
<td><strong>Contextual Factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fit of technology option with existing and proposed demand management measures</td>
<td>SB</td>
<td>MB</td>
<td>SB</td>
<td>MB</td>
<td>MB</td>
</tr>
<tr>
<td>Impact during construction</td>
<td>N</td>
<td>SA</td>
<td>SA</td>
<td>MA</td>
<td>LA</td>
</tr>
<tr>
<td>System image</td>
<td>N</td>
<td>SB</td>
<td>SB</td>
<td>MB</td>
<td>LB</td>
</tr>
<tr>
<td>Likely abstraction of patronage from existing public transport services</td>
<td>N</td>
<td>LB</td>
<td>N</td>
<td>LB</td>
<td>SA</td>
</tr>
<tr>
<td>Degree to which technology option is proven</td>
<td>LB</td>
<td>LB</td>
<td>MB</td>
<td>MB</td>
<td>MB</td>
</tr>
<tr>
<td><strong>Supply Opportunities and Constraints</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to implement within existing highway boundary</td>
<td>LB</td>
<td>MB</td>
<td>LB</td>
<td>SA</td>
<td>MA</td>
</tr>
<tr>
<td>Must be fully segregated along corridors X and Y</td>
<td>N</td>
<td>MB</td>
<td>N</td>
<td>LB</td>
<td>LB</td>
</tr>
<tr>
<td>System must serve historic city centre with minimal disruption to built environment</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>MA</td>
<td>MA</td>
</tr>
</tbody>
</table>
What is Affordability?

2.52 The purpose of this step is to provide preliminary operating and whole life financial and economic appraisal results which will indicate:

- the degree to which the scheme is likely to cover its operating costs (including the costs of any asset refurbishment or renewals that will be required during the life of the system); and
- whether the scheme is likely to be financially affordable, such that:
  - the capital costs are acceptable given the capital available to the promoter and the relevant funding agencies (including any private sector finance and the costs associated with that finance) and given the other competing calls for that capital (which may involve other transport schemes at a local, regional or national level), and;
  - the capital costs, finance costs (if applicable) and any operating subsidy are sustainable for a given level of funding.

2.53 The question of what is ‘economically sustainable’ is as much a political judgement as a technical one. This judgement will depend, among other things, upon the whole life economic appraisal which will include the economic benefits not necessarily realised as cash in the financial appraisal.

2.54 It should be noted that value for money will be assessed in Step 3, where the relationship between system costs and the delivery of benefits (both qualitative and quantitative) will be assessed.

2.55 The key inputs to the affordability assessment are as follows:

- Choice of technology determining:
  - Vehicle capacity for the chosen technology (including multiple units using articulations or train-type operation);
  - ‘Attractiveness’ to the travelling public (in terms of comfort, perceived ‘image’, reliability and average vehicle speed and hence journey time);
  - Average unit operating cost;
- Assumed operating headway;
- Degree of segregation and hence practicable average journey time and journey time reliability\(^\text{10}\);
- Assumed fare level;
- Forecast demand – which depends on ‘attractiveness’, headway and fare as well as local demographic and other contextual factors such as the availability of integrated ticketing and the attractiveness of alternative travel choices;
- Capital costs, including contingencies to cover for unforeseen risks;
- The level of any hypothecated revenues from road pricing schemes or work place parking levies – which can be used to offset any operating deficits;
- The level of any external funding – which can be used to offset capital costs beyond those which can be funded through any operating margins.

---

\(^{10}\text{There is a limit to the minimum headway that can be provided when offering priority to transit vehicles in unsegregated situations due to the practicalities of junction operation.}\)
2.56 The forecast demand, revenues, system capacity and costs all depend upon one another, either directly or indirectly:

- Demand depends upon fare, headway and journey time\(^{11}\);
- Revenue depends upon fare and demand; and
- Capacity, capital and operating costs depend on journey time and headway.

2.57 Given these relationships, the consideration of demand, supply, revenues and costs is complex. The following flow chart demonstrates the key linkages and the iterative nature of any analysis. The chart makes reference to financial viability in the conventional sense of ‘do the operating margins (after inclusion of costs for any asset refurbishment or renewals that will be required during the life of the system) cover the capital costs over the scheme’s life?’ In reality relatively few public transport schemes would be judged as viable under this narrow criterion. Thus, the flow-chart is provided to demonstrate the complexity of the interactions, not as a prescriptive template for decision making.

2.58 Two important points to note are that for a scheme to be financially viable:

- Any public and private capital funding, any capitalised operating margins plus a reasonable rate of return on any private capital must equal or exceed the scheme capital cost. However, it may be difficult to determine the level of capital funding likely to be available, as this may depend on spending priorities (at the local, regional or national level) and potentially volatile sources such as developer contributions; and
- It is desirable that revenues (including any hypothecated from elsewhere\(^{12}\)) equal or exceed operating (including maintenance) costs. However, it is recognised that this may not always be achievable and that the benefits delivered by the system may justify subsidy. It will be important to determine whether any such subsidy can be sustained by the bodies responsible for funding.

2.59 The first of these points is straightforward – money must be available for it to be spent. The second point warrants closer inspection. There may be many potential schemes for which the financial discounted cash-flow appraisal yields a negative present value but for which the wider benefits are sufficient to yield a positive present value when assessed for economic costs and benefits, or for which the environmental and social benefits justifying operating subsidy.

\(^{11}\) In practice demand also depends on many other parameters such as journey time reliability, access/egress time (and therefore stop frequency and feeder services), the role of integration (physical measures, fares, services and information) and the demographic context. The point here is that many of the key drivers of demand are inextricably linked in a complex relationship.

\(^{12}\) It should be noted that hypothecated revenues used for subsidies (from, for instance, road user charging) will be recorded as a local authority cost and would reduce the scheme Benefit:Cost Ratio and reduce any Value for Money assessment.
2.60 In simple terms, any social cost-benefit appraisal should include:

- user time savings;
- reductions in vehicle operating costs due to fewer car trips and the increased efficiency of operation of the remaining cars and public transport vehicles;
- reductions in accident costs due to fewer car trips;
- non-user time savings due to reductions in road traffic congestion; and
- revenues, including loss of revenue on existing services.

2.61 When assessed in this way, it may be seen that a scheme which is not financially viable may still be a good scheme in economic terms – these are the schemes for which the funders will be required to either a) provide capital in the knowledge that it will not all be paid back, and/or b) provide ongoing subsidy. Consequently, while the second of the two points in paragraph 2.58 is desirable, it is by no means essential.

2.62 A further complication here is that the current DfT Value for Money (VfM) criteria allow for the inclusion in the economic appraisal of monetised benefits for additional impacts, such as reduced levels of pollutants and the generation of new jobs.

These additional VfM criteria should further improve the economic performance of a typical mass transit scheme such that a scheme may be attractive in VfM terms but not in financial terms or in the terms of a conventional economic appraisal. It is worthy of note that any scheme with more costs than benefits, when measured using the VfM criteria, is highly unlikely to be funded by Government.

---

13 The reality is somewhat more complex. For the more formal appraisal required under Phase 2 of this guidance and as enshrined in existing guidance, it is necessary to ensure taxation impacts (such as loss of fuel taxes) are included and that all measures are in the same unit of account (i.e. either in market prices – including the 20.9% average rate of indirect taxation – or in factor prices)

14 Revenues should be reflected as both a cost to users and a benefit to operators

15 ‘Guidance on Value for Money’ (DfT, December 2004)
Figure 3: Assessing demand

1. Select technology
   - Vehicle capacity
   - ‘Attractiveness’
   - Unit operating cost

2. Select degree of segregation
   - Minimum headway for priority operation
   - Journey times
   - Reliability

3. Select target headway
   - Operating costs
   - Calculate demand

4. Select fare level
   - Does revenue exceed cost?
     - Yes
     - Does capacity exceed demand?
       - Yes
       - Operationally viable
     - No2
     - Is subsidy acceptable?
       - No1
       - Yes
       - Financially viable?
         - Operating Margin
         - Capital Costs
         - Hypothecated road pricing revenues

5. Feedback

1 a) adjust headway (increase segregation if necessary), and/or b) adjust fares - both are iterative process of trial and error
2 a) increase vehicle capacity, and/or b) reduce headway (increase segregation if necessary), and/or c) increase fares
Output from Affordability Analysis

2.63 Step 2 of Phase 1 of the guidance should allow estimation of the following values for each technology option:

- Capital cost;
- Cash flows;
- Financial benefit:cost ratio; and
- Economic benefit:cost ratio.

2.64 These values will complement the largely qualitative data for each technology option developed in Step 1 of Phase 1 with all being presented together as an Appraisal Summary Table for comparison in Step 3, discussed subsequently.

2.65 If all the options show poor economic performance (i.e. discounted costs exceed discounted benefits) then either:

a) the process should be stopped at this point; or
b) if the process is to continue, Value for Money appraisal results should be developed according to the latest DfT guidance.

2.66 The VfM benefit:cost ratios would then be compared along with the other measures in Step 3. By considering VfM only if necessary at this stage, the total amount of analysis required under Phase 1 Step 2 of this guidance should be reduced. It should be noted that the effectiveness of options being promoted for environmental or regeneration purposes should be reflected in the qualitative assessment already undertaken within Step 1.

Demand

2.67 The greatest unknown is arguably the likely level of patronage. This is an area in which forecasts for UK light rail systems have been unreliable and an area which is potentially sensitive to the alteration of any scheme proposals at detailed design stage. Demand depends upon:

- Movement patterns and their relationship with the proposed alignment:
  - potential catchment areas\(^{16}\);
  - population densities;
  - location of jobs; and
  - degree to which the proposed system provides access to local centres;
- Conditions on the existing highway network;
- Existing public transport options:
  - journey times;
  - reliability\(^ {17}\);
  - fares;
  - headways;
  - existing mode shares; and
  - response of existing service operators;
- Proposed service characteristics:
  - journey time\(^ {18}\);
  - reliability\(^ {17}\);
  - fare; and
  - headway;
- ‘Attractiveness’ of proposed system including perceptions of image and security, integration with other transport services and the availability of through ticketing; and
- Existing evidence on travellers’ willingness to switch modes.

2.68 Undertaking the assessment of demand is not a trivial exercise even at this early phase of strategic assessment. For the estimates to be useful they need to be realistic and reflect detailed knowledge of the local context. In practice most of the background work to this analysis will be common between technology options being compared and therefore will not need repeating for the assessment of every technology. In particular, the planning and demographic context and the attributes of existing travel options will be the same, irrespective of which technology option is under consideration.

\(^{16}\) including the effect of physical barriers such as canals and the potential impact of gradients on the accessibility of the system to pedestrians

\(^{17}\) in terms of both punctuality and variation in travel times

\(^{18}\) and by inference, the advantage (or otherwise) in journey time compared to the private car and existing public transport services
2.69 There are a number of conventional approaches to the estimation of future travel demand for a mass transit scheme and three of these are introduced below.

2.70 **Mode Choice** - one approach is to start with a mode choice transport model in which travellers’ behaviour is modelled in a disaggregate manner using a logit choice model. The ‘choice’ is modelled on the basis of the door-to-door travel cost using the new scheme compared to that using each of the existing alternatives. The costs used are ‘perceived’ costs – they reflect travellers’ predisposition to one mode over another and therefore reflect issues such as image and reliability which are very difficult to quantify in absolute terms. The output from the model may typically be characterised by, ‘for a given set of costs of travel from A to B, x% of the travellers will choose to use the proposed system’. The accuracy of such forecasts is significantly increased by the consideration of separate demand segments which reflect, for instance, the lower value of time of those on low incomes and/or those travelling for leisure purposes. The effect of other demand responses – such as change of destination or change in frequency of trip making - would need to be considered in addition. Indeed, more complex transport demand models often explicitly consider such responses but these are extremely data intensive and require significant time to develop.

2.71 **Trip Rate** – another approach relies on the use of models which predict trip rates per capita and/or employment place on the basis of observations of existing schemes using the technology option concerned. Care needs to be exercised when transferring such rates from other locations, to ensure that the existing context is relevant to the context under consideration. The potential for errors is reduced by ‘segmenting’ the demand such that different rates are used for different segments of the population and/or for different journey purposes.

2.72 **Elasticity** - for a scheme which is an upgrade of an existing public transport system, the use of an elasticity model in conjunction with existing data on public transport demand might be contemplated. Such a model would be calibrated using observed changes in demand in response to observed changes in attributes such as headway and journey time, experienced using the existing system, or transferred from similar systems elsewhere. The model might be adjusted to reflect changes in service quality and, again, would be improved by the separate consideration of different demand segments.

2.73 The conventional approaches to transport modelling underpin the appraisal studies typically undertaken at the detailed planning stage, referred to as Phase 2 in this guidance. Many of the technical issues are discussed in the DfT’s WebTAG and in ‘Major scheme appraisal in local transport plans: Part 3’. However, at the Strategic Assessment stage of the process a less detailed analysis is appropriate, although depending upon the context, aspects of the more detailed modelling and appraisal approach may be found to be useful – for instance, in the context of a mode choice model, the use of locally derived stated preference data for quantifying differences in travellers’ willingness to transfer to systems using alternative transit technologies.

