Bus Priority Measures Best Practice Report

November 2007

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Executive Summary

EXECUTIVE SUMMARY

Bus Priority Best Practice

This report was commissioned as part of the project to develop a Bus Priority Strategy for Worcestershire for inclusion within the Worcestershire Integrated Passenger Transport Strategy. The report sets out bus priority scheme best practice and draws from examples in the UK and elsewhere. The Bus Priority Strategy will form a vital input to the wider strategy for passenger transport infrastructure in Worcestershire and the definition of the Integrated Passenger Transport Strategy. It will also provide the evidence base required to underpin funding bids to external bodies (such as the Department for Transport) for enhancement of the Worcestershire passenger transport network.

For the purpose of this report bus priority can be summarised as the provision or amendment of infrastructure and/or traffic control and management systems designed to improve the performance, efficiency, cost and image of bus travel. The key aims being to generate greater use of passenger transport and encourage modal shift from private car to bus and to the wider passenger transport network. These aims are in line with national, regional and local transport policies on encouraging use of sustainable transport.

Increasing traffic volumes and its associated adverse impacts on congestion, air quality and carbon emissions is a key problem in Worcestershire and elsewhere in the UK. The situation is likely to continue to deteriorate, as long as the private car remains the dominant mode of travel choice, even for short journeys. In addition, the impact of the proposed growth in travel demand arising from the Regional Spatial Strategy puts further emphasis on the need to provide a sustainable and realistic alternative to the car for certain types of journeys.

Addressing the issue of travel demand solely through large-scale road construction is neither a viable nor a sustainable option as the impact on our local communities would be huge in terms of the environment, land take, property demolition and isolation. We must, therefore, find other solutions that can meet peoples' desire to travel, by creating an attractive alternative that will encourage greater use of passenger transport, cycles and walking and reduce the reliance on the car.

There is clear evidence that bus priority measures have a major role in supporting balanced and integrated transport strategies seeking to improve the quality of passenger transport. Bus priority measures can ensure that passenger transport (and walking and cycling) can offer a realistic and sustainable alternative to the private car, whilst supporting economic prosperity and an improved environment for residents and visitors alike.

Bus priority measures are designed to give higher priority to bus services (high capacity/high efficiency) over low occupancy vehicles (lower capacity and less efficient) along congested sections of the road network, (particularly in urban areas). Where applicable bus priority measures should also provide priority access to key generators and attractors of travel demand.

Effective and systematic measures protecting buses from the effects of traffic congestion has been demonstrated to have a beneficial impact on bus journey times, service reliability and punctuality, passenger demand, revenue and the level of subsidy required to deliver a high quality passenger transport network. Decreasing journey time variability through the provision of bus priority measures:

- Enables timetables to be constructed with greater certainty
- Reduces the need to provide additional time to allow for out of course delays, thereby reducing vehicle and crew requirements and costs
- Reduces the need to have differential journey times between peak and off-peak periods
- Enables more easily understood and simple timetables to be developed
- Enables users to place greater reliance on the achievement of advertised journey times, increasing confidence in the dependability of the service

Conversely, slow and unreliable bus services have a significant adverse impact on bus network performance in terms of:

- The numbers of vehicles and crew required to operate bus services.
- The costs of operating the bus network (as vehicle and crew requirements are the main determinants of operating costs)
- The attractiveness of the services to potential passengers (particularly those who have a choice of transport modes) with a consequent negative knock-on effect on:
  - Farebox (ticket) revenue
  - The level of financial support required to maintain and improve the bus and wider passenger transport network

A wide range of bus priority measures and techniques have been researched and evidence of their effectiveness reported upon. These provide the bus priority "toolkit" for Worcestershire, including:

- **SEGREGATED MEASURES** – Including guided/unguided busways (bus-only roads)
- **ON-LINE (ON-ROAD) PHYSICAL MEASURES** – Including bus lanes, bus gates, bus stop build-outs and half-width lay-bys
- **TECHNOLOGICAL MEASURES** – Including traffic queue relocation, Selective Vehicle Detection (SVD) at signal controlled junctions, parking management, area traffic management, bus design and ticketing system design
- **ENFORCEMENT MEASURES** – Including technological measures such as enforcement cameras and physical measures such as barriers

Where cited, the term 'best practice' is used to describe excellence in terms of measures which:

- Have been shown to deliver benefits to bus passengers and operators
- Are realistic and deliverable
- Can be incorporated within a strategy, which seeks to improve the performance of road based passenger transport.
- Define clear parameters, which provide clarity on the standard and quality of passenger transport infrastructure that can be expected from a transport authority.
- Detail the criteria by which infrastructure schemes will be assessed to ascertain their value and relevance

Recommendations

On the basis of the research, it is proposed that the Worcestershire Bus Priority Strategy must be constructed such that the County Council is sufficiently prepared to apply a consistent approach to all bus priority projects across the county. The Worcestershire Bus Priority Strategy must, as a minimum, provide clear guidance on the following topics:

- **Bus Network Hierarchy** and its relationship with the level of bus priority provided
- **Operating Speed and Reliability Targets** and their relationship with the Bus Network Hierarchy
- **Bus Priority in Central Business Districts**
- **Bus Priority on Urban Arterial Corridors** (including Park and Ride routes)
- **Bus Priority at Key Junctions**
- **Appraisal of Bus Priority Schemes**
- **Bus Priority Enforcement**
- **Delivery Methods for Bus Priority Schemes**

BUS NETWORK HIERACHY FOR WORCSTERSHIRE

This must define the bus network hierarchy for Worcestershire. It is recommended that, as a minimum, the hierarchy should include:

- **Premium (Bus Rapid Transit) Routes**. These to be provided with **Systematic Bus Priority** measures, sufficient to:
  - Deliver operating speeds of at least 30km/hr on average (excluding bus stop dwell times)
  - Ensure that Inter-peak journey operating speeds are maintained throughout the operating day
  - Ensure that buses are provided with priority access to junction stop lines and pass through traffic signal controlled junctions during the first available green phase
  - Ensure that, wherever possible, buses stop only to set down and pick up passengers (i.e. are not stationary in traffic queues)
  - Provide priority for a minimum of 6 buses per hour per direction (i.e. a bus every 10 minutes)
  - Support the provision of passenger transport infrastructure, information systems, vehicles and ticketing meeting the Worcestershire County Council "Gold Standard" (see Infrastructure Best Practice Report for details)

- **Core Routes.** These to be provided with Bus Priority measures, sufficient to:
  - Deliver operating speeds of at least 25km/hr on average (excluding bus stop dwell times)
  - Ensure that buses are provided with priority access to junction stop lines
  - Ensure that, wherever possible, buses stop only to set down and pick up passengers (i.e. are not stationary in traffic queues)
  - Provide priority for a minimum of 3 buses per hour per direction (i.e. a bus every 20 minutes)
  - Support the provision of passenger transport infrastructure, information systems, vehicles and ticketing meeting the Worcestershire County Council "Silver Standard" (see Infrastructure Best Practice Report for details)

- **Other (Feeder) Routes.** These to be provided with Bus Priority measures, sufficient to:
    - o Deliver operating speeds of at least 20km/hr on average (excluding bus stop dwell times)
    - o Support the provision of passenger transport infrastructure, information systems, vehicles and ticketing meeting the Worcestershire County Council "Bronze Standard" (see Infrastructure Best Practice Report for details)

OPERATING SPEEDS AND RELIABILITY TARGETS

This section of the strategy must specify in detail the operating speeds and reliability targets for the Premium (Bus Rapid Transit) and Core Routes on a corridor basis. These targets will permit effective assessment of key routes, to identify the scale of bus priority measures required to increase operating speeds and reliability. The Premium (Bus Rapid Transit) and Core Routes (including Park and Ride) will be subject to the most stringent targets. The targets must be specified in terms of:

- Operating speeds
- Bus stop dwell times
- Average wait times for passengers (a measure of reliability)
- Punctuality (adherence to schedule)

BUS PRIORITY IN CENTRAL BUSINESS DISTRICTS

This section of the strategy must specify in detail the levels of bus priority that should be delivered in town/city centre environments, to ensure that buses are provided with the optimum operating conditions and access to key journey attractors and generators. It is recommended that the Worcestershire Bus Priority Strategy provide specific targets for each CBD. This section will be heavily influenced by the outcomes of the Traffic Management & Land Use Strategies (see separate Best Practice Reports). The operating speeds and reliability targets set out above will also be used for bus priority in CBDs.

BUS PRIORITY ON URBAN ARTERIAL CORRIDORS (including Park & Ride routes)
This section of the strategy must specify the levels of bus priority that should be delivered on key urban arterial corridors. The level of priority to be expressed in terms of the targets set out above.

BUS PRIORITY AT KEY JUNCTIONS

This section of the strategy must specify the key junctions at which bus priority measures are required to deliver the journey time and reliability targets set out for each tier of the bus network hierarchy. Key junctions that delay buses must be identified, with a view to installation of the appropriate bus priority infrastructure and/or Selective Vehicle Detection systems.

APPRAISAL OF BUS PRIORITY SCHEMES

This section of the strategy must specify the appraisal process for Bus Priority Schemes. This must be to a level sufficient to allow appraisal of the costs (capital and operating) and benefits (for users, non-users and operators over the life of the scheme) to ensure that the

County Council is suitably informed to be able to develop these schemes quickly and cost effectively.

BUS PRIORITY ENFORCEMENT

This section of the strategy must formalise the policing of bus priority schemes. It is recommended that the strategy set out an integrated countywide enforcement scheme, to include Bus Lane Enforcement Cameras (both mobile and static), CCTV and traffic regulation order enforcement officers to monitor use of bus priority installations.

DELIVERY METHODS FOR BUS PRIORITY SCHEMES

This section of the strategy must formalise a delivery process for approved Bus Priority Schemes, including the following elements:

- A formal consultation process (see the Passenger Transport Consultation Strategy Best Practice Report)
- Accessibility requirements (see Passenger Transport Accessibility Strategy Best Practice Report)
- Expected project delivery timescales
- Expected project delivery costs
- Resource requirements

OTHER RECOMMENDATIONS

Bus Stop Lay-bys:
These installations have an adverse impact on bus stop dwell times, overall journey times and service reliability. It is recommended, therefore, that most existing bus lay-bys should be removed as part of the Worcestershire Bus Priority Strategy. They should be replaced where appropriate, with bus stop borders where these support the achievement of the appropriate journey time, reliability and operating speed targets set out for that particular route or transport corridor. There will be isolated cases where retaining bus lay-bys may be required for safety reasons. This should be clarified in the Bus Priority Strategy for Worcestershire.

Selective Vehicle Detection in Worcester
The SCOOT urban traffic management system in Worcester city has the potential to be programmed to provide additional priority for bus services within the city. It is recommended that a review of the city centre bus route system take place, to ascertain how this might be modified to make better use of limited city centre road space to ensure rapid access into and egress from the city centre, including Crowngate Bus Station.

Partnerships
Effective partnerships can support the development, funding and delivery of the bus priority strategy. It is recommended that, where appropriate, the following partnerships are set up to help deliver and fund the Worcestershire Bus priority Strategy:

- Voluntary Quality Partnership (VQP)
- Statutory Quality Partnership (SQP)
- Punctuality Improvement Partnerships (PIPs)

These offer scope for the consolidation of partnership working between residents, operators, Districts and the County Council, to set standards on key corridors to improve bus services and make them more attractive to existing and potential users.

Bus Priority Measures
Best Practice Report
November 2007

Introduction

1. INTRODUCTION

1.1 This report was commissioned as part of the project to develop a Bus Priority Strategy for Worcestershire. It sets out bus priority scheme best practice and draws from examples in the UK and elsewhere. The Bus Priority Strategy will form a vital input to the wider passenger transport infrastructure strategy, and the definition of the Integrated Passenger Transport Strategy.

1.2 Bus Priority is the installation or amendment of dedicated infrastructure to either separate bus movements from general traffic, or to provide buses with higher priority than general traffic along congested sections of the road network, (particularly in urban areas) and to provide priority access to key generators and attractors of travel demand. Bus priority measures are implemented to decrease journey times, increase reliability and reduce the costs of operating a given level of bus service. This has the dual benefit of making travel by bus more attractive (or ideally, the mode of choice).

1.3 The *Methodology* is covered in Section 2. This section includes the research plan that was undertaken to develop this best practice report. The *Examples of Best Practice* provide an overview of the sources of information used in this report, and why these were chosen as examples of best practice.

1.4 *Segregated Bus Priority Measures* are elaborated in Section 4. This section covers the highest tier of bus priority, including both guided and unguided busway variants in operation.

1.5 *On-Line (On-Road) Physical Bus Priority Measures* are provided in Section 5. This section covers the secondary tiers of bus priority, where segregated measures are impossible or inappropriate. This section includes the following elements:

- *Bus Lay-bys*
- *Bus Stop Borders (Build-Outs)*
- *Bus Gates*
- *With-Flow Bus Lanes*
- *Contra-Flow Bus Lanes*
- *Tidal Flow Bus Lanes*
- *Inset On-Street Parking and Parking Restriction*
- *Junction Design*

1.6 *Technological Measures* are covered in Section 6. This section discusses Selective Vehicle Detection, and current advances in technology that can be used to provide a co-ordinated approach to bus priority at traffic signals; either individually or as part of a corridor approach.

1.7 *Other Bus Priority Measures* are covered in Section 7. This section briefly covers other elements of bus priority that will be covered by other sub strategies of the Integrated Passenger Transport Strategy for Worcestershire.

1.8 *Bus Priority Enforcement Measures* are explained in Section 8. This section looks at how bus priority measures can be enforced, including recent advances in technological enforcement options.

1.9 *Appraisal Methods* are detailed in Section 9. This section looks at various methods for appraising the value and benefits delivered through the implementation of bus priority schemes.

1.10 *Partnership Working for Bus Priority* is elaborated in Section 10. This section explores different options for partnership working, which have brought about effective use and development of required bus priority measures.

1.11 The *Recommendations* are given in Section 11. This section details the findings of this report, and suggests items for inclusion in the proposed Bus Priority Strategy.