2.74 The estimation of future demand may be improved where the needs of transport users are known and understood. Ideally, this means that public consultation should be a key part of forecasting demand for services – preferably using a pro-active approach rather than the conventional passive approach characterised by public exhibitions. In practice, however, it may not be practicable or politically desirable to consult at this initial Strategic Assessment phase of the process.

---

19 Such “complex models” may well be required in the more detailed Phase 2 assessment but are unlikely to be justified solely for the Strategic Assessment (Phase 1) part of the process.
2.75 In general, using the above ‘Mode Choice’ approach as an example, the approach to preliminary demand forecasting may be characterised by the following stages:

- establish catchment areas;
- estimate the numbers of travellers with both an origin and a destination within scope of the proposed system (including an estimate for potential Park and Ride usage and access to/from the system via other public transport services);
- consider growth from the present to a technically and politically acceptable future year by which the proposed system is intended to address the current (and predicted future) problems which have given rise to the proposals;\(^{20}\);
- assess the likely performance of the existing travel options and their ability to cater for that future growth with particular attention to traffic congestion and overcrowding on existing public transport services;
- assess the potential transfer from existing travel options to the new system and the existing operator response;
- consider whether change in trip destination is likely to be a major source of additional patronage and attempt to quantify the likely scale of this;
- assess the potential for new trips generated\(^{21}\) by the availability of the new system;
- for each of the technology options under consideration select an initial set of realistic operating characteristics (which are likely to differ by technology) – i.e. headways, fares, journey times, perceived image, other levels of service;
- undertake initial economic and financial appraisal estimates;
- investigate the sensitivity of the likely transfer to the assumed operating characteristics; and
- iteratively adjust the set of operating characteristics using the findings of this investigation, to yield the best balance between costs and benefits (which is likely to differ for each technology option).

\(^{20}\) Consideration should be given to scenarios reflecting optimistic and pessimistic assumptions about the future. Note that subsequently in this guidance, the issue of risk is discussed, and its potential effect upon patronage forecasts. Any sensitivity tests should be undertaken using ‘most likely’ demand assumptions which sit between the optimistic and pessimistic assumptions suggested here.

\(^{21}\) In practice this is very difficult and is one of the sources of inaccuracy in previous patronage demand forecasting studies. Unless local evidence points to the existence of a market ready to be tapped (such as potential travellers who are currently suppressed from travelling due to traffic congestion and the absence of practicable alternatives) then it would be prudent as a first estimate to ignore such ‘generated’ patronage. In general it should be assumed that suppressed peak period demand will be expressed in other forms (largely commuter road traffic) and that generated trips will occur principally in the off-peak period.
For reasons already discussed the ‘best balance’ referred to in the final bullet point is not readily defined and will differ from case to case depending upon the technical, political and funding context.

The iterative process described above is at the heart of Phase 1 Step 2 of this guidance. The complexities and variation in local contexts are such that this guidance does not seek to provide a prescriptive process of analysis. Rather it is recommended that due consideration be given to the issues raised here and that, where assumptions are made or certain issues ignored for convenience, these should be clearly highlighted by the promoter. The danger is that considerable resources are subsequently expended on the detailed modelling and appraisal of options which could have been eliminated far more cost-effectively during an earlier phase of the process.

The remainder of this section of the guidance is aimed at informing the assumptions to be made in the above process of demand estimation and in the associated preliminary economic and financial appraisals.

It is important for all those involved in the process of estimating future potential demand to recognise that the estimates produced are subject to very considerable risk. A recently published international analysis of the accuracy of the demand planning process for major road and rail schemes suggests that the vast majority of demand forecasts for rail schemes are over-estimated and that outturn patronage is typically half that forecast. Given the systematic nature of the inaccuracies found in this study and many other anecdotal examples likely to be known to scheme promoters, it would be imprudent not to at least ‘test’ the performance of the scheme under the assumption of only 50% of the first estimate of patronage.

The best source of evidence is likely to be local studies, as these will reflect local circumstances and characteristics. In the absence of local information, the Demand for Public Transport guidance provides useful sources for many demand modelling assumptions. The guidance contains valuations of in-vehicle time, access time and waiting time for different transport modes. Demand elasticities of wait time and of fare are tabulated, both of which are key in the iterative process of analysing demand described above. Elasticities are presented for both short- and long-term changes and are distinguished by public transport mode. Other useful material includes valuation of bus stop facilities and the perceived cost of crowding on public transport services.

A selection of evidence of demand related to mode shift from car and public transport for mass transit systems which have been implemented in the U.K. is tabulated below. It should be noted that there is limited information available for bus based systems at present, especially those where intensive investment has taken place (such as Crawley Fastway).

<table>
<thead>
<tr>
<th>Light rail</th>
<th>Guided bus</th>
<th>Bus lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>% transfer from car</td>
<td>12.5% - 20%</td>
<td>3%</td>
</tr>
<tr>
<td>% transfer from other public transport</td>
<td>48% - 69%</td>
<td>6%</td>
</tr>
</tbody>
</table>

22 “How (In)accurate Are Demand Forecasts in Public Works Projects?”, Flyvbjerg, Skamris Holm and Buhl. Journal of the American Planning Association Vol. 71, No. 2, Spring 2005. Chicago, U.S.A. The study considered 210 schemes for which readily comparable data were available, from 14 countries, focused on Western Europe. It is the largest study of its type.


24 The rail industry’s ‘Passenger Demand Forecasting Handbook’ (currently version 4, ATOC, 2002) includes the results of detailed analysis of rail demand elasticities, including those with respect to fare. However the analyses are founded on data largely from outside the Passenger Transport Executive areas and being related solely to heavy rail demand are not directly relevant here.

25 Figures relate to Croydon, Manchester and Sheffield. Taken from ‘Croydon Tramlink Impact Study’ (TfL, 2002), ‘Demand for Public Transport’ (TRL, 2004) and ‘Sheffield Supertram Monitoring Study’ (Atkins 1997)

26 Figures relate to Leeds Superbus from ‘Scott Hall Road Quality Bus Corridor Monitoring’ (SDG, 1997)

27 Figures relate to West Midlands Line 33 and Elstree and Borehamwood Network, from ‘Quality Partnerships: Good Practice Guide’ (TAS, 2001)
Fare Revenues

2.82 Assumed fare levels and the regime within which charges are made are key assumptions which the scheme promoter needs to make. Increasing fares will tend to reduce patronage (and potentially overall revenues as well) and reducing fares will tend to have the opposite effect. Beyond this there is little that can be said definitively and different fare levels will be appropriate in different contexts. However, there is some consistency in fares per km for public transport in UK urban areas. The following table shows average fares for a selection of major UK LRT and bus schemes (N.B. this table includes concessionary fare revenue for buses but not light rail systems).

2.83 Excepting Sheffield, where ‘Supertram’ patronage levels were disappointingly low and therefore the breakeven average fare per km higher than expected, the typical range is 10-15p/km for light rail against 9p/km (outside London) for bus. It should be noted that the bus figures are based on all UK bus services, for which the average ridership per vehicle is 11 passengers. Given the relatively dense urban contexts in which mass transit schemes are likely to be considered, the average breakeven fare per passenger-km which is given above is likely to be an overestimate for the purposes of this guidance.

2.84 In the absence of better information it is advised that a fare level of 13p/km is assumed for tram-based schemes, reducing to half this for un-guided bus schemes. From this point a fare elasticity of demand taken from the following table should be assumed in the first instance with which the balance between supply, demand and revenue may be adjusted in an attempt to ensure that:

- a) the demand is catered for by the supply; and
- b) revenue equals or exceeds operating costs.

### Table 6: Average fares for selected UK systems

<table>
<thead>
<tr>
<th></th>
<th>UK light rail</th>
<th>UK standard bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average fare</td>
<td>£0.67 - £1.10</td>
<td>£0.82</td>
</tr>
<tr>
<td>Average fare per passenger km</td>
<td>£0.08 - £0.15</td>
<td>£0.14</td>
</tr>
<tr>
<td>Breakeven average fare</td>
<td>£0.67 - £1.61</td>
<td></td>
</tr>
<tr>
<td>Breakeven average fare per passenger km</td>
<td>£0.10 - £0.20</td>
<td>£0.09</td>
</tr>
</tbody>
</table>

28 Note that, in practice, for deregulated systems the promoter does not have direct control of fares. In some cases, for instance Manchester Metrolink, it was a condition of Government grant that the promoter would have no control over fares. However, at this early stage of considering affordability it is inevitable that reasonable assumptions need to be made.


30 Derived from 2002/03 UK bus statistics as published in ‘Transport Statistics for Great Britain’ (2004). Also includes the assumption that an average UK bus has 11 passengers as stated in ‘Buses and Coaches – the transport solution’ (CPT, 2003).

Table 7: Example fare elasticities

<table>
<thead>
<tr>
<th>Length of forecast period</th>
<th>Bus</th>
<th>Metro</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short run</td>
<td>-0.42</td>
<td>-0.30</td>
<td>-0.46</td>
</tr>
<tr>
<td>Long run</td>
<td>-1.01</td>
<td>-0.65</td>
<td>-0.65</td>
</tr>
</tbody>
</table>

2.85 The revenue assessment should take into account the effects of integrated ticketing, travelcards and concessionary fares where these are known.

2.86 Operating costs are considered in greater detail below but basically depend upon the selected technology and the headway. Revenues are simply the product of the demand (in passenger km) and the fare level (in p/km). However there are at least two issues external to the scheme per se which may impact upon the net revenues which are required to meet operating costs:

- Hypothecated revenues from any road user charging or work place parking levies that may be introduced in tandem with the scheme; and
- Fare revenues abstracted from other public transport services.

2.87 The first issue, while representing a good opportunity to implement schemes which otherwise would not ‘pay’ for themselves, is likely to be highly politically sensitive. The presence of road pricing or similar fiscal demand management measures may be publicly unacceptable and therefore represent a political risk to the scheme’s implementation. The second issue could be an equally large stumbling block unless existing operators are included in the scheme development process.

Operating Costs

2.88 Operating costs vary considerably between rail-based and bus-based systems but the available evidence suggests there is little distinction between costs of different bus-based systems, such as the effect of route guidance. It could be argued that guidance concentrates pavement loads onto a relatively narrow and invariant strip, but providing any busway has been designed with this in mind, such as in Leeds and Edinburgh, the anecdotal evidence available in the UK is that track maintenance costs are near zero. Evidence from Essen has shown that guideways have required little or no maintenance over an extended period of time; this would be consistent with the relatively low vehicle flows (compared with roads carrying general traffic). Equally, there is currently insufficient long-term experience to state reliable additional operating cost figures for other relevant technologies such as in-vehicle transponders and guidance wheels/mechanisms.
2.89 Where busways are concerned, the operating cost of the busway may or may not be the responsibility of the local highway authority, depending upon how the powers to build the scheme are obtained. In most cases the highway authority will be responsible, though in Edinburgh for example the City Council is responsible for busway maintenance in its capacity as scheme promoter and not as the local highway authority, as the busways are not public roads. Irrespective of whether the costs of operating and maintaining busways should be included in the financial appraisal, and for consistency with the appraisal of light rail schemes, they should certainly be included in the economic appraisal.

2.90 It might be expected that traffic enforcement on priority lanes on highways and segregated sections would add additional (relatively small) operating costs. However relevant data which shows these costs separated out from general highway policing costs is not readily available.

2.91 Policing and control of light rail systems involves the construction, maintenance and staffing of dedicated control rooms the cost of which is likely to be significant but which may easily be overlooked in the initial strategic assessment process.

2.92 Depreciation is a potentially very important issue. While light rail vehicles are considerably more costly to purchase, they are typically depreciated over 30 years, albeit with a programmed refurbishment after 15 years. Evidence from the Bus Industry Monitor 2004 indicates that the average age of the bus fleet is about 8 years\(^{35}\). Given that the overall bus industry fleet size is little changed over the previous year, this implies a current ‘life-expectancy’ over which buses may be depreciated of 16 years. Intermediate technology vehicles may be built to an intermediate specification and the depreciation period for such vehicles is likely to depend upon the technology adopted.

Conventionally propelled vehicles may have similar life-expectancy to existing buses, whereas electrically propelled vehicles may have a life-expectancy toward that for light rail vehicles. It should be noted that any change in the depreciation policy of the major UK bus operators will have a direct bearing on the average operating life and hence operating costs for bus.

2.93 Depreciation costs should be included for the mass transit infrastructure as well as for the vehicles. These costs are small for bus-based systems owing to the simplicity of the infrastructure and its relative longevity. Light rail systems are likely to require replacement of tracks, power supplies and communications equipment during the operational life of the system. Table 9 overleaf shows some example depreciation periods for both vehicles and infrastructure.

Table 8: Examples of systems operating costs

<table>
<thead>
<tr>
<th></th>
<th>UK light rail(^{32})</th>
<th>UK bus(^{33})</th>
</tr>
</thead>
<tbody>
<tr>
<td>£ per vehicle km</td>
<td>£3.79</td>
<td>£0.94</td>
</tr>
<tr>
<td>£ per passenger km</td>
<td>£0.14</td>
<td>£0.08(^{34})</td>
</tr>
</tbody>
</table>

\(^{32}\) Based on mean 2003/04 costs for Manchester, Tyne & Wear, Sheffield, Midland Metro and Croydon as reported in Rapid Transit Monitor
Figures include depreciation

\(^{33}\) Figures for 2002/03 taken from ‘Transport Statistics for Great Britain’, 2004. Figures include depreciation

\(^{34}\) Estimated from £ per vehicle km according to average vehicle occupancy of 11 passengers as presented in ‘Buses and Coaches – the Transport Solution’ (CPT, 2003)

\(^{35}\) 10 years for double-deck buses and 7½ years for single deckers
2.94 In calculating bus-based systems operating costs, it is advised to consider a number of key variables, principally daily drivers cost, fuel cost, running maintenance, costs of tyres and fixed costs (such as tax, insurance and time based maintenance such as MoT preparation). Such costs will also be location specific, as is illustrated by the significant variation in driver wages across the UK.

Capital Costs

2.95 Out-turn capital costs for recent mass transit systems are presented below. It is notable that for each technology there is a very considerable range of capital costs. These ranges reflect the different contexts in which each system has been implemented.

Table 9: Examples of depreciation periods

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Depreciation period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light rail vehicle</td>
<td>23 to 30</td>
</tr>
<tr>
<td>Bus</td>
<td>7 to 16</td>
</tr>
<tr>
<td>IT, furniture and fittings</td>
<td>3 to 10</td>
</tr>
<tr>
<td>Light rail infrastructure</td>
<td>30 to 50</td>
</tr>
</tbody>
</table>

Table 10: Examples of out-turn capital costs (2002 prices)

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Light rail</th>
<th>Bus lanes</th>
<th>Busways</th>
<th>Conventional guided bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure cost (£m/km, 2-way)</td>
<td>5.25(^{31})</td>
<td>0.006-0.3</td>
<td>2.7-15</td>
<td>2.7-4.3</td>
</tr>
<tr>
<td>Vehicle cost (£'000)</td>
<td>850-2,150</td>
<td>120-200</td>
<td>120-200</td>
<td>120-200(^{42})</td>
</tr>
<tr>
<td>Expected lifetime (yrs)</td>
<td>25-50</td>
<td>8-14</td>
<td>8-14</td>
<td>8-14</td>
</tr>
</tbody>
</table>

\(^{34}\) For Midland Metro and Tyne and Wear Metro, based on depreciation assumptions in 2003/04 Annual Reports for Centro and Tyne and Wear Metro respectively

\(^{37}\) Based on depreciation assumptions contained within 2003/04 Annual Reports for Stagecoach and First

\(^{38}\) Based on depreciation assumptions contained within 2003/04 Annual Report for Stagecoach

\(^{39}\) Based on depreciation assumptions contained within 2003/04 Annual Report for Tyne and Wear Metro

\(^{40}\) Figures taken from ‘TEST study’ (www.tsu.ox.ac.uk/test/index.html)

\(^{41}\) Taken from UK schemes only, as opposed to the £3m/km-£63m/km presented in the ‘TEST study’ which includes international experience

\(^{42}\) Range adjusted from the narrower range provided in the source data to reflect the fact that guided bus vehicle costs do not differ significantly from those of other buses of a similar standard
2.96 The overall scheme capital cost is more dependent upon contextual factors such as the scale of earthworks required, the number and scale of required structures and the degree of utilities diversions. These factors are likely to be similar for most of the technologies under consideration so that any differences in, for instance, the unit cost of tram track compared to busway are likely to be drowned by other factors. This makes the use of capital costs in Phase 1 of the assessment process a potentially misleading exercise. However, the outturn figures do show that in general bus-based systems are cheaper than tram-based systems.

2.97 While capital costs for bus based systems are usually less than for tram systems, tram systems can be cheaper when whole life costs are taken into account because of their lower operating costs where high passenger demand exists. Work undertaken by TfL has indicated that for a high cost urban corridor, the total cost per place km per annum (capital and operating costs) is cheaper for trams above a capacity of about 4,000 places per hour.

2.98 For the purposes of initial comparison and testing of system affordability, suggested capital costs assumptions are presented below generically for light rail and guided bus infrastructure. The most appropriate cost should be used in each case, depending upon the exact technology option under consideration. In each case, should more accurate local information be available, this should be used in preference.

Table 11: Capital costs assumptions (£m per km at 2002 prices)  

<table>
<thead>
<tr>
<th>General cost considerations</th>
<th>Light rail</th>
<th>Guided bus</th>
<th>Bus lane / Bus priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land and utilities diversion</td>
<td>1.9 – 3.5</td>
<td>0.1 – 2.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Civils and trackwork</td>
<td>0.6 – 5.0</td>
<td>1.4 – 2.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Stops</td>
<td>0.1 – 1.3</td>
<td>0.2</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Electrical (incl. power supply &amp; overhead line equipment)</td>
<td>0.4 – 1.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Communications &amp; signalling</td>
<td>&lt;0.1 – 0.8</td>
<td>&lt;0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Depot / Control centre</td>
<td>0.6 – 0.8</td>
<td>0.1</td>
<td>-</td>
</tr>
<tr>
<td>Highway works</td>
<td>&lt;0.1 – 2.1</td>
<td>0.1 – 2.2</td>
<td>&lt;0.1 – 0.5</td>
</tr>
<tr>
<td>Traffic management</td>
<td>0.1 – 0.4</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Design &amp; management</td>
<td>0.5 – 1.9</td>
<td>0.1 – 0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Contingency</td>
<td>0.6 – 0.7</td>
<td>0.4</td>
<td>&lt;0.1 – 0.1</td>
</tr>
<tr>
<td>Park &amp; Ride</td>
<td>0.1</td>
<td>0.1</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>8.6 – 14.5</strong></td>
<td><strong>2 – 5</strong></td>
<td><strong>0.7 – 0.9</strong></td>
</tr>
</tbody>
</table>

43 For details of references used see Appendix A2
44 Exceptional costs such as tunnelling or the need for numerous major structures has seen this figure exceeded, notably for Manchester Metrolink Phase 2 which cost £21.2m/km. See Table 12 for more detail
2.99 In each case a range is presented; much of the range can be explained solely by the physical context in which the scheme is implemented. An analysis of capital costs for UK light rail schemes illustrates the effect of alignment type on overall costs. In the following table the ranges of percentage of route length on railway and on street are shown together with the range of capital costs (excluding vehicles) per route km. ‘Railway’ includes both operational railways and former rail alignments. ‘On street’ includes tracks laid within the carriageway or within the highway boundary. Land costs are included where appropriate, but it should be noted that these show substantial variation by location.

2.100 It can be seen that alignments with a high proportion of street running have costs significantly higher than those with extensive use of railway formations. This is due to the higher costs of construction and the need to relocate statutory undertakers’ plant and equipment. The lowest costs are for extensive use of railway formations and track sharing.

2.101 When attempting to develop cost estimates for a particular context, it should be noted that rail based systems will require construction throughout the length of the system (except where any use is made of existing rail infrastructure) and thus such costs should be applied to the entire length of the system. However, it is important to note that with bus-based systems there is flexibility to mix the use of new and existing infrastructure and to run buses alongside general traffic. This means that, where practicable, unnecessary or particularly expensive elements of new infrastructure may be left out of the scheme. Where sections of infrastructure are left out in this way, there is still the opportunity to add them back in at a later date if required, or to leave them out completely. Either way, the effect is to reduce the scheme infrastructure costs for both guided-bus and bus lane/priority schemes.

Table 12: Effect of alignment type on overall capital costs for UK light rail schemes

<table>
<thead>
<tr>
<th>Type of alignment</th>
<th>Percentage on railway</th>
<th>Percentage on street</th>
<th>Capital cost £m/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Majority street environment</td>
<td>0 – 14 %</td>
<td>40 – 70 %</td>
<td>12 - 22</td>
</tr>
<tr>
<td>Mixed street and segregated</td>
<td>0 – 60 %</td>
<td>20 – 65 %</td>
<td>10 - 13</td>
</tr>
<tr>
<td>Extensive use of former railway</td>
<td>64 – 100 %</td>
<td>0 – 15 %</td>
<td>6 - 9</td>
</tr>
<tr>
<td>Heavy rail track sharing</td>
<td>100 %</td>
<td>0 %</td>
<td>5 - 6</td>
</tr>
</tbody>
</table>
2.102 In all cases land costs have been excluded from the table but as these can be very considerable, they should be considered explicitly in all cases, using local data. At the end of the appraisal period any new infrastructure will have a residual value which may be fed back into the financial and economic appraisals as a credit, suitably discounted. At a minimum, the residual asset value should comprise the land cost in current prices.

2.103 Given the uncertainty associated with capital costs at this stage, an initial sensitivity test should be to check whether the option is still affordable if costs are significantly greater. Currently DfT provides advice on the appropriate level of optimism bias to use. This is closely linked to the level of risk analysis which has been undertaken, and is expected to reduce over the course of the scheme development. Ideally any preferred option emerging from the Phase 1 Strategic Assessment should be affordable even with the optimism bias factor applied to the scheme costs. The issue of risk is discussed in greater detail at the end of this section.

**Capacity**

2.104 Ideally capacity should equal or exceed demand (subject to consideration of what is likely to be acceptable in terms of peak period crowding). In most cases capacity should exceed current demand by an allowance that caters for future growth. It should also be noted that vehicle capacity may be based upon a ‘comfortable’ rather than ‘crush’ level of loading (especially for rail based vehicles that do not have absolute limits on capacity).

2.105 A politically and technically acceptable design horizon needs to be agreed by the promoter – typically 10 years from scheme opening. With demand for that year already estimated, the choice is whether to design the system for peak period or all-day conditions. The required capacity may be significantly different; in London the peak hour demand is roughly 1/3 extra – and the costs and benefits of meeting this demand will differ too. Ideally the choice of capacity to be provided should be made having considered the financial and economic appraisals for both peak and all-day situations, though in practice the choice may be influenced directly by consideration of stated policy objectives.

2.106 As the level of demand would be expected to change from the present, it is important to consider the demand profile over time and to check that the capacity of the option under consideration remains sufficient for the forecast demand over the design period.

2.107 In the absence of better information, a reasonable assumption is that demand grows linearly over time between the estimated demand in the opening year to that at the design year, and potentially beyond. Where key developments are proposed it may be possible to construct a more accurate demand profile which reflects these developments. Indeed, where other transport schemes are committed, there may be demand implications for the scheme in hand which may again be reflected in a non-linear demand profile. While these issues are challenging to deal with they are fundamental to understanding how the requirement for a mass transit system may change over time. This understanding may give rise to proposals for phased implementation of a system; extending the system catchment, increasing the frequency of service or even upgrading the technology in future years. Such incremental solutions offer considerably increased flexibility and reduce the risks of inaccurate demand estimations: if the demand simply does not grow as predicted then the system need not be upgraded. Bus-based systems lend themselves more readily to such an incremental implementation.
2.108 In simple terms the peak hourly capacity between two points may be calculated as the vehicle capacity multiplied by the number of vehicles per peak hour. It is important to note that the practical in-service capacity is significantly less than the absolute capacity. In practice therefore only 75% of the theoretical capacity should be assumed when undertaking analyses\textsuperscript{45}. Consideration should be given to the comfort levels for passengers, particularly in relation to the alternative travel choices available to potential passengers and the length of the journeys being made. However, most mass transit systems, even the lower capacity bus-based options, can provide sufficient capacity to cater for very busy UK urban corridors. Outside London, ultimate capacity is unlikely to be an issue on which options can be dismissed outright. Research by Brand and Preston provides ranges of average daily passenger demand against average (total social) cost per passenger km\textsuperscript{46}.

2.109 It is critical to note that the maximum capacities in these ranges may not be achievable in practice for a number of operational reasons, including:

- junction capacities (for systems with road based sections);
- dwell times at stops;
- ability to provide junction priorities (for systems with road based sections); and
- signalling restrictions (for track based systems)

### Table 13: Systems capacity

<table>
<thead>
<tr>
<th>Technology</th>
<th>Maximum system capacity (passengers per hour per direction)\textsuperscript{47}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard bus</td>
<td>2,500 – 4,000</td>
</tr>
<tr>
<td>Busway</td>
<td>4,000 – 6,000</td>
</tr>
<tr>
<td>Guided bus</td>
<td>4,000 – 6,000</td>
</tr>
<tr>
<td>Tram/Light rail</td>
<td>12,000 – 18,000</td>
</tr>
<tr>
<td>Heavy rail</td>
<td>10,000 – 30,000</td>
</tr>
</tbody>
</table>

2.110 Although a detailed understanding of these constraints is unlikely to be available at this early Strategic Assessment phase of the process, it is important that allowances are made and that theoretical maximum capacities are not applied inappropriately.

\textsuperscript{45} In the London context 85% is typically used, but where there are cumulative boardings and tidal flow patterns this is likely to be too high. In the off-peak period the proportion may be lower still, owing to the fact that leisure travellers have a lower threshold of discomfort than commuters.


\textsuperscript{47} Figures adapted from TfL report ‘Light Transit in London’ (February 2004)

\textsuperscript{48} Higher capacities can be obtained for fully segregated grade separated systems, possibly up to 25,000 pphpd for busway and light rail systems or 60,000 pphpd for heavy rail. However such demand levels are only found in very large dense conurbations and do not apply to UK conditions.
Segregation

2.111 In assessing the balance between supply and demand and between cost and revenue, the degree of segregation is an issue in that it may determine the minimum headway, the minimum journey time and the maximum journey time reliability which is achievable.