Bus Priority Measures Best Practice Report
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Methodology

2. METHODOLOGY

2.1 A research plan was generated by the project team, with the aim of identifying the research topics that were considered pertinent to be included within any Bus Priority Strategy for Worcestershire. The research plan was undertaken to advise on best practice under the following headings:

- *SEGREGATED MEASURES – Including guided/unguided busways*
- *ON-LINE (ON-ROAD) PHYSICAL MEASURES – Including with-flow and contra-flow bus lanes, bus gates, bus stop build-outs and half-width lay-bys*
- *TECHNOLOGICAL MEASURES – Including queue relocation, Selective Vehicle Detection (SVD), Parking management, area traffic management, vehicle design and ticketing system design.*
- *ENFORCEMENT MEASURES – Including physical barriers such as rising bollards, enforcement cameras and parking restriction enforcement.*
- *APPRAISAL METHODS FOR BUS PRIORITY MEASURES – Including user and operator benefits, non-user benefits/disbenefits, viability benchmarking and passenger/traffic/journey time benchmarking.*
- *PARTNERSHIP WORKING FOR BUS PRIORITY – including how operators and infrastructure providers can work more closely together to improve bus services on priority routes.*

2.2 A series of Bus Strategies, Local Transport Plans, Case Studies and related documents were collated from a multitude of domestic and international passenger transport authorities. These documents were then scrutinised and relevant information was extracted for analysis.

2.3 Where cited, the term 'best practice' is used to describe excellence in terms of measures which:

- *Have been shown to deliver benefits to bus passengers and operators*
- *Are realistic and deliverable*
- *Can be incorporated within a strategy, which seeks to improve the performance of road based passenger transport.*
- *Define clear parameters, which provide clarity on the standard and quality of passenger transport infrastructure that can be expected from a transport authority.*
- *Detail the criteria by which infrastructure schemes will be assessed to ascertain their value and relevance.*

2.4 Bus Priority is vital to improve the performance, efficiency, cost and image of bus travel across Worcestershire, to encourage modal shift. Slow and unreliable bus services have a significant adverse impact on bus network performance in terms of:

- *The number of vehicles and crew required to operate bus services.*
- *The costs of operating the bus network (as vehicle and crew requirements are the main determinants of operating costs)*
- *The attractiveness of the services to potential passengers (particularly those who have a choice of modes) with a knock-on effect on:*
    1. *Farebox (ticket) revenue*
    2. *The level of financial support required to maintain and ultimately improve the bus network*

2.5 Conversely, effective and systematic measures protecting buses from the effects of traffic congestion will have a beneficial impact on journey times, service reliability, passenger demand, revenue and the level of subsidy required to deliver a high quality passenger transport network. Decreasing journey time variability through priority measures:

- *Enables timetables to be constructed with greater certainty*
- *Reduces the need to provide additional time to allow for out of course delays, thereby reducing vehicle and crew requirements and costs*
- *Reduces the need to have differential journey times between peak and off-peak periods*
- *Enables more easily understood and simple timetables to be developed*
- *Enables users to place greater reliance on the achievement of advertised journey times, increasing confidence in the dependability of the service*

If Worcestershire is to attract major operators for effective competition in the deregulated open market, investment in bus priority and other bus related infrastructure will be key. Systematic priority measures which are designed to improve the operational performance and attractiveness (to users) of the bus network will help to emphasise the county's commitment to enhancing road-based passenger transport and will be an important element in attracting additional bus operators to set up business in the county.

2.6 Examples of Best Practice

2.6.1 Best practice for bus priority measures in the United Kingdom has been sourced from documentation supplied by the highest-ranking transport authorities as measured by the Best Value Performance Indicators (BVPI).

> *"Best Value Performance Indicators (BVPIs) are gathered and submitted by the [national] Government as part of a national set of performance measures for the range of local government services. There are currently 94 BVPIs that have to be included in Best Value Performance Plans, providing the public and local and central government with a means of monitoring, analysing and comparing the achievements of local authorities.[1]"*

The Best Value Performance Indicators that have been used to identify passenger transport best practice in this report are as follows:

- **BV104** – Satisfaction with local bus services
- **E15 CPA Indicator** – Satisfaction with local bus services (users last 12 months)

2.6.2 There is a vast array of other successful bus priority systems, ranging from bus lanes over small sections of a given route, through to extensive bus priority schemes (often referred to a Bus Rapid Transit) worldwide. The Bus Rapid Transit (BRT) concept has been embraced particularly fervently in the Americas, with many of the major conurbations across the continent showcasing examples.

2.6.3 A series of examples of Best Practice have been included in this report (these are provided in Table 2.1), although a great many more were studied. The full list of research documents is provided in Appendix A.

[1] http://www.idea.gov.uk/idk/core/page.do?pageId=1089961

Table 2.1 – Examples of Best Practice Featured in This Report

AUTHOR / ORGANISATION	EXAMPLE / DOCUMENT
Department for Transport, UK	Bus Priority – The Way Ahead
Transport for London, UK	Bus Pre-Signals Selective Vehicle Detection Traffic Calming Measures for Bus Routes Keeping London Moving
Cidade de Curitiba, Brazil	Rede Integrada de Transporte
Worcestershire County Council, UK	The Matchborough Circular
Halton Borough Council, UK	The Runcorn and Halton Busways
City of Adelaide Metro, Australia	The O-Bahn
West Yorkshire Metro, UK	Scott Hall Road and York Road Guided Busways
Department of Transportation, USA	Characteristics of Bus Rapid Transit for Decision Making

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Segregated Bus Measures
Bus Rapid Transit

3. SEGREGATED MEASURES / BUS RAPID TRANSIT

3.1 Segregated bus priority measures offer the highest possible level of bus priority. Where segregated measures have been provided, buses can offer a premium quality ‘tram-like’ service, bypassing congested urban arterial routes used by general traffic, using dedicated and separate (segregated) busways. The busways provide virtually delay free and reliable point-to-point journey times combining operating, system and physical elements into a permanently integrated system with a strong image and identity.

3.2 It is generally recognised that the most successful bus systems worldwide employ extensive use of segregated bus priority measures. Essentially, segregated measures involve separating the bus service from general traffic on dedicated busways (bus only roads), which have the following core benefits:

- *Excellent reliability*
- *High operating speeds*
- *Short dwell times at bus stops/stations (step free access/egress)*
- *Dramatically reduced journey times*

3.3 These benefits ensure that full-scale BRT services enjoy significant patronage increases, which improve passenger transport demand and mode shares and the financial performance of the network. Segregated busways can also be used to meet the needs of ‘express’ and ‘stopping’ services through the use of bus stop lay-bys which allow higher speed (express) buses to share the same busway as lower speed (local/stopping) buses. Segregated systems can also allow individual bus services to provide both the “feeder” and “main line” (BRT) sections of a service, thereby delivering the benefits of Bus Rapid Transit to much wider catchments at a lower infrastructure cost than for light rail systems.

3.4 Segregated bus priority measures can either be guided or unguided. These are explained below. A key advantage of segregated guided and unguided busways is their potential for modal upgrade. For example, once a segregated permanent way has been created, it is relatively inexpensive to upgrade the corridor to run trolley buses or trams, should corridor patronage warrant this.

3.5 Unguided Busways

3.5.1 Unguided busways are segregated bus-only roads which usually form part of a BRT network. The vehicle is steered as normal by the driver along the length of the segregated busway.