2.112 The biggest control on unsegregated system capacity will usually be the degree of priority which can be given to the chosen technology where it interacts with the existing transport network. Highway capacity and junction considerations are likely to limit maximum practical frequency and at known key ‘pinch-points’ it would be advisable for promoters to understand this relationship. The maximum practical frequency affects the ability to deliver a specific level of frequency on a given corridor, thus affecting the attractiveness of the system under consideration and, in combination with the largest vehicle size, will determine the maximum capacity that can be provided.

Risk

2.113 There are many uncertainties in the planning and implementation of mass transit systems and indeed the rationale behind Phase 3 of this guidance is that risks should be reduced by rigorously monitoring changes in the system design (and in the context within which it is to be implemented) to ensure the scheme is still sensible. Apart from contextual risks such as the dependence of the scheme upon a particular development being built or upon subsequent political decisions such as the will to maintain any ongoing subsidy, there are many other potential risks. These risks include ‘technology risk’ – is there practical experience using the technology concerned and do we know that it works – but in practice such risks can largely be designed-out at the scheme design stage and should be well understood before any capital funding is required. In accordance with good practice and existing guidance, the development of any major scheme is expected to be accompanied by an appropriate risk management strategy.

2.114 Any scheme involving private finance will be subject to very detailed financial risk assessment by the bidders and the banks which advise them. This risk will be ‘priced’ and used by the bidders to adjust their required financial return, with the ‘pricing’ of risk influenced by the experience of delivery of similar systems. Indeed there are currently several major schemes where the cost of such risks to the private sector was of such a magnitude as to warrant Government approvals being withdrawn, despite the initial analysis being acceptable. This points to the importance of explicitly considering risk at an early stage. Although all the issues are unlikely to be understood until Phase 2 of this process is complete, it is recommended that issues that may subsequently be construed as risks at a subsequent stage should be identified and noted even during the initial Strategic Assessment phase. Any such issues should be reflected in the ASTs used to compare technology options during Phase 1.

2.115 The key risks at this initial Strategic Assessment Phase are those relating to capital costs and demand. Risk in demand equates to risk in benefits (whether measured financially as revenue, or economically as social benefits including consumer surplus). The risks in both costs and demand are now receiving more attention from academics and practitioners alike, as has been noted in the preceding sections.

2.116 With costs typically having been systematically underestimated and demand systematically overestimated, it is clear that these two important areas of risk have in the past compounded one another. Since the planning process and the practitioners applying it have not changed in any fundamental way, it is reasonable to assume that these risks will continue to be systematic and may continue to compound one another, albeit at a lower level as the importance of this issue becomes better known.
2.117 Adoption of a pre-implementation monitoring regime as advocated in Phase 3 should help to ensure that contextual changes and design changes at the implementation stage are better understood and accommodated through the risk management process, thereby reducing that element of risk which has previously arisen in the later stages of a scheme’s development. However during the initial phase of the planning process it would be prudent to assume that all the risk previously observed on a wide-scale basis is still present. In doing so, three risk checks are recommended to assess the degree to which an option, which on paper is affordable, is likely to remain affordable at the point of implementation:

- a) Best current estimate of cost (including risk) plus inclusion of optimism bias, as shown in the table below:\footnote{Procedures for Dealing with Optimism Bias in Transport Planning, Bent Flyvbjerg, 2004. Note that although this document is available on both the HM Treasury website (www.hm-treasury.gov.uk/media/376/3A/Optimism%20Bias_Guidance%20Document_june04.pdf), and on the DfT website, (www.dft.gov.uk/stellent/groups/dft_localtrans/documents/downloadable/dft_localtrans_029632.pdf), DfT advises that the findings and recommendations are those of the authors and do not necessarily represent the views of the Department. Current DfT guidance is provided in WebTAG Unit 3.9.4. For the purposes of this sensitivity testing, uplifts relating to the 80th percentile are recommended (in this case there is still a 20% chance of the scheme costs over-running).}


- c) Both the above sensitivities, taken together.

\begin{table}
\centering
\caption{Applicable capital expenditure optimism bias uplifts}
\begin{tabular}{|l|l|l|l|}
\hline
\textbf{Category} & \textbf{Type of project} & \textbf{Applicable optimism bias uplift} \\
\hline
\multirow{5}{*}{Roads} & Motorway & \multirow{5}{*}{\textbf{15\%}} & \multirow{5}{*}{\textbf{32\%}} \\
& Trunk roads & & \\
& Local roads & & \\
& Bicycle facilities & & \\
& Pedestrian facilities & & \\
& Park and ride & & \\
& Bus lane schemes & & \\
& Guided buses on wheels & & \\
\hline
\multirow{4}{*}{Rail} & Metro & \multirow{4}{*}{\textbf{40\%}} & \multirow{4}{*}{\textbf{57\%}} \\
& Light rail & & \\
& Guided buses on tracks & & \\
& Conventional rail & & \\
& High speed rail & & \\
\hline
\multirow{2}{*}{Fixed links} & Bridges & \multirow{2}{*}{\textbf{23\%}} & \multirow{2}{*}{\textbf{55\%}} \\
& Tunnels & & \\
\hline
\multirow{2}{*}{Building projects} & Stations & \multirow{2}{*}{\textbf{4 - 51\%}} & \\
& Terminal buildings & & \\
\hline
\multirow{1}{*}{IT project} & IT system development & \multirow{1}{*}{\textbf{10 – 200\%}} & \\
\hline
\multirow{1}{*}{Standard civil engineering} & Included for reference purposes only & \multirow{1}{*}{\textbf{3 – 44\%}} & \\
\hline
\multirow{1}{*}{Non-standard civil engineering} & Included for reference purposes only & \multirow{1}{*}{\textbf{6 – 66\%}} & \\
\hline
\end{tabular}
\end{table}

\footnote{Based on Mott MacDonald study, p.32; no probability distribution available.}
2.118 Options which remain valid in the third of these sensitivity tests are clearly attractive and would be expected to be taken forward. Those which fail any of these tests, in the sense that the required funding in terms of capital or ongoing operating subsidy becomes unsustainable, may be taken forward providing the promoter recognises the risks associated with such choices and ultimately the decision makers are made aware.

2.119 The purpose of this step is to bring together the results of the qualitative AST based assessment from Step 1 with the results of the financial assessment from Step 2. This will enable a high level ‘cost/benefit’ comparison to be undertaken, giving a measure of the value for money offered by each of the technology options. It should be recognised that at this level the benefits are assessed on an essentially qualitative basis and this must be taken into account in the decision making process at this stage.

2.120 There should be fewer technology options remaining in the analysis compared to those initially considered in Step 1, following the rejection of options at the preceding Steps 1 and 2. Therefore, a second process of AST scoring can be undertaken in an effort to provide greater distinction between the remaining options. This scoring can take account of the quantitative analysis from Step 2. The demand estimates will be of particular importance, as these will help refine the qualitative assessments of both the user and non-user benefits likely to be delivered by each technology option.

2.121 Depending upon the context of the system it may be appropriate to provide a quantified estimate of user benefits at this stage. These can be estimated on the basis of the patronage forecasts from Step 2 and an assessment of the typical travel time (monetised), fare and other cost changes that the forecast users will incur. It should be noted that it is unlikely that the analysis at this stage will permit any quantification of non-user benefits or dis-benefits.
2.122 The ‘cost/benefit’ comparison in the Step 3 review should enable further elimination of unsuitable options, after which the remaining technology options should be ranked and a preferred list of the best performing options taken forward for more detailed appraisal under the Phase 2 process. It is anticipated that in normal circumstances a minimum of three options should be taken forward to Phase 2. However in some cases fewer, or more, than three realistic technology options may remain as having the potential to provide affordable and effective solutions.

Step 3 - AST Refinement

2.123 The ASTs for the remaining technology options should be refined in the light of the analyses undertaken in Step 2. Refinement should be possible in the four main areas of the AST, as described in Step 1 above. The process of establishing patronage, revenue and cost estimates in Step 2 will lead to greater definition of the inputs defining the key characteristics of each technology option. This will enable a general refinement of the AST, with greater precision concerning the key system attributes including:

- routes;
- stops;
- travel times;
- service frequencies; and
- capacities.

2.124 The outputs from Step 2, in particular the patronage forecasts, will enable the effects of the alternative technology options to be more closely defined. Examples of areas where the patronage estimates from the quantitative assessment from Step 2 will assist AST refinement include:

- Problems:
  - the degree to which forecast demand is met;
  - the impact upon highway congestion;
  - potential reduction in car use; and
  - changes in air quality;

- Scheme/system specific objectives:
  - mode shift;
  - capacity provision; and
  - improvements in air quality;

- Contextual factors:
  - the degree of consistency with policy objectives such as demand management and re-allocation of road space;
  - the relevance of the competitive environment; and
  - effects of topography on catchment areas.

2.125 The estimation of capital costs in Step 2 will require more detailed knowledge of the effects on system implementation. This can be reflected in the refined AST, notably in the section on physical opportunities and constraints.

2.126 Finally the quantitative work from Step 2 should enable a better determination of risk within the AST process, in particular giving more detail as to the potential scale of risk. Key areas of risk that will be capable of refinement as a result of the Step 2 analyses include:

- Patronage;
- Revenue;
- Capital costs; and
- Operating costs.
2.127 The refined AST should be reviewed to determine whether the additional information enables the elimination of any technology options at this point. However it is anticipated that in most cases the refinement process will lead to greater distinction between technology options rather than enable further option rejection.

Step 3 – Cost/benefit Comparison

2.128 A comparison should be undertaken of the AST performance and quantitative financial estimates for each of the technology options. The purpose of this ‘cost/benefit’ assessment is to provide a comparison of the value for money offered by each option. It should be noted that this will not be a straightforward comparison of costs and benefits in monetised terms, but an assessment of the relationship between the degree to which an option delivers objectives and benefits and the impacts and costs associated with that delivery.

2.129 It is recommended that a Technology Option Appraisal Summary Table (TOAST) be produced that brings together, in a summary form, the key indicators for each technology option. The indicators to be used in the TOAST will be those that provide distinction between the alternative technology options and thus will contribute to the decision making process. Thus the structure of the TOAST will depend upon the mass transit technologies remaining after Steps 1 and 2 and the context within which they will be implemented and operated. It is anticipated that a typical TOAST will include at least:

- the degree to which each option contributes to the principal problems identified in Step 1;
- the extent to which each option delivers the principal objectives identified in Step 1;
- the impact of contextual factors where this varies between options (for example all options may be similarly affected by parking management proposals whereas the competitive environment may affect rail-based technologies more than bus-based technologies);
- physical constraints and opportunities, again where these distinguish between options (for example topography may affect catchment areas for all options whereas land-take constraints will impact more upon systems requiring greater segregation);
- capital costs;
- operating subsidy/margin; and
- whole-life costs.

2.130 The TOAST should also include an assessment of risk associated with each of the elements in the table. This should indicate an estimate of both the probability that there may be variance and the potential scale of impact of that variance. For example there may be a low probability of change occurring in a policy context (such as parking demand management), but the scale of the impact of that change upon patronage could be large.

Step 3 – Ranking of Technology Options

2.131 On the basis of the TOAST, an assessment will be made of the value for money represented by each technology option. This will require comparison of:

- the benefits delivered by each option;
- the impacts arising from each option; and
- the whole-life costs associated with each option.
2.132 This comparison will inevitably be judgemental, given that many of the benefits will be assessed on a qualitative basis. However, professional experience should provide a sufficient comparison to enable the technology options to be ranked on a value for money basis. It is likely that the comparisons will fall in to three broad categories:

- options that have similar benefits but different costs – in this case the lower cost option(s) will be preferred;
- options that have similar costs but provide different levels of benefit – in this case those providing the higher levels of benefit will be preferred; and
- options that have both dissimilar costs and dissimilar benefits.

2.133 For those options with significant differences in both costs and benefits then judgement will be required as to the overall value for money reflected. Where there are large differences in both costs and benefits (for example a low intensity/low cost measure applied across a large area compared with a high intensity/high cost measure in a specific corridor) then it would be appropriate to take these alternatives forward for more detailed comparison in Phase 2.

Step 3 – Shortlist of Technology Options

2.134 The final task in Step 3 will be to produce a shortlist of technology options to be taken forward to Phase 2. This will be based upon the best performing options from the ranking exercise above. In most cases it is recommended that three options should be taken forward to Phase 2. However, it is recognised that in many situations this number may vary if fewer, or more, than three realistic options remain at this stage.

Independent Review of Phase 1

2.135 It is recommended that the results of Phase 1 be subject to an independent review. The scale of this review will depend upon the nature of the scheme and its cost. The review should include key stakeholders but be independent of the promoters of the system. Key aspects of the Phase 1 process that the review should consider will include:

- the range of technology options considered;
- the extent to which alternative geographic areas have been included;
- the problems and objectives identified;
- the contextual factors assumed (e.g. policy measures, land use developments);
- the patronage forecasts (reference to case studies should be adopted where possible); and
- system costs.
3. Phase 2
Scheme
Identification
3.1 Phase 2 of the process focuses on scheme development and appraisal, an area which is currently well documented and for which comprehensive guidance already exists. It is not intended that this guidance will replace or supersede existing guidance; rather the intention is to try and assist promoters in their application of the appraisal processes contained within existing guidance documents, illustrating how Phases 1 and 3 can usefully link into this process, and highlighting those areas where difficulties are commonly experienced.