3.5.2 The following examples of unguided busways have been selected to represent best practice, as they represent design excellence in terms of both modal shift and passenger growth:

- **Rede Integrade de Transporte** – Curitiba, Paraná, Brazil
- **The Matchborough Circular** – Redditch, Worcestershire
- **The Runcorn and Halton Busways** - Runcorn, Cheshire

3.6 Rede Integrada de Transporte - Curitiba, Paraná, Brazil

3.6.1 One of the oldest and most successful BRT schemes worldwide is that of Curitiba in the Paraná Region of Brazil. The Curitiba BRT system is created from a network of segregated, unguided busways, with limited stops and step free access:

> *"Each of the five arteries contains one two-way lane devoted exclusively to express buses. This inner lane is flanked on either side by 1) a local access lane for cars and 2) a high-capacity one-way route for use by both cars and buses. Separating traffic types and establishing exclusive bus lanes on the city's predominant arteries helped to mould two defining characteristics of the city's transport system: a safe, reliable, and efficient bus service operating without the hazards and delays inherent to mixed-traffic bus service; and densification of development along the bus routes.[2]"*

3.6.2 Car ownership in Curitiba is the second highest in Brazil, with one car for every three people. This is substantially lower than the car access figure in Worcester, for example, where there are currently three cars to every four residents. The provision of an efficient and effective BRT network supported by segregated busways helps to provide a realistic alternative to car use.

3.6.3 The development of the 'Rede Integrade de Transporte' has heavily influenced city development control, with all major developments planned around the network, to encourage modal shift.

3.6.4 Figures 3.1 and 3.2 show a street in Curitiba adapted for use by the city's BRT system, and an example of a bus stop located on a segregated busway.

Figures 3.1 & 3.2 – BRT in Curitiba, Paraná, Brazil

[2] http://www.dismantle.org/curitiba.htm

The 'Rede Integrada de Transporte" has been an outstanding success, delivering the following benefits:

- 85% of the urban population of Curitiba use the network
- A 60% share of motorised journeys in the urban area
- Some corridors are now being considered for modal upgrade to trams to cater for demand growth.
- High average speed (20kph) across the network (inclusive of dwell times).
- Iconic 'tube' stations which provide:
    - Step free access
    - Pre-purchased ticketing
    - Optimised journey times

3.7 The Matchborough Circular - Redditch, Worcestershire

3.7.1 The Redditch segregated busway in Worcestershire is a very good UK example of the use of this type of bus infrastructure. The route was purpose built as part of the Redditch new-town development in the 1960s, and connects Redditch Town Centre with the Alexandra Hospital, passing through the centre of the suburban districts of Church Hill, Winyates, Matchborough, Greenlands and Lodge Park.

3.7.2 The route operates along a 5-mile stretch of segregated busway at an average speed (inclusive of dwell times) of approximately 30kph. Bus services operate a combined frequency of 10 buses per hour in each direction, with the result that the route is, arguably, the best performing urban bus service in Worcestershire. The Matchborough Circular route has achieved high bus mode shares:

- Matchborough <-> Redditch Centre 28%
- Greenlands <-> Redditch Centre 20%

This compares well to comparable local conurbations:

- Kidderminster 3.2%
- Worcester 5.6%

3.7.3 The success of this busway is largely due to the planning policies in place in Redditch, where residential areas were planned to be no further than 500 metres away from the busway, thus ensuring that residents were within a short walk of bus services.

3.7.4 Unfortunately, a similar busway was not constructed for the west of the borough. This has reinforced the disparity between bus usage and mode shares between the East and West of the Borough.

3.7.5 A map showing the route of the Matchborough Circular is shown in Figure 3.3. Blue shaded parts of the route denote traffic free busways.

Figure 3.3 - The route of the Matchborough Circular, Redditch

The Matchborough Circular has delivered the following benefits:

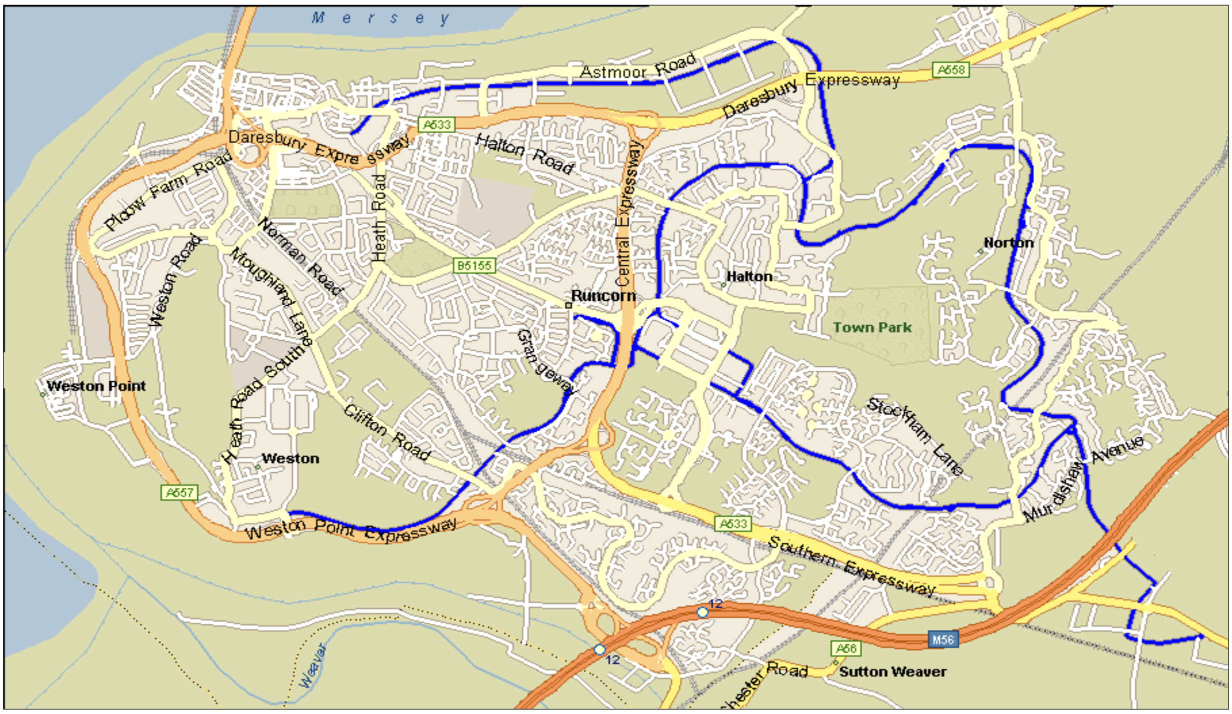
- 28% motorised mode share
- All residential developments within a 500 metre walk of the busway
- High average speed (30kph) across the network (inclusive of dwell times).
- A commercially operated daytime bus network requiring no financial support from Worcestershire County Council.
- Competition between commercial bus operators, driving up service frequencies up to 16 buses per hour (a bus every 3-4 minutes)
- Direct and reliable access from residential areas to:
    - Alexandra Hospital
    - Kingfisher Shopping Centre
    - Redditch Town Centre
    - Rail Station
    - Schools and Further Education Establishments

3.8 **The Runcorn and Halton Busways, Runcorn, Cheshire**

3.8.1 The busways in Runcorn and Halton, Cheshire were constructed as one of the first complete Bus Rapid Transit systems across an urban area in the United Kingdom. The system is constructed as a 12-mile long figure of eight, with residential areas located within a 500-metre walk of a bus stop on the busway (the bus stops are evenly spaced along the route to ensure maximum pedestrian accessibility to the network). The system opened in 1971, and links residential areas, education establishments, the railway station and the Shopping City retail centre.