3.2 Figure 4 illustrates the way in which Phase 2 links into the overarching process of scheme development and appraisal. This starts with the identification of need for a mass transit solution arising from the LTP or RSS/RTS process, which in turn leads into Phase 1 and a strategic assessment of technology options. Phase 2 (scheme development and appraisal) then feeds directly into Phase 3 as the preferred option is taken forward through the detailed design processes towards implementation and delivery.

3.3 Where significant changes occur to system parameters (such as scheme costs or performance) in the Phase 2 or Phase 3 elements of the process, consideration should be given to the need to re-examine the earlier Phase(s), as illustrated in Figure 4. Such iteration will be required where the changes are of a scale that would affect the decisions made in the previous Phase. This is most likely to occur as a result of increases in estimated system costs or reductions in forecast patronage.
Figure 4: Strategy development and scheme identification

LTP / RTS / RSS
- Objectives
- Understanding current situation
- Understanding future situation
- Consultation, participation, information

Mass Transit System required

Options for solutions

Appraisal framework testing and evaluation

Preferred scheme
Lower cost alternative
Next best alternative

Funding sources

Monitoring, evaluation & scheme development

Implementation

Monitoring & evaluation

AMT Guidance Phase 1

AST outputs shortlist of options:
- Preferred scheme
- Lower cost alternative
- Next best alternative

AMT Guidance Phase 2
Application of MSA Guidance

AMT Guidance Phase 3

52 Based on WebTAG Unit 1.1 - Figure 1.1
3.4 At present the main source of guidance for scheme development and appraisal is contained within the Department for Transport’s on-line WebTAG\(^{53}\) facility. The site provides guidance on conducting transport studies and developing local highway and public transport schemes, including appraisal of major schemes within LTPs.

3.5 Current appraisal guidance has its origins in the ‘New Deal for Transport’ and the ‘Guidance on the Methodology for Multi-Modal Studies’ (GOMMMS) which has now been superseded and incorporated into WebTAG. WebTAG incorporates relevant links to the HM Treasury document ‘The Green Book, Appraisal and Evaluation in Central Government’ and provides detailed information on the use of the Green Book within transport appraisal\(^ {54}\).

3.6 Figure 4 sets out the approach required to ensure that appraisal is part of an overall process. Although the guidance is focused on development and appraisal of transport strategies and/or plans, it also establishes the process as the most appropriate framework for the “development and appraisal of Local Authority Transport Strategies, major highway and public transport schemes which are part of LTPs, and trunk road and motorway schemes”\(^ {55}\).

3.7 The vast majority of mass transit systems are likely to be promoted either independently by local government e.g. local authorities working alone, Passenger Transport Executives, and Transport for London, or by a local authority working in partnership with operators and private developers/funders. In most situations, it is likely that the scheme will be seeking some element of funding through the LTP process as a major scheme bid. Even where a scheme is not seeking a funding contribution from central government, it is still expected that the scheme should fit within the context of the LTP, and should be included within the appraisal of the LTP as a whole, as the Department will take these things into consideration when undertaking the overall assessment of an authority’s LTP\(^ {56}\).

3.8 Thus it is sensible to focus on the role of scheme development and appraisal within the context of the overall process set out in Figure 4, and specifically in the context of the Major Scheme appraisal in LTPs\(^ {57}\). The implications of recently published draft Guidance to Local Authorities seeking DfT funding for local transport major schemes\(^ {58}\) must also be taken into consideration. However, it is noted that this document focuses more on the process and stages in the submission and approval of a major scheme bid, rather than on the detailed option appraisal.

---

53 [www.WebTAG.org.uk](http://www.WebTAG.org.uk)
54 ‘Transport Appraisal and the New Green Book’
55 WebTAG Unit 2.1 Para 1.1.2
56 WebTAG Unit 1.4 Para 1.1.5
57 WebTAG Units 1.4/3.9
58 Draft Guidance published by DfT, 8 April 2005
Linking Phase 1 to Phase 2

3.9 Figure 4 sets out the approach for the wider process of strategy development and scheme identification, which promoters will have followed in order to identify mass transit (albeit an unspecified technology) as an appropriate solution. However, it can be seen that Phase 1 also closely replicates the tasks carried out through the LTP or RTS development excluding the consultation element, which is not likely to be required as part of the Phase 1 process but, which may be further developed as part of Phase 2. This is entirely appropriate, and it demonstrates that the short-listing of technologies is being undertaken in accordance with accepted appraisal and assessment techniques.

3.10 Thus, Phase 1 results in the identification of a ranked list of mass transit technology options set against a background of local context criteria and objectives, and incorporating a strategic level assessment of demand, as well as costs and revenues.

3.11 The number of technology options remaining at the end of Phase 1 will then guide the way in which the Phase 2 process is undertaken. In most cases Phase 1 will have resulted in a clear elimination of technology options on the basis that these will not meet objectives and will not provide sufficient mitigation of problems. The ranking process will enable identification of ‘preferred’, ‘lower-cost alternative’, and in some cases ‘next best alternative’ technology options to be taken forward for further appraisal.

3.12 However, in some cases the results from Phase 1 may give rise to a situation whereby the differences between technologies are limited, such that further detailed appraisal of more than three technology options is required. Conversely, the Phase 1 assessment may also have resulted in an elimination of technology options such that fewer than three options remain for further detailed assessment.

Application of Major Scheme Appraisal Guidance

3.13 Further assessment of the technology options arising from Phase 1 and taken forward to Phase 2, will be undertaken in accordance with the Major Scheme Appraisal Guidance. As this guidance for carrying out detailed assessments in accordance with the ‘New Approach to Appraisal’ already exists in the form of comprehensive WebTAG Units, it is not intended to reproduce or summarise this information here. Instead we have sought to identify those points, in the appraisal process which have a greater ability to impact on scheme delivery and performance at a later date. These points are discussed further in the remainder of this section.
3.14 The Major Scheme Appraisal Guidance is focused on ‘scheme’ development and as such enables the comparison of different scheme options, usually in the form of different modes. In this context, application of the existing guidance under Phase 2 assumes the assessment of different technology options as alternative schemes, acknowledging for example, that promoters may be assessing several different types of bus. However, this does not preclude the appraisal of different schemes within a particular technology option e.g. two routes for LRT.

3.15 As risk affects all areas of major scheme development, it is important to understand the ways in which risks can be managed, how they can be quantified, who should be responsible for the risks (e.g. potential transfer under PFI agreements) and those factors which are likely to have the greatest impact. Whilst risks and cost increases should be managed through the risk assessment process and through the inclusion of an allowance for optimism bias promoters should be alive to the key areas of uncertainty. Thus the remainder of this section considers a number of issues, each of which should essentially be considered a project risk.

Optimism Bias

3.16 WebTAG guidance on optimism bias is enhanced by additional information provided in supplementary guidance to the HM Treasury Green Book. This document provides guidance on the stages in scheme development at which optimism bias can be reduced. Further information is provided in recent research undertaken for the Department, offering guidance on appropriate levels of optimism bias to be applied to different technology options.

Sensitivity Testing

3.17 Sensitivity testing is an integral part of the major scheme appraisal process, enabling promoters to assess the potential scale of impact of some of the risk factors, and as such should be carried out to assess the effects of a range of variables on the scheme appraisal. Existing major scheme appraisal guidance suggests that this will include ‘changes to endogenous variables such as costs, traffic/patronage, revenues, and to changes in the underlying assumptions on which the forecasts are based’. Sensitivity tests should also be considered in the context of the requirements for the monitoring process, identified in Phase 3.

---

59 WebTAG Unit 3.9.3
60 WebTAG Unit 3.9.4
61 www.hm-treasury.gov.uk/media/885/68/GreenBook_optimism_bias.pdf
62 ‘Procedures for dealing with Optimism Bias in Transport Planning’, Bent Flyvbjerg, June 2004
63 WebTAG Unit 3.9.2
Patronage forecasts

3.18 Detailed guidance on the development of demand forecasting models for the appraisal of major public transport schemes was published in 2003, and can be found on the Department’s website. Revised guidance on the modelling and forecasting of public transport schemes is available as a consultation document on the WebTAG site (www.webtag.org.uk).

Interaction with other modes

3.19 In order to ensure that existing modes are modelled as accurately as possible against the new mode or the mass transit proposals, promoters must have a clear understanding of the environment in which the mass transit system will be operating. This will be best achieved by working in conjunction with existing operators, and the importance of having these groups on board cannot be underestimated. Working closely with operators will enable promoters to understand the likely response of providers, for example if there is substantial mode shift from bus to LRT, what actions would operators be likely to take in terms of changes to service patterns, fares, routes and frequencies, etc. Importantly this will help to establish whether the new mode will ‘compete’ with or complement existing services, and importantly, will help to assess any negative impacts that the new mode may have on these.

Demographics

3.20 Patronage forecasts should take into account, as far as is practicably possible, the demographics of the area being served by the mass transit system, such that appropriate consideration is given to (for example) age, income, journey purpose, and nature of employment.

Catchments

3.21 The use of appropriate catchment areas within the demand forecasting must be linked to realistic walk-distances, where possible taking account of local topography, and promoters should avoid the blanket assumption that all dwellings within a given radius, of say a proposed stop, have equal access to the new mode. It is important that any assumptions about different catchment areas for different modes should be evidence based.

---

64 www.dft.gov.uk/stellent/groups/dft_localtrans/documents/page/dft_localtrans_504021.hcsp
Quality

3.22 Although it is difficult to appraise, consideration should be given to the potential effects of quality issues on patronage forecasts. This would include elements such as comfort, punctuality and predictability, reliability, marketing and promotion, and provision of information. These issues were discussed in the recently published TRL report, ‘Demand for Public Transport’.

Do-Minimum and Do-Something Scenarios

3.23 The assessment of a scheme will require the development of a future year scenario (with different scenarios for different future years), against which the situation with the scheme is compared. Traditionally this scenario has been a ‘do-minimum’, where only committed land use and transport schemes are included, together with an allowance for general travel growth. More recent practice has seen the use of future year scenarios that represent the ‘most likely’ future situation. This will include land use and transport developments that are deemed ‘likely’ to take place.

3.24 Where alternative scenarios involve changes in land use, promoters must ensure that these are as realistic as possible. In order to develop the most appropriate solution, and to take account of the wider inter-action between land use and transport planning, these should be subject to sensitivity testing.

3.25 Sensitivity tests should also examine ‘pessimistic’ and ‘optimistic’ scenarios, with the pessimistic case containing only land use and transport developments deemed to have a high probability of occurring and the optimistic case including developments with lower levels of probability.

3.26 Of particular importance to mass transit schemes will be policy measures relating to restraint upon car use. Sensitivity tests should examine the degree to which forecast patronage is dependent on any such restraint. Where such policy measures are not yet committed, it is recommended that a sensitivity test be undertaken that reflects the current policy situation.

Information

3.27 The use of up-to-date and relevant information which is ‘fit for purpose’ is a fundamental element in the development of any demand forecasting model. Where current data is not available, promoters must be alive to the potential for significant changes in travel patterns or travel behaviour, for example, changes associated with new housing or retail developments, an identifiable increase in home working, or perhaps an identifiable increase in wealth resulting in the availability of different travel options. In such circumstances, observations made in surveys previously undertaken are likely to be superseded, and the relevance of such data would require close scrutiny.

65 www.demandforpublictransport.co.uk/TRL593.pdf
Use of Mode Constants

3.28 The effects of chosen mode constants for use in the demand modelling should be carefully considered. This is particularly relevant when considering the differences assumed regarding the perception of LRT and bus modes. Typically, selected mode constants implicitly include a range of service related factors, when in reality LRT and bus modes offering similar levels of service are likely to provide similar levels of attraction. This would appear to be supported by general experience of LRT in the UK (where patronage has tended to be over-forecast) and the particular example of Crawley where bus patronage is around 40% above forecast. Thus, it is suggested that where service levels are similar, if bus and rail-based alternatives are not modelled with the same mode constant this must be carried out as a sensitivity test. An evidence based checklist (using local data where possible) should be established to identify the ‘level of service’ impacts associated with each mode. This could include:

• Seating versus standing (comfort versus capacity);
• Reliability;
• Information;
• Access;
• Need for interchange (and interchange conditions); and
• Integration between modes (particularly timetabling integration).

Other Modelling Issues

3.29 The accuracy of model inputs, in particular journey times assumed for the new mode and the performance of the competing modes (both car and public transport) is an area in which optimistic assumptions can lead to large over-estimates in patronage forecasts. Ensuring that the new mode is modelled correctly, for example in terms of interaction with the existing highway network, and in particular delays at junctions, will give greater confidence in the ability of the proposal to deliver the forecast patronage.

Costs

3.30 Along with over-optimistic patronage forecasts, cost increases have the potential for the highest impact on the ability of promoters to deliver a scheme.

Land

3.31 Whilst appropriate allocations can be made for costs associated with necessary land-take, increases that can arise as a result of detailed negotiations as the scheme progresses, along with the effects of time lag between inception and implementation, should be closely monitored under the Phase 3 process.
3.32 The cost implications associated with utilities diversions vary according to the type of technology being implemented, usually affecting rail based systems (either LRT or some types of guided-bus technology) running on highway. As an area which carries a large degree of uncertainty, and which has the potential for large and unexpected cost increases, this is an area of risk which local authorities will usually seek to transfer to the contractor. To enable these costs to be better managed, it has been suggested\(^\text{66}\) that where utilities need to be diverted, this work could be carried out by the promoters or their sub-contractors, rather than by the utility companies.

3.33 The method of procurement for a given system will also affect the way in which costs are handled and the risks associated with those costs. In practice LRT systems are typically delivered through public-private partnerships, enabling an element of risk sharing and transfer, whereas bus-based systems are usually delivered by a local authority operating independently, although there are examples of public-private partnerships such as those delivering guided bus projects in Leeds.

3.34 It will be important to consider the likely procurement method(s) and consider the effects that this will have upon system delivery. Areas that may be affected include:

- costs (e.g. cost of external finance, cost of risk transfer);
- risks (e.g. degree to which they can be transferred); and
- timescales.

\(^{66}\) HoC Public Accounts Committee (HC440 5 April 2005)
3.35 As the more detailed scheme design for each technology option emerges, promoters must ensure that the chosen alignment is able to deliver the forecast demand/patronage, and that the impacts of physical constraints, or indeed opportunities, are fully acknowledged.

3.36 Apparent opportunities in the built environment can also influence scheme design. A prime example is that of the disused heavy rail corridor. Whilst such a corridor can have many benefits in terms of cost, land-take and environmental impacts, promoters should be clear as to why the corridor is now available (for example it was not well situated in the first place, it no longer serves suitable catchment areas or it had unfavourable characteristics such as difficult or insecure passenger access to stops on sections of cutting or embankment). Conversely, conversion of a heavy rail line as part of a light rail system, with associated improvements in frequency and penetration, may provide an effective solution as demonstrated for example, in Manchester and Croydon. However, the very fact that an alignment is available may lead to limited consideration of other more appropriate alignments that would offer better penetration of catchment areas, but which are perceived to be more costly or more difficult to deliver.

3.37 It is also important that promoters remain alive to this issue throughout the development and refinement of the scheme design. At the beginning of the Phase 2 process, detailed alignment is unlikely to have been finalised, and access and egress points (stops) on the system will be modelled in terms of origins and destinations. Ensuring that an appropriate alignment can be delivered without compromising patronage forecasts is a major challenge faced by promoters, occurring at a level of detail which demand modelling and associated sensitivity testing is unlikely to be able to address. This point is best illustrated by the example shown below.

A proposal is developed to ensure that a new mass transit system integrates with the existing heavy rail network, and appropriate interchange opportunities and penalties are incorporated into the demand forecast modelling. In real terms, it is envisaged that interchange movements between the two modes would be facilitated by direct links between the rail station and the new mass transit system, such that the new mode would have a high profile in the surrounding environment. However, as the scheme design progresses, delivery of the preferred alignment for the new system e.g. to the front of the railway station is compromised (possibly as a result of land-ownership issues, or unforeseen cost increases). Further investigation reveals that an alternative alignment can be delivered to the rear of the railway station and the scheme design continues on this basis.

Note: Whilst this would be unlikely to affect any major changes to the way in which the scheme was modelled, and thus the resulting patronage forecasts, the real impacts may be far reaching. A system for which access is perceived to be in ‘the wrong place’ is unlikely to realise the forecast levels of patronage demand and thus the associated benefits.
3.38 The need to prepare an Economic Impact Report (EIR) flows directly from the central Government Economy Objective and is set out in guidance on Wider Economic Impacts\textsuperscript{67}. The guidance\textsuperscript{68} notes that the main intention of preparing an EIR is to “investigate the distribution of the impacts captured by the transport economic efficiency appraisal and the potential manifestation of those impacts in terms of changes in employment levels”. However, whilst many proposals are likely to have regeneration as a key local objective, an EIR need only be produced for Regeneration Areas, identified as those with ‘a specific regeneration priority in achieving the objectives of the relevant regional economic strategy’.

### Strategic Environmental Assessment

3.39 WebTAG Unit 2.11 provides guidance on the preparation of Strategic Environmental Assessments (SEAs) for transport plans and programmes. As a Strategic Environmental Assessment will normally be required for new transport plans and programmes, and in some cases for extensions and additions to those plans, the development of any new major public transport scheme will be incorporated into this process. Submitted as a Major Scheme Business Case, a bid for funding for a new public transport scheme would not require a separate SEA.

3.40 The results of the Phase 2 activity should be compared against the outputs from Phase 1 to determine the degree to which key system values may have changed during the more detailed assessment process in Phase 2. In particular, estimates of costs and patronage may be subject to significant change from the values determined in Phase 1. This review should examine whether the changes in such values would be sufficient to remove the advantages previously determined for the preferred options and thus alter the conclusions from Phase 1. Where this is the case, the Phase 1 work should be repeated using the more detailed valuations from Phase 2 and, if appropriate, alternative option(s) taken forward to Phase 2.

3.41 It should be noted that some of the more detailed valuations may apply to a number of the options being examined in Phase 2 (e.g. land acquisition costs) and thus appropriate corrections should be made to all affected options.

---

\textsuperscript{67} WebTAG Unit 2.8
\textsuperscript{68} WebTAG Unit 2.8 Para 1.3.5

---

PHASE 2 OUTPUT:
APPRAISAL SUMMARY TABLES FOR PREFERRED OPTIONS TO BE TAKEN FORWARD TO PHASE 3
4. Phase 3
Scheme
Refinement and
Monitoring
4.1 The Phase 3 process comprises monitoring of both internal and external changes that take place during scheme design and implementation which may affect the costs and performance of the preferred scheme. The purpose of this Phase is to ensure that the scheme ultimately delivered performs in accordance with expectations.

4.2 An important part of this review process will be to determine that the conclusions reached in Phases 1 and 2 continue to be valid. As with Phase 2, the more detailed assessment and work in Phase 3 may result in significant changes to key scheme values. Where these changes remove the advantage previously shown for the preferred option, it will be necessary to repeat the work in Phase 2 and, where appropriate, Phase 1 using the revised valuations. The most likely areas where such changes will occur are system costs and patronage. The changes in such valuations should be applied in Phase 1 and 2 to all options affected by the more detailed information.

4.3 It is noted that some changes in Phase 3 (such as cost escalations that cannot be controlled to reasonable levels) may result in there being no scheme available for a particular technology option that would represent value for money. In this situation that particular technology option would need to be abandoned.

4.4 The identification of risks using a risk register and quantified risk assessment should be an on-going process. It is recommended that the risk register is renewed at least every six months to remove risks that have been ‘managed out’, to add new risks as more contemporaneous information comes to light, and to ensure that risks are placed with those who are best able to manage them.

4.5 Internal design changes will occur during scheme design and implementation for a number of reasons including outputs from activities such as:
- value engineering;
- safety audits;
- public consultation;
- detailed engineering investigations;
- environmental assessments; and
- risk management and mitigation.

4.6 To date Phase 3 has rarely been undertaken in full for mass transit system design, although elements of this Phase are required as part of the LTP/Annex E process. The NAO report demonstrated how design changes have often occurred at a late stage in order to (for example) reduce capital costs, but the impacts of these changes upon scheme performance (especially whole-life costs and patronage) have generally not been assessed. In addition, there has been a lack of direct linkage to other transport and non-transport policies that contribute to scheme performance and help ‘lock-in’ the benefits delivered by the scheme. Whilst it is impracticable to analyse all design and external factors that would affect performance, the sensitivity tests in Phase 2 should identify the critical factors affecting scheme performance and enable the quantification of the effects of variation in these factors.
4.7 A ‘monitoring plan’ is recommended, which will ensure that:

- both internal and external factors are monitored on a regular basis. These factors will include changes to system design, costs and performance;
- monitored changes are assessed at both an individual and a cumulative level;
- the results of sensitivity tests (undertaken as part of the standard major scheme appraisal process) are used to assess the impact of change factors; and
- where impacts (individually or cumulatively) exceed a threshold, the overall performance of the preferred scheme will be re-assessed and consideration given to scheme modification. In some circumstances, adoption of an alternative technology option or scheme may be appropriate; this would be determined through re-evaluation by returning to either Phase 1 or Phase 2 of the process. The threshold will be determined from the sensitivity tests undertaken in Phase 2 and the differences between the preferred scheme and the alternative options or schemes.

4.8 The main elements of the Phase 3 process are discussed in more detail below.

The Monitoring Process

4.9 Regular monitoring should be undertaken of both internal and external factors that are likely to affect scheme performance. It is recommended that these be monitored separately, as all significant (internal) design changes can be recorded and assessed by the scheme promoter whereas external factors will require periodic review of the external environment.

4.10 Whilst such changes will initially be assessed at an individual level, it is essential that a regular assessment is undertaken to determine the cumulative impacts of such changes. It should be noted that in some cases the cumulative impacts of a series of changes may be greater than the sum of the impacts of the changes assessed individually. For example, a 5% increase in journey time may only result in a 2% drop in patronage, whereas a 10% increase in journey time may result in a 10% drop in patronage – in excess of the 4% that would result from an individual assessment of two 5% journey time increases.

Internal Monitoring

4.11 The system promoter should maintain a record of all scheme design changes with an assessment of the impact of the change. This assessment will determine whether the change is likely to have a significant impact upon scheme performance and whether further assessment is required. The assessment should consider the following aspects of the scheme performance:

- capital cost;
- operating cost;
- timescale;
- service pattern (e.g. routes, stops);
- service level (e.g. capacity, run times, frequencies, reliability);
- access to the service (e.g. stop locations; interchanges, park and ride etc.); and
- public/political perception.
4.12 There are many areas where internal change may occur during scheme design and implementation; typical examples include:

- physical design features such as route, route treatments and stops;
- operating service features as detailed above;
- ancillary scheme features such as information systems, ticketing arrangements;
- procurement methodology; and
- operating arrangements (e.g. partnership arrangements).

4.13 The monitoring process should record the judgement made as to whether each recorded change will have a significant impact upon scheme performance. The initial judgement will determine whether:

- the recorded change will have any impact upon the scheme performance aspects detailed above;
- the sensitivity tests are sufficient to judge the scale of impact;
- what the impact would be;
- whether this would change the relationship to the other options (e.g. removal of P&R would affect all options similarly whereas changes to LRT run times due to geometric design would only affect LRT options); and
- whether further work would be required.

4.14 Particular attention should be given to system costs and patronage forecasts, as these have been shown to be the most consistent areas of under-performance.

4.15 An example of an internal monitoring plan table is shown below.

Table 15: Example internal monitoring table

<table>
<thead>
<tr>
<th>Change</th>
<th>Effect</th>
<th>Impact</th>
<th>Assessment</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional stop added</td>
<td>Increase in catchment and patronage</td>
<td>Net patronage increase 2%</td>
<td>Overall effect slightly beneficial</td>
<td>Add to cumulative change record</td>
</tr>
<tr>
<td></td>
<td>Increase in journey time, leading to</td>
<td>Operating cost increase 1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>increased cost and reduced patronage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced speed due to geometric constraints</td>
<td>Lengthen journey times</td>
<td>Patronage reduced by 2% - 4%</td>
<td>Reduction in performance not sufficient to change assessment</td>
<td>Test effect of additional vehicles to restore frequency</td>
</tr>
<tr>
<td></td>
<td>Reduce headway</td>
<td></td>
<td></td>
<td>Add to cumulative change record</td>
</tr>
</tbody>
</table>
External Monitoring

4.16 The external monitoring process should comprise a review of the external factors that have been determined as likely to significantly affect scheme performance. The factors to be reviewed will include those originally forecast not to change (e.g. existing land uses) and those forecast to change (such as new land use developments). The purpose of the monitoring is to determine whether the context within which the scheme is being promoted remains consistent with that anticipated. Unlike the internal monitoring, where changes are under the control of the promoter and can be monitored as they occur, it is recommended that periodic reviews be undertaken of the external factors. These reviews can be linked to key points in the scheme project lifecycle, such as:

- funding application;
- application for planning powers; and
- invitation of tenders for scheme implementation.

4.17 The principal external factors that should be subject to periodic review will depend upon the scheme and the context within which it is being promoted. The external factors having the most influence over the scheme will have been identified during the Phase 1 process and refined and quantified during Phase 2 through the sensitivity testing activity. Typical external factors that are likely to be important at this stage will include:

- land use (existing and new);
- policy environment (e.g. demand management, parking control);
- highway network supply and performance; and
- competing public transport modes.

4.18 As with the internal monitoring exercise, the monitoring should record the judgement made as to whether each recorded change will have a significant impact upon scheme performance together with any action required.