3.8.2 The Runcorn and Halton busways were designed to allow 65 kph running speeds, and to deliver a 50:50 motorised mode share between car and bus across the town. In reality, the mode shares realised were closer to 30% (similar to the Redditch busway). A map showing the Runcorn and Halton Busway network is shown in Figure 3.4. Blue shaded parts of the route denote traffic free busways.

Figure 3.4 – Map showing extent and design of Runcorn BRT system



The Runcorn and Halton Busways have delivered the following benefits:

- Up to 30% motorised mode share
- All residential developments within a 500 metre walk of the busway
- Maximum operating speed of 65kph across the network
- Direct and reliable access from residential areas to:
    - Shopping City Retail Centre
    - Rail Station
    - Runcorn Town Centre
    - Schools and Further Education Establishments

3.9 Guided Busways

3.9.1 Guided busways are segregated bus-only roads, but where the buses are guided automatically using a guidance system. The driver is responsible for braking, accelerating, controlling the bus doors and sometimes ticket issuing. On the majority of systems, once off the guideway, the driver operators the bus as normal. There are a range of guidance technologies, including:

- Rail Guidance
- Kerb Guidance (fitted with special guide wheels)
- Optical Guidance using Geographic Positioning Systems (GPS)

Rail Guided Busways

3.9.2 There is some debate as to whether rail guided buses are, in fact, a guided bus or a tram. For the purposes of this report, a tram is defined as a vehicle that is continuously rail guided, but can operate both on segregated alignments (as for heavy rail [train] systems) and also on road in general traffic (where a train cannot). Where a rail-guided bus is able to “disconnect” from the rail guidance system and operate as a conventional (manually steered) vehicle off the guideway system it is considered to be a guided bus system. However, where the bus cannot be manually steered off the guideway it should be considered as being a rubber tyred tram.

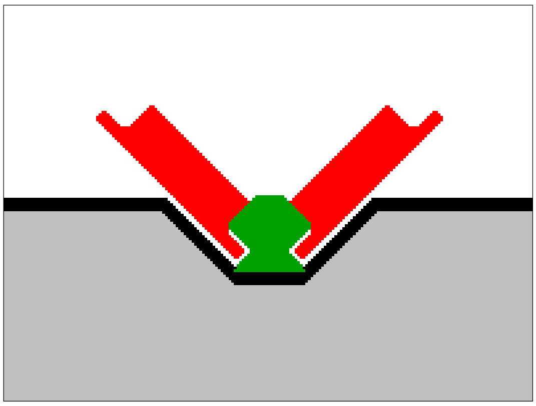
3.9.3 There are two rail guided bus systems currently in everyday operation. These are:

- The Translohr System (permanently guided, therefore considered to be a rubber tyred tram)
- The Bombardier Guided Light Transit (GLT) System (can be manually steered off the guideway, therefore considered to be a guided bus)

Translohr Rail Guided Bus System

3.9.4 The Translohr system has been adopted for use in Clermont Ferrand in France, Tianjin in China, and Padua and Venezia in Italy. The system is guided by a special rail that is grasped by a pair of vehicle-mounted metal guide wheels set at 45˚to the road and 90˚of each other. The weight of the vehicle is supported on rubber tyres on bogies, to which the guide wheels are attached. Power is supplied by overhead lines, or by rechargeable batteries in areas where there are no overhead pantographs. The Translohr system is intended for guidance only operation, hence the vehicles are not fitted with licence plates, and are not regarded as buses. An example of the Translohr guide wheel arrangement is shown in Figure 3.5.

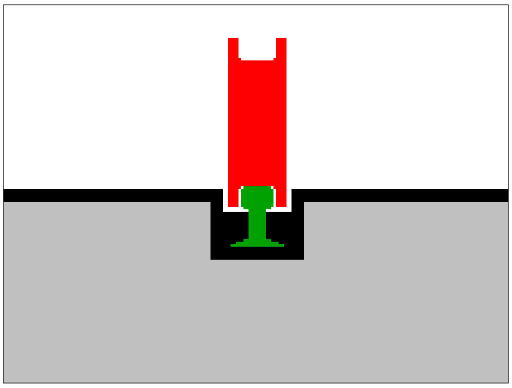
Figure 3.5 - Translohr Guide Wheel Configuration



Bombardier GLT Rail Guided Bus System

3.9.5 The Bombardier GLT System is in use in Nancy and Caen in France. These vehicles, as they are able to leave the rails and operate independently, are considered as buses, and so are required to have rear view mirrors, lights and number plates. Bombardier GLT vehicles have a steering wheel, though this is not used when the vehicle is using a guide rail. Figure 3.6 shows the Bombardier GLT guide wheel arrangement.

Figure 3.6 - Bombardier GLT Guide Wheel Arrangement



3.9.6 Both systems offer a tram-like experience, although such systems offer some advantages over trams including:

- Potentially smaller turning radii
- Simpler infrastructure installation than trams
- Ability to climb steeper gradients than trams (up to 13%)
- Quieter system than trams

However, the Bombardier GLT system has encountered significant technical difficulties in Nancy with derailments, where the guidance system has become detached from the guide rail and the vehicle becomes 'stranded'.

Kerb Guided Busways

The Adelaide O-Bahn, Adelaide, South Australia

3.9.7 The Adelaide O-Bahn in South Australia is the world's fastest busway, with a design operating speed of 65mph. The Adelaide O-Bahn system is a 12km (8 miles) long segregated, kerb-guided busway with three stations/interchanges between the terminus and Adelaide central business district. The system was constructed in the mid-1980s to provide a rapid transport service for the burgeoning northeastern suburbs, replacing an earlier plan for a tramway extension. The design of the Adelaide O-Bahn is pioneering and unique, in that the O-Bahn runs on a specifically designed track, which combines elements of both bus and rail systems.

3.9.8 The fleet used on the Adelaide O-Bahn are fitted with ABS brakes (which can bring a bus to a complete standstill from its normal operating speed within two bus lengths) and guide wheels, which are connected directly to the steering mechanisms of the buses. The guide wheels prevent the tyres from rubbing against the kerbs, which have been fitted along the length of the track. The wheels on the O-Bahn bus fleet are fitted with aluminium inner wheels, so that if a bus tyre bursts during operation, the guide wheel prevents the bus from erratic movement, and the inner wheel allows the bus to be driven to the nearest 'station' at a speed of approximately 40kph (25mph).

3.9.9 Apart from the final stretch through the Central Business District, the Adelaide O-Bahn system is entirely separate from the road network. There are only three stations/interchanges along the entire length of the route, roughly spaced 3-4 kilometres apart. The spacing of these 'stations' is vital, as it ensures excellent journey times and travelling speeds (up to 100kph) between the suburbs and the Central Business District.

3.9.10 As an enforcement measure, the Adelaide O-Bahn track is fitted with "sump buster" devices. This rips out a car's sump (oil pan) if the car enters the O-Bahn track at any one of the interchanges, ensuring that the track is traffic free.[3] A section of the O-Bahn is shown in Figure 3.7.

[3] http://www.adelaidemetro.com.au/guides/obahn.html

Figure 3.7 – The Adelaide O-Bahn passes along the Torrens Valley.

The Adelaide O-Bahn system:

…is 12 kilometres long, making it the longest and fastest guided bus service in the world, travelling at speeds up to 100km/h.

…carries more than 7 million passengers a year, including local, interstate and overseas visitors.

…is capable of moving 18,000 people an hour in each direction.

… when compared with equivalent rail systems, has proved to be almost 50 per cent cheaper to operate while providing a faster, more flexible service.

… cost $98 million (£49 million) to build, inclusive of the bus fleet.

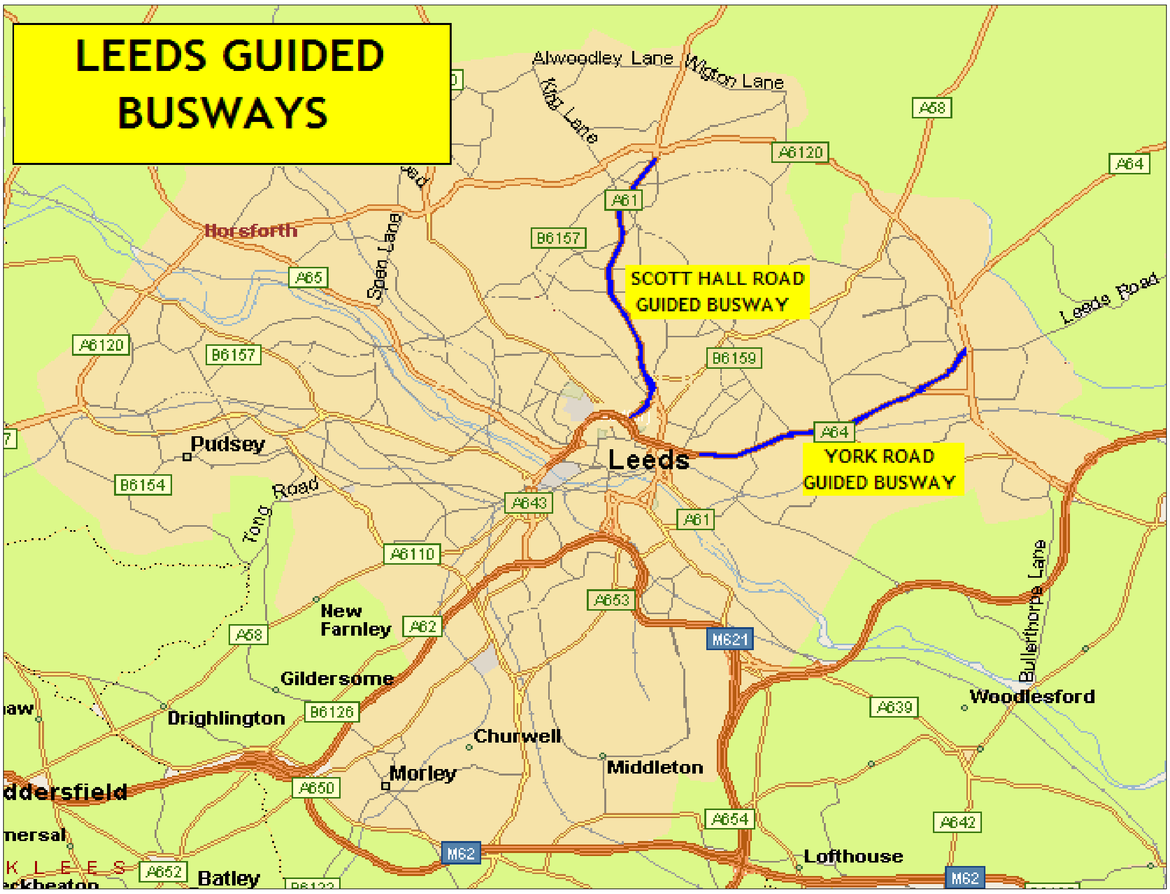
…connects previously remote north eastern residential suburbs of Adelaide with the facilities of the central business district. Promoting sustainable travel across the urban area.

Scott Hall Road / York Road Guided Busways, Leeds, West Yorkshire

3.9.11 The Scott Hall Road and York Road kerb guided busways in Leeds together form one of two schemes implemented by Metro West Yorkshire (the other was on Manchester Road in Bradford). The two busways were delivered as a partnership between Leeds City Council, Metro, First Group plc and Arriva Group plc. At the time of construction, the route was unique, in that the guided busway was actually installed on the highway, (either in the median of dual carriageways or alongside an existing carriageway) to maximise the accessibility and the benefits of the installation.

3.9.12 A map showing the location of the busways is provided in Figure 3.8.

Figure 3.8 - Map of Leeds Showing Guided Busway Corridors



3.9.13 Figures 3.9 and 3.10 illustrate two sections of the Leeds Guided Busways. Figure 3.9 illustrates a section of guided busway located alongside the existing carriageway, whilst Figure 3.10 shows a section of busway located in the median (centre section) of a dual carriageway. The 20 mph sign in Figure 3.10 is imposed because of the bus 'station' beyond. The normal operating speed along the route is 40 mph. In both cases the segregated busways enable buses to overtake general traffic and bypass traffic queues during the congested peak periods. This has the added benefit that car drivers can clearly see the bus 'overtaking' the general traffic flow, enabling the guided busway technology to help sell the benefits of the system to people travelling along the corridor.

Figure 3.9 – Guided Busways, Leeds, West Yorkshire

Figure 3.10 – Guided Busways, Leeds, West Yorkshire

The Scott Hall Road and York Road busways in Leeds have delivered the following benefits:

- 70% increase in patronage over 5 years.
- Buses travel along the corridor significantly faster (11 minutes at peak times and 6 minutes off-peak) than general traffic.
- Excellent quality infrastructure, and location alongside the highway ensure that the service 'markets itself'. Encouraging modal shift by example.
- Level boarding at bus stops, improving access and reducing bus stop dwell times
- Significant reliability benefits for bus users and operators.
- Improved quality of ride due to guidance system.

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On-line (On-road) Physical Measures

4 ON-LINE (ON-ROAD) PHYSICAL MEASURES

4.1 Introduction

4.1.1 On-Line (or on-road) physical measures are generally used in lieu of segregated measures, where full scale BRT would either be too expensive in comparison with the benefits, or impractical due to planning constraints. On-line physical measures are particularly popular in the UK, since many cities have narrow, ancient street patterns and layouts in town centres as a legacy of disjointed, and in some cases non-existent historic town planning policies.

4.1.2 A major use of on-line physical measures is to break the hegemony of the car in central business districts, by giving priority, or in some cases exclusive access to passenger transport and in many cases, cyclists. Some key examples of on-line physical measures are:

- *Removal of bus stop lay-bys*
- *Bus Stop Borders (Build-outs)*
- *Bus Gates*
- *With-Flow and Tidal-Flow Bus Lanes*
- *Contra-Flow Bus Lanes*
- *Parking Management and Inset On-Street Parking*
- *Junction Design*

4.1.3 On-line (on-road) physical measures can be applied in part along corridors, or as part of a larger package of systematic corridor-length bus priority measures. Best practice shows that the greatest benefits are achieved where improvements are considered as part of a complete corridor approach, as this usually maximises journey time, reliability, demand, revenue and operating cost benefits.