4.19 An example of an external monitoring plan table is shown below.

<table>
<thead>
<tr>
<th>Change</th>
<th>Effect</th>
<th>Impact</th>
<th>Assessment</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major land use development delayed by 5 yrs</td>
<td>Forecast patronage increase delayed</td>
<td>Reduction in forecast patronage of 6% between 2010 &amp; 2015</td>
<td>Reduced revenue can be offset by delaying service frequency enhancement</td>
<td>Delay planned increase in service frequencies</td>
</tr>
<tr>
<td>Long stay parking constraints introduced</td>
<td>Increased peak hour demand</td>
<td>Peak hour patronage increased by 4%-8%</td>
<td>Increased peak hour revenue</td>
<td>Record revenue increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak hour capacity reached 4 yrs early</td>
<td>Review potential to increase peak hour capacity</td>
<td></td>
</tr>
</tbody>
</table>

Table 16: Example external monitoring table
4.20 An important part of the monitoring process will be the decision making that takes place as a result of changes that have been identified. Decisions are likely to fall into three main groups:

• changes to scheme design to accommodate or mitigate the identified change;
• promotion of changes to the external environment; and
• change to an alternative scheme or technology option.

4.21 It should be noted that the ability to make these decisions will be influenced by the nature of the scheme and the stage in its development process. For example, it is unlikely that change to an alternative scheme or technology option would be considered for a scheme for which powers have been obtained, unless the impact of the monitored change was extreme.

4.22 Where large scale changes are identified, then it may be appropriate to re-assess the available options through a return to Phase 1 or Phase 2 of the process.

4.23 Each of the groups of decisions identified above is considered briefly below.

System Design Changes

4.24 The most common response to change during the design and implementation stage is a redesign of an aspect of the scheme. Examples might include changes to:

• infrastructure design;
• extent of priority measures;
• stop locations;
• routes;
• service patterns;
• frequencies;
• fares; and
• ancillary features such as information systems or park and ride provision.

Change to External Environment

4.25 The scheme promoter may, or may not, be in a position to control aspects of the external environment. For example, where a scheme is promoted directly or jointly by a local authority then it should be possible to promote policy changes to assist the preservation or enhancement of the system performance and thus reduce risk associated with delivery of the system outputs and benefits. Examples may include:

• parking management;
• road space allocation; and
• demand management measures.

4.26 In addition smaller scale locally-based measures may be promoted to aid system performance, including changes to (for example):

• junction layouts;
• traffic signal timings; and
• parking/waiting restrictions.

4.27 In situations where the local authority is not directly involved in the promotion of a mass transit system, there may still be opportunities for the promoter to encourage and/or assist the development of policies and measures. However the reduced degree of control in this situation will tend to lead to higher levels of risk associated with delivery of system outputs and benefits.

4.28 A further area of the external environment where changes may be sought is the relationship with other public transport operations. This is a potentially complex area due to competition regulations, but changes could be sought to (for example):

• ticketing and fare arrangements;
• service routes and frequencies; and
• interchange between services and modes.
Alternative system or technology

4.29 The scheme promoter should consider alternative schemes or technology options where monitored changes (individually or cumulatively):

- result in large scale impacts upon scheme/system performance that equal or exceed the differences between the preferred and next best option(s) determined in Phase 2; and
- change the balance between the system being promoted and alternative schemes or technologies.

4.30 This will require review of the alternative scheme or technology options assessed in Phase 2 to determine whether these alternatives may offer a better solution. This is likely to require re-assessment of the alternatives to ensure that the effects of the monitored changes are applied to the alternatives where appropriate (for example changes to land use developments would affect all options).

4.31 As noted previously, particular attention should be given to system costs and patronage forecasts. Cost escalation and below forecast patronage have been shown to be common problems associated with mass transit systems. Where the factors resulting in cost or patronage changes affect the preferred option to a greater extent than alternative options, then it is likely to be necessary to reassess the alternatives through a return to Phase 1 or Phase 2 of the process. This might result in the abandonment of a particular technology option (for example where costs escalate beyond reasonable levels and no value for money scheme exists) or identification of a scheme that is reduced in scope.

Post - Implementation Monitoring

4.32 The monitoring and review process detailed above may be extended to continue during the post-opening phase of system operation. This would be of particular importance where further significant changes are forecast to occur during the operational period. These may include factors such as:

- Extensions to the system;
- Changes to the system services (such as increased frequencies);
- Major changes in the policy environment (such as the introduction of demand management measures, for example road user charging);
- Major changes in the transport network and/or supply; and
- Major land use changes.

4.33 The precise nature of any monitoring, post-implementation, will depend upon the nature of the system and the context within which it is being delivered. However, the same basic philosophy applies; the purpose of the monitoring is to ensure (as far as is practicable) that the system continues to deliver the forecast performance and thus benefits. Given that the system has already been implemented, the results of monitoring at this stage can be used to:

- Optimise the services using the system (e.g. capacities, routes, frequencies);
- Plan enhancements to the system (e.g. new stops, park and ride sites); and
- Recommend changes to the external environment that would enhance the system performance (e.g. local transport policy, transport operator partnership arrangements).

PHASE 3 OUTPUT:
FULLY APPRAISED AND TESTED PREFERRED OPTIONS
5. Data

5.1 As part of this guidance, technical data is provided to assist with the quantitative calculations required, particularly those outlined in Step 2 of Phase 1. The appendices to the guidance provide details of capital costs and operating costs for a number of existing and proposed mass transit systems in the UK. It should be noted that the recorded costs vary significantly and are strongly influenced by the context within which an individual scheme is being promoted. It should also be noted that there is a general lack of robust data relating to bus-based schemes. This results from a combination of a relative lack of experience of measures such as guided bus, a lack of detailed monitoring of enhanced bus based systems and the commercial confidentiality attached to bus-based cost information.

5.2 The data sources that have been researched emphasise the need for a systematic approach to system monitoring and data collection in order to provide information that will enhance the robustness of quantification of costs associated with mass transit systems. Thus it is recommended that DfT give serious consideration to a programme of data collection and monitoring for mass transit systems (similar to that adopted by the Highways Agency for trunk road schemes), particularly those using bus-based technology.

In particular there is a lack of data relating to bus systems that have been subject to intensive investment (such as Crawley ‘Fastway’ and the guided bus systems in Leeds and Bradford) and this is an important area for improved data collection.
Supporting Information in Appendices

5.3 The appendices aim to provide both the guidance user with technical information to support cost calculations conducted as part of Phase 1, and to give detail of the references used and how these may be obtained.

Appendix A – Capital costs

Table A1 – Existing Mass Transit Schemes/Systems

5.4 Table A1 provides the guidance user with an indication of the capital costs of particular mass transit options. Cost totals are presented for existing UK mass transit schemes, to give both an indication of the range of costs for each option and to provide a “reality-check” for any cost calculations made as part of the Phase 1 process.

Table A2 – Capital Cost Breakdown

5.5 Table A2 provides a detailed breakdown of the key capital costs associated with mass transit options. It is intended to give an indication of what costs should be considered in the provisional cost calculations for Phase 1 and to provide approximate guidelines for component costs.

5.6 Cost breakdown examples are provided for light rail, guided bus, bus priority and trolleybus schemes, populated, where available, with data from existing mass transit schemes. However, due to a lack of published information (particularly for bus-based options) and a concern that few existing schemes will provide up-to-date data, costs have also been gleaned from a number of schemes not yet implemented.

5.7 Figures are presented as both total costs and costs per kilometre. All figures have been factored to a 2002 price base and any calculation should consider DfT guidance on optimism bias.
Appendix B – Operating costs

5.8 Appendix B provides an indication of operating costs for mass transit systems, to be considered again as part of the Phase 1 process.

Table B1 – UK Light Rail System Operating Costs

5.9 Light rail costs are included for each of the existing UK systems (with the exception of Nottingham Line One for which no information is currently available). These are presented in per kilometre costs and as cost per passenger journey.

5.10 Revenue data is also supplied, in order to illustrate the extent to which this has covered or exceeded the operating costs.

Table B2 – Operating Costs for Bus-Based Systems

5.11 Bus-based system operating costs, due to operator commercial confidentiality, are presented differently to light rail and relate to a list of parameters based upon general industry experience.

5.12 It should be taken into consideration that there is assumed to be no significant difference in unit costs between buses operating conventionally, as guided bus or on other busway/bus lane services (due to the low costs associated with kerb based guidance equipment). However, overall operating costs will depend upon operating conditions and bus based systems that improve conditions (such as reducing average journey time or increasing journey time reliability) will reduce overall operating costs.

Appendix C – References

5.13 Appendix C provides both a reference to the documents referred to in the guidance and a guide to obtaining more detailed information on a mass transit option.

5.14 References are presented in a tabular format, with information on:

- the modes the document relates to;
- the type of discussion contained within the document (e.g. costs, wider benefits); and
- how the document can be obtained/accessed (with website addresses included).

5.15 References are also distinguished by whether they relate directly to UK experiences or those of other countries. It will be apparent that there is less information on UK bus-based options compared to light rail, particularly in relation to guided bus systems.
### Appendices A - Capital costs

Table A1 - Existing mass transit schemes/systems

<table>
<thead>
<tr>
<th>System Type</th>
<th>System Name (References shown in brackets)</th>
<th>Opening Year</th>
<th>Route Length (km)</th>
<th>Pre-existing heavy rail alignment length (km)</th>
<th>Segregated route length (km)</th>
<th>Guideway Length (km)</th>
<th>Number of vehicles</th>
<th>Number of stops</th>
<th>Total capital cost (£m)</th>
<th>Total cost per km (£m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIGHT RAIL</td>
<td>Croydon Tramlink</td>
<td>2000</td>
<td>28</td>
<td>17</td>
<td>14</td>
<td>-</td>
<td>24</td>
<td>38</td>
<td>200</td>
<td>7.14</td>
</tr>
<tr>
<td></td>
<td>Initial System (14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manchester Metrolink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phase 1 - Bury to Altrincham (14, 16)</td>
<td>1992</td>
<td>31</td>
<td>28.2</td>
<td>-</td>
<td>-</td>
<td>26</td>
<td>10</td>
<td>145</td>
<td>4.68</td>
</tr>
<tr>
<td></td>
<td>Phase 2 - Eccles via Salford Quays (14, 16)</td>
<td>2000</td>
<td>6</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>27</td>
<td>150</td>
<td>25.00</td>
</tr>
<tr>
<td></td>
<td>Nottingham Express Transit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Line One (14, 16)</td>
<td>2004</td>
<td>13.5</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>15</td>
<td>24</td>
<td>200</td>
<td>14.81</td>
</tr>
<tr>
<td></td>
<td>Sheffield Supertram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lines 1 and 2 (14, 16)</td>
<td>1994</td>
<td>29</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>25</td>
<td>48</td>
<td>240</td>
<td>8.28</td>
</tr>
<tr>
<td></td>
<td>Tyne and Wear Metro</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunderland Extension (14, 16)</td>
<td>2002</td>
<td>18.5</td>
<td>18.5</td>
<td>18.5</td>
<td>-</td>
<td>-</td>
<td>13</td>
<td>98</td>
<td>5.30</td>
</tr>
<tr>
<td></td>
<td>West Midlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Line 1 (14, 16)</td>
<td>1999</td>
<td>20.4</td>
<td>18</td>
<td>18.4</td>
<td>-</td>
<td>16</td>
<td>23</td>
<td>145</td>
<td>7.11</td>
</tr>
<tr>
<td></td>
<td>Bradford</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manchester Road (14)</td>
<td>2002</td>
<td>3.7</td>
<td>-</td>
<td>3.5</td>
<td>2.3</td>
<td>67</td>
<td>-</td>
<td>7</td>
<td>1.89</td>
</tr>
<tr>
<td></td>
<td>Crawley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fastway - all phases (14)</td>
<td>2005*</td>
<td>24</td>
<td>-</td>
<td>10.9</td>
<td>2.2</td>
<td>23</td>
<td>-</td>
<td>35</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>Leeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scott Hall Road (14)</td>
<td>1995</td>
<td>5</td>
<td>-</td>
<td>1.5</td>
<td>21</td>
<td>-</td>
<td>-</td>
<td>4.5</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>East Leeds (York Road) (14)</td>
<td>2001</td>
<td>6.8</td>
<td>4.7</td>
<td>2.1</td>
<td>83</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>1.47</td>
</tr>
<tr>
<td></td>
<td>Watford</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St Albans Road Green Route (5)</td>
<td>1999</td>
<td>4.1</td>
<td>-</td>
<td>0.885</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.76</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>Rotherham</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corporation Street Contra-flow Bus Lane (5)</td>
<td>2002</td>
<td>0.28</td>
<td>-</td>
<td>0.28</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.25</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>Leicester</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A47 Hinckley Road With-flow Bus Lane (5)</td>
<td>1997</td>
<td>6</td>
<td>-</td>
<td>4.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.2</td>
<td>0.20</td>
</tr>
</tbody>
</table>

**NOTE:** Cost breakdows are not usually available for commercial reasons.

*Estimated completed year for the final phase of the original scheme.
## Table A2 – Capital cost breakdown

<table>
<thead>
<tr>
<th>ROUTE DESCRIPTION</th>
<th>Light Rail</th>
<th>Bus Lanes</th>
<th>Trolleybus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (km)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total guideway/track length</td>
<td>30* 18.2 15.5 14.3 24 10 6 22</td>
<td>40 12 8</td>
<td>13 2.041</td>
</tr>
<tr>
<td>% of route with guidance</td>
<td>100% 100% 100% 100% 100% 100% 100% 100%</td>
<td>57% 100% 100%</td>
<td>0%</td>
</tr>
<tr>
<td>Total segregated length</td>
<td>10 6</td>
<td>23 12 8</td>
<td>10</td>
</tr>
<tr>
<td>% of route which is segregated</td>
<td>0% 0% 0% 70% 0% 0% 100% 0%</td>
<td>57% 100% 100%</td>
<td>77%</td>
</tr>
<tr>
<td>Number of stops/stations</td>
<td>26 29 23 16 19 11 5 25</td>
<td>12 8 40***</td>
<td>40***</td>
</tr>
<tr>
<td>Number of vehicles</td>
<td>21 16 13</td>
<td>73 15***</td>
<td>15***</td>
</tr>
</tbody>
</table>