4.1.4 Transport for London are recognised as being the UK leaders in best practice for On-Line Bus Priority measures. There are a number of reasons for this:

- *Finance – With the implementation of the Central London Congestion Charge, all revenues from this charge have to be spent on passenger transport and related highway infrastructure, as a result of revenue hypothecation. Hence, London has extensive funding to experiment and improve with various bus priority measures.*

- *Rail Capacity Constraints – The London Underground Rail (Tube) Network is under intense pressure at peak times. By improving bus services, this has taken pressure away from this network and encouraged modal shift.*

- *Regulated Bus Network – London was the only place in the UK where the bus network continued to be regulated, as a result, services can be routed to make excellent use of bus priority installations as they are installed, thereby maximising the benefits.*

4.1.5 As a result of these factors, Transport for London has embraced on-line physical measures with fervour, since many of the city's ancient thoroughfares are too narrow to permit full-scale BRT schemes. The Transport for London (TfL) bus priority team have published a number of best practise documents, based on their experiences of successful implementation of on-line physical measures to improve bus journey times and reliability. This documentation serves as a series of excellent reference documents for the design, implementation and operation of bus priority, and so has been used extensively to identify best practice in this report.

4.1.6 In addition, Transport for London's "Accessible Bus Stop Design Guidance" technical advice note covers all aspects of successful bus stop design, to minimise journey times, improve safety and standards, and to make the bus an attractive alternative to car use.

4.2 Removal of Bus Lay-bys

4.2.1 A feature of many bus stops in the UK built between 1950 and 1980 is that they were situated in specially created bus lay-bys, so as not to disrupt the flow of traffic. Indeed, there are a great number of bus stop lay-bys in Worcestershire, particularly in the northern commuter towns of Kidderminster, Bromsgrove, Redditch. However, with the growth in traffic volumes and vehicle speeds as a result of higher performance vehicles, this has an adverse impact on bus journey times and reliability, as buses are required to wait longer to re-join the traffic flow. A solution to this problem is the process of either fully in-filling or part in-filling these bus lay-bys. The relocation of bus stops at the side of the highway ensures optimum priority for the bus over general traffic.

4.2.2 Recent research undertaken by Transport for London has shown that the following advantages can be realised by in-filling bus lay-bys and replacing then with kerbside stops:

- *Make it easier for the bus to stop adjacent to the kerb;*
- *Make it easier and quicker for passengers to board/alight; and*
- *Reduce delays to buses by between 2 and 4 seconds per bus (on average).*[4]

4.2.3 The Transport for London document makes specific reference to the non-desirability of bus lay-bys:

> *"Bus bays (or lay-bys) present inherent operational problems for buses and they should not be used, unless there are compelling safety or capacity reasons."* [5]

4.3 Bus Stop Borders or Build-Outs

4.3.1 Bus stop borders (sometimes referred to as 'build-outs') are used primarily on roads and residential streets where on-street parking prevents buses from stopping close enough to the kerb to ensure accessibility for mobility-impaired passengers. Being unable to stop adjacent to the kerb also increases boarding and alighting times for all passengers and increases journey times and adversely impacts on reliability.

[4] Pg 34, http://www.tfl.gov.uk/assets/downloads/businessandpartners/accessibile_bus_stop_design_guidance.pdf

[5] Pg 34, http://www.tfl.gov.uk/assets/downloads/businessandpartners/accessibile_bus_stop_design_guidance.pdf

4.3.2 A bus stop border effectively 'builds out' the kerb, so that the bus stop is relocated within the traffic flow. This ensures that on-street parking is unaffected, whilst providing optimum accessibility to the bus stop for passengers and vehicles, and minimising bus dwell times.

4.3.3 There are numerous advantages that can be achieved where bus stop borders are implemented:

- *Minimises the kerbside space required;*
- *Deters illegal parking;*
- *Maintains the place of the bus in the traffic stream;*
- *Allows the bus to line up parallel to the kerb, largely without time consuming manoeuvres;*
- *Reduces boarding/alighting time;*
- *Reduces overall time spent at the bus stop; and*
- *Creates additional footway space for passengers to wait.*[6]

4.3.4 Figure 4.1 provides an example of Bus Stop construction best practice in London.

Figure 4.1 – Bus Stop Border (Build-Out) in London

4.4 Bus Gates

4.4.1 Bus gates, and bus only links, are short lengths of carriageway reserved exclusively for buses (and sometimes cyclists and taxis), to allow buses to maintain or provide passengers with access to key locations and facilities. They are used to keep unwanted traffic out of an area whilst allowing the operation of a bus service on a

[6] Pg 31, http://www.tfl.gov.uk/assets/downloads/businessandpartners/accessibile_bus_stop_design_guidance.pdf

direct route that is attractive to passengers.[7] A Traffic Regulation Order is required for the installation of a bus gate.

4.4.2 An example of a taxi using a bus gate in Cambridge is shown in Figure 4.2. The taxi has been fitted with a transponder, which activates the rising bollard. Not all bus gates are enforced using a physical barrier such as that shown in Figure 4.2. Traffic signals can be used, as shown in Figure 4.3, which shows an example in Worcester. However, effective enforcement of bus gates is imperative to enable them to deliver their benefits.

Figure 4.2 – Taxi Using Bus Gate With Rising Bollard in Cambridge

Figure 4.3 – Bus Using a Traffic Signal Controlled Bus Gate on Droitwich Road, Worcester

[7] Pg 107, http://www.dft.gov.uk/pgr/regional/buses/bpf/busprioritythewayahead12/busprioritythewayaheadpdfversion

4.3.5 Bus gates are also suited for use on heavily congested arterial routes, difficult junctions, and town centre 'rat runs', where buses are required to use these routes to access key services. Bus gates can be used:

- As part of priority measures to enable buses to bypass traffic queues
- To enable buses to bypass otherwise congested parts of the network
- To maintain / improve passenger transport access to key locations and facilities.

4.3.6 Bus gates are particularly effective at providing access to residential areas and industrial estates, whilst preventing the route becoming a rat run for general traffic. Bus gates may prove highly effective in Worcester city in particular, as they will help to compensate for space limitations on the medieval streets in the city's highly compact central business district.

4.3.7 Unfortunately, bus gates are often subject to violation, and so it is often necessary to implement other measures to reduce the attractiveness of the route to general traffic. Options for enforcement include:

- Installing rising barriers or bollards, which are activated by on-bus transponders (see Section 7)
- Installing sump busters, which cause major damage to non-permitted vehicles (self enforcing) (See Figure 4.4.)
- Narrowing the carriageway to the minimum required for bus operation
- Using different coloured surface treatments,
- Installing enforcement cameras, and/or
- Installing extensive traffic calming measures

4.3.8 Figure 4.4 shows a sump buster installed on a busway to discourage use by general traffic.

Figure 4.4 – A Sump Buster Installed on a Busway in Ipswich

4.4 With-Flow and Tidal-Flow Bus Lanes

4.4.1 With-flow bus lanes have a variety of uses in heavily congested sections of bus routes. In particular, with-flow bus lanes are particularly suited for implementation on arterial routes into city centres, in that they ensure the following benefits:

- Cheaper to implement than segregated measures where there is limited roadspace and/or land availability
- Faster and more reliable bus journey times than cars on the same route
- Encourage modal shift by projecting an attractive image to potential bus users

With-flow bus lanes are generally available for use exclusively by cyclists, buses and hackney cabs. An example of a working with-flow bus lane is shown in Figure 4.5.

Figure 4.5 – With-flow bus lane in operation in Glasgow

4.4.2 Similarly to bus gates, bus lanes are often subject to violation by general traffic. Problems include:

- Bus lane use by other permitted vehicles (e.g. cycles, hackney cabs, community transport and tour buses)
- Bus lane use by non-permitted vehicles (e.g. private hire taxis, minicabs, cars, HGVs)
- Illegal parking and waiting

4.4.3 Bus lane use by other permitted vehicles can sometimes cause problems for buses using bus lanes. In particular, private hire taxis and minicabs can abstract from bus patronage by picking up and setting down illegally in the bus lane. This can also cause delays to existing bus services, and encourage use by other cars.