### CAPITAL COST BREAKDOWN (£m)

#### Standard Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land &amp; Utilities</td>
<td>89.78</td>
<td>52.58</td>
<td>23.09</td>
</tr>
<tr>
<td>(of which Utilities)</td>
<td>32.14</td>
<td>18.24</td>
<td>7.18</td>
</tr>
<tr>
<td>Civils and Tracks</td>
<td>18.6</td>
<td>11.35</td>
<td>7.54</td>
</tr>
<tr>
<td>Stands</td>
<td>3.03</td>
<td>2.03</td>
<td>1.33</td>
</tr>
<tr>
<td>Electrical (Power Supply and Overhead Line Equipment)</td>
<td>10.71</td>
<td>6.24</td>
<td>3.35</td>
</tr>
<tr>
<td>Communications and Signalling</td>
<td>6.93</td>
<td>4.46</td>
<td>2.83</td>
</tr>
<tr>
<td>Vehicles</td>
<td>91.72</td>
<td>54.62</td>
<td>31.93</td>
</tr>
<tr>
<td>Depot/Control Centre</td>
<td>24.45</td>
<td>14.64</td>
<td>8.84</td>
</tr>
<tr>
<td>Highways Works</td>
<td>1.08</td>
<td>0.62</td>
<td>0.36</td>
</tr>
<tr>
<td>Traffic Management</td>
<td>1.62</td>
<td>1.01</td>
<td>0.62</td>
</tr>
<tr>
<td>Design &amp; Management</td>
<td>21.1</td>
<td>12.61</td>
<td>7.31</td>
</tr>
<tr>
<td>Contingency</td>
<td>21.1</td>
<td>12.61</td>
<td>7.31</td>
</tr>
<tr>
<td>Park and Ride</td>
<td>- 2.09</td>
<td>- 1.26</td>
<td>- 0.74</td>
</tr>
<tr>
<td>Insurance</td>
<td>- 3.61</td>
<td>- 2.23</td>
<td>- 1.19</td>
</tr>
</tbody>
</table>

All values shown at 2002 prices
(References shown in brackets)
### Note: These figures are based on costs at Q1 1998, updated to a 2002 price base. More recent figures are currently unavailable, because of commercial sensitivity as part of the current procurement process. These will not be able to be published until a successful contract is in place.

* Actual route length of proposed Cross River Transit is 16km; figures shown relate to what is outlined in the cost breakdown contained within Cross River Transit Summary Report.

** Figure for Electrical cost includes cost of Communications and Signalling.

*** Unless otherwise known, costs have been split on a pro-rata basis between guided and non-guided sections e.g. vehicle costs.

**** Civils and Tracks costs included under Highway Works costs.

#### Light Rail

<table>
<thead>
<tr>
<th>Proposed</th>
<th>Range</th>
<th>Other</th>
<th>Standard Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Rail</td>
<td>-</td>
<td>-</td>
<td>3.70</td>
<td>2.45</td>
</tr>
<tr>
<td>Tramway</td>
<td>-</td>
<td>-</td>
<td>3.70</td>
<td>2.45</td>
</tr>
<tr>
<td>Cross River Transit</td>
<td>-</td>
<td>-</td>
<td>3.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### Other

<table>
<thead>
<tr>
<th>Proposed</th>
<th>Range</th>
<th>Other</th>
<th>Standard Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Rail</td>
<td>-</td>
<td>-</td>
<td>3.70</td>
<td>2.45</td>
</tr>
<tr>
<td>Tramway</td>
<td>-</td>
<td>-</td>
<td>3.70</td>
<td>2.45</td>
</tr>
<tr>
<td>Cross River Transit</td>
<td>-</td>
<td>-</td>
<td>3.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Appendices B - Operating costs

Table B1 - UK Light Rail System Operating Costs

All values shown in 2002 prices

Figures adapted from Rapid Transit Monitor 2004 (ref no. 14)

<table>
<thead>
<tr>
<th>ROUTE DESCRIPTION</th>
<th>Manchester Metrolink</th>
<th>Tyne and Wear Metro</th>
<th>Sheffield Supertram</th>
<th>Midland Metro</th>
<th>Croydon Tramlink</th>
<th>London Docklands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (km)</td>
<td>37.5</td>
<td>59</td>
<td>29</td>
<td>20</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Total guideway/track length</td>
<td>37.5</td>
<td>49</td>
<td>29</td>
<td>20</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>No. of stops/stations</td>
<td>37</td>
<td>46</td>
<td>48</td>
<td>23</td>
<td>38</td>
<td>34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATING COSTS</th>
<th>System Name</th>
<th>Manchester Metrolink</th>
<th>Tyne and Wear Metro</th>
<th>Sheffield Supertram</th>
<th>Midland Metro</th>
<th>Croydon Tramlink</th>
<th>London Docklands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (£m)</td>
<td></td>
<td>13.48</td>
<td>27.08</td>
<td>7.95</td>
<td>7.74</td>
<td>12.13</td>
<td>29.91</td>
</tr>
<tr>
<td>- per passenger journey (£)</td>
<td></td>
<td>0.74</td>
<td>0.81</td>
<td>0.70</td>
<td>1.61</td>
<td>0.67</td>
<td>0.72</td>
</tr>
<tr>
<td>- per passenger km (£)</td>
<td></td>
<td>0.10</td>
<td>0.11</td>
<td>0.20</td>
<td>0.15</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>- per place km (£)</td>
<td></td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>- per train km (£)</td>
<td></td>
<td>2.93</td>
<td>5.76</td>
<td>3.31</td>
<td>4.84</td>
<td>5.05</td>
<td>10.31</td>
</tr>
<tr>
<td>- per vehicle km (£)</td>
<td></td>
<td>2.88</td>
<td>2.88</td>
<td>3.31</td>
<td>4.84</td>
<td>5.05</td>
<td>5.16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REVENUE</th>
<th>System Name</th>
<th>Manchester Metrolink</th>
<th>Tyne and Wear Metro</th>
<th>Sheffield Supertram</th>
<th>Midland Metro</th>
<th>Croydon Tramlink</th>
<th>London Docklands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (£m)</td>
<td></td>
<td>20.1</td>
<td>26.44</td>
<td>7.6</td>
<td>3.9</td>
<td>12.9</td>
<td>32.2</td>
</tr>
<tr>
<td>Surplus / Loss (£m)</td>
<td></td>
<td>6.62</td>
<td>-0.64</td>
<td>-0.35</td>
<td>-3.84</td>
<td>0.77</td>
<td>2.29</td>
</tr>
<tr>
<td>Surplus / (Loss) per pax journey (£)</td>
<td></td>
<td>0.36</td>
<td>-0.02</td>
<td>-0.03</td>
<td>-0.80</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Surplus / (Loss) per pax km (£)</td>
<td></td>
<td>0.05</td>
<td>-0.00</td>
<td>-0.01</td>
<td>-0.08</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Range | Minimum | Maximum | Average |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7.74</td>
<td>29.9</td>
<td>16.4</td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td>0.2</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>0.01</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>2.93</td>
<td>10.3</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>2.88</td>
<td>5.2</td>
<td>4.0</td>
<td></td>
</tr>
</tbody>
</table>
Table B2 - Operating Cost Parameters for Bus-Based Systems

<table>
<thead>
<tr>
<th>Cost Unit</th>
<th>Example Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Rate</td>
<td>£10.00 per hour</td>
</tr>
<tr>
<td>Cost of 1 gallon of fuel</td>
<td>£1.50</td>
</tr>
<tr>
<td>Km per gallon of fuel</td>
<td>1.5km</td>
</tr>
<tr>
<td>Cost of tyres per km</td>
<td>£0.009 per km</td>
</tr>
<tr>
<td>Running maintenance costs per km</td>
<td>£0.217 per km</td>
</tr>
<tr>
<td>Annual cost of time based vehicle costs (including tax, insurance and time-based maintenance costs such as MoT preparation)</td>
<td>£2,000 per bus</td>
</tr>
<tr>
<td>Cost of each bus</td>
<td>£120,000 - £200,000 per bus*</td>
</tr>
<tr>
<td>Vehicle lifetime</td>
<td>7 - 16 years**</td>
</tr>
</tbody>
</table>

Notes: Parameters listed are based upon typical industry experience. All figures are illustrative and any operating cost calculation should consider scheme-specific and regional variations (e.g. in driver rates).

* Based on values presented in Table 9 of the Main Report. See Table for references.
** Based on values presented in Table 8 of the Main Report. See Table for references.
### Key data resources

<table>
<thead>
<tr>
<th>Document Reference Number</th>
<th>Document Title</th>
<th>Web Link</th>
<th>UK</th>
<th>Continental Europe</th>
<th>North America</th>
<th>Other</th>
<th>Light Rail</th>
<th>Conventional Bus</th>
<th>Bus Lanes</th>
<th>Buses</th>
<th>Guided Bus</th>
<th>Other</th>
<th>Capital Costs</th>
<th>Operating Costs</th>
<th>Funding</th>
<th>Fares/Revenue</th>
<th>Patronage Forecast</th>
<th>Outturn Patronage</th>
<th>Issues Discussed</th>
<th>Barriers to Success</th>
<th>Scheme Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Reference Number</td>
<td>Document Title</td>
<td>Web Link</td>
<td>Relates to...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------</td>
<td>----------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Document Title</td>
<td>Document Reference</td>
<td>Web Link</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----</td>
<td>---------------------</td>
<td>-------</td>
<td>-------------</td>
<td>------------------</td>
<td>-----------</td>
<td>---------</td>
<td>------------</td>
<td>-------</td>
<td>--------------</td>
<td>------------------</td>
<td>---------</td>
<td>--------------</td>
<td>-------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>----------------------</td>
<td>-----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Document Title</td>
<td>Document Reference</td>
<td>Website Link</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Other useful data sources

<table>
<thead>
<tr>
<th>Document Reference Number</th>
<th>Document Title</th>
<th>Web Link</th>
<th>Relates to</th>
<th>Mode(s) Covered</th>
<th>Issues Discussed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Reference Number</td>
<td>Document Title</td>
<td>Web Link</td>
<td>Relates to</td>
<td>Modes(s) Covered</td>
<td>Issues Discussed</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>36</td>
<td>GMPT (2005). Cost plan for Chorlton District Centre Quality Bus Corridor. GMPT, Manchester (Excel spreadsheet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Document Reference Number</td>
<td>Document Title</td>
<td>Web Link</td>
<td>Relates to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Document Reference Number</td>
<td>Document Title</td>
<td>Web Link</td>
<td>Relates to</td>
<td>Mode(s) Covered</td>
<td>Issues Discussed</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------</td>
<td>----------</td>
<td>------------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
</tbody>
</table>

The table above outlines the document references, titles, and web links, along with the geographical locations and issues discussed for various transportation modes.
<table>
<thead>
<tr>
<th>Document Reference</th>
<th>Document Title</th>
<th>Web Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td></td>
<td><a href="http://www.uctc.net/papers/681.pdf">link</a></td>
</tr>
<tr>
<td>57</td>
<td></td>
<td><a href="http://gulliver.trb.org/publications/tcrp/tcrp78/guidebk2.htm">link</a></td>
</tr>
<tr>
<td>58</td>
<td></td>
<td><a href="http://www.tfl.gov.uk/tfl/pdfdocs/crossriver.pdf">link</a></td>
</tr>
<tr>
<td>59</td>
<td></td>
<td><a href="http://www.tfl.gov.uk/trams/pdfdocs/pr_2september2002_summary.pdf">link</a></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td><a href="http://trb.org/news/blurb_detail.asp?id=1698">link</a></td>
</tr>
<tr>
<td>61</td>
<td></td>
<td><a href="http://tt.tiedinburgh.co.uk/downloads/new_sept2004/STAGAppraisalLine1(Sep2004).pdf">link</a></td>
</tr>
<tr>
<td>62</td>
<td></td>
<td><a href="http://trb.org/news/blurb_detail.asp?id=1698">link</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Issue Discussed</th>
<th>Source Country</th>
<th>Relates to Mode(s) Covered</th>
<th>Issues Discussed</th>
</tr>
</thead>
</table>

### Table:

<table>
<thead>
<tr>
<th>Document Reference</th>
<th>Document Title</th>
<th>Web Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Reference Number</td>
<td>Document Title</td>
<td>Web Link</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
<tr>
<td>63</td>
<td>UITP (2002). Better Mobility in Urban Areas. UITP General Commission for Urban Life.</td>
<td><a href="http://www.uitp.com/publications/brochures/better.cfm">http://www.uitp.com/publications/brochures/better.cfm</a></td>
</tr>
<tr>
<td>65</td>
<td>Wilson, T (2004). Report on Adelaide O-Bahn: Items of Interest for Planning Cambridge’s Guided Busway. Steer Davis Gleaves.</td>
<td></td>
</tr>
</tbody>
</table>