4.4.4 Best practice suggests that neither Hackney cabs, nor private hire taxis should be permitted to use bus lanes whilst the lane is in use by bus services. Emergency service vehicles are not technically permitted to use bus lanes, however, this has never been enforced, and particularly in the case of Worcester, it would be highly distasteful to the general public for the Bus Priority Strategy to recommend otherwise. Best practice taken from Transport for London guidelines allow the following to use bus lanes, in addition to statutory permitted vehicles:

- *On-duty police and other emergency services*
- *Royal mail vehicles making collections or deliveries*
- *Refuse vehicles making collections*[8]

4.4.5 Traditionally, cyclists have shared bus lanes, however, this can cause buses to slow when following cyclists. As a result, where space has allowed, some authorities have provided either a separate cycle lane or dual use footpath, to increase cyclist safety and maintain the effectiveness of the bus lane.

4.4.6 Tidal-Flow Bus Lanes have been implemented on some capacity constrained corridors, where limited road space means that it is only possible to implement a single bus lane, often located in the centre of the carriageway. The direction of flow changes according to the time of day, to afford highest priority to peak movements. For example, a tidal flow bus lane will provide bus priority for buses entering a central business district in the morning peak, and similarly for buses leaving the central business district in the afternoon peak.

4.4.7 There are very few examples of tidal-flow bus lanes in the UK, as there are difficulties in enforcing these installations. However, in cases of severe capacity constraints and limited roadspace, tidal-flow bus lanes provide an alternative to with-flow bus lanes as a means of providing priority measures in both directions in response to tidal (peak period) traffic congestion. In Worcestershire, the Barbourne Road Corridor is a prime example of a location where a tidal-flow bus lane could bring significant benefits, subject to meeting safety and signage requirements.

4.5 Contra-flow bus lanes

4.5.1 Contra-flow bus lanes are almost identical to with-flow bus lanes in their construction and use, with the key exception that the bus lane flows in the opposite direction to regular traffic. Contra-flow bus lanes are used to make use of existing one-way routes to provide direct access for buses to key services and facilities. A contra-flow bus lane requires a traffic regulation order to be installed. Figure 4.6 shows a good working example of a contra-flow bus lane along Foregate Street in Worcester City.

[8] http://www.tfl.gov.uk/assets/downloads/trafenf-TR050788-Say-Cheese.pdf

Figure 4.6 – Contra Flow Bus Lane in Worcester City

4.6 Parking Management & Inset On-Street Parking Bays

4.6.1 Illegal parking, waiting, and bus lane use by non-permitted vehicles has a negative impact on the effectiveness of a bus lane to reduce bus journey times and improve service reliability. Where on-street parking needs to be retained (for deliveries, or in areas where heritage housing does not provide for parking), inset-parking bays can be provided. These bays are constructed so as to be separate to the bus lane, and thus do not interfere (when properly enforced) with bus lane operations, allowing community functions and the bus lane to co-exist. An example of an inset-parking bay is provided in Figure 4.7.

Figure 4.7 – Inset Parking Bay in Bus Lane, Barbourne Road, Worcester

4.6.2 As inset parking often experiences high demand, many authorities where this has been used have implemented demand management by means of a residents/users permit or time restricted parking. In London, Bus Lane Enforcement cameras have been used, to police illegal parking, waiting and improper use of inset parking bays. Elements of parking management are covered extensively in the Traffic and Parking Management Strategy.

4.7 Junction Design

4.7.1 Often, it is possible to redesign junctions to afford higher bus priority. There are number of examples of best practice in junction redesign, and these are covered extensively in the Traffic and Parking Management Strategy.

On-line (on-road) physical measures, when applied as part of a systematic corridor-led approach, can deliver the following benefits:

- Reduced journey times along congested routes
- Improved safety for passengers and operators
- Significant reliability benefits for bus users and operators
- Smoother journey experience due to reduced congestion
- Reduced operating costs
- Increased demand and revenue (due to journey time and reliability improvements)
- More commercially viable and financially sustainable bus network

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Technological Measures

5 TECHNOLOGICAL MEASURES

5.1 Technological measures are, in essence, the use of technology to provide new or additional bus priority on transport corridors. Normally, this is undertaken through enhanced signal control systems.

5.2 There have been a series of technological advances in bus priority recently, which can often be used in conjunction with physical bus priority measures to provide systematic and corridor length priority for buses, which enhance bus network performance in congested areas.

5.3 New technologies, such as Selective Vehicle Detection at traffic signals, and SCOOT (traffic management across a network of linked sets of traffic signals) can bring about a series of benefits:

- *Reduced travel times*
- *Increased reliability*
- *Increased service frequencies with the same number of vehicles*
- *Operational savings*[9]

5.4 Where isolated junctions are mentioned in this report, this refers to signal sets, which have no communicative links with other signal sets, and therefore only manage traffic flows over a relatively small geographic area. Linked traffic signal sets can cover much larger geographic areas, and can be used collectively to manage traffic across a much wider area.

5.5 Selective Vehicle Detection at Individual Traffic Signal Sets (Microprocessor Optimised Vehicle Actuation)

5.5.1 Selective Vehicle Detection at individual signal sets is used to afford buses priority access to the junction stop line on highly congested routes. This affords buses higher priority over lower priority traffic.

5.5.2 Selective Vehicle Detection at Individual Signals is often used in conjunction with bus gates (known as pre-signals), so that when a previously detected bus pulls up to the signal controlled bus gate, regular traffic is halted, allowing the bus to take a place at the front of the traffic queue, giving bus services full priority over other vehicles. Alternatively, if a particular traffic queue has a bus waiting within it, the queue will be afforded temporary priority over all other queues approaching the junction.

5.5.3 Pre-signals with Selective Vehicle Detection can provide significant benefits:

> *"With-flow bus lanes often terminate upstream of signal controlled junctions, providing a setback area for use by all traffic, designed to minimise any loss in junction capacity. Pre-signals are a new form of control, designed to reduce queuing delay for buses, by installing traffic signals at or near the end of the bus lane to provide buses with priority access to the junction. Signals apply to non-priority traffic and may also apply to buses, according to the design. Other designs which are termed "pre-signals" include*

[9] Pg 2, http://www.tfl.gov.uk/assets/downloads/businessandpartners/svd-brochure-2006.pdf

(i) layouts where the bus lane extends to the main stop line and buses are given an early signal start, (ii) pre-signals at upstream junctions (e.g. bus-only entries) and (iii) pre-signals at roundabout entries."[10]

5.5.4 Selective Vehicle Detection works by fitting vehicles with transponders (sometimes referred to as 'tags') which are sensed by either roadside beacons, or loops fitted in the highway on the run up to signals.

5.5.5 A feature of Selective Vehicle Detection is that it can be adjusted to take into account variable operational issues, in that it can differentiate between various types of services. Feeder services, for example can be given lower priority than core/express routes, with limited stops. Transport for London have used SVD measures extensively, and have reported an impressive 38% increase in bus patronage since 1999, which has been attributed largely to the implementation of SVD along with other complimentary bus priority measures. [11]

5.5.6 Selective Vehicle Detection is cheap to implement, and highly successful:

"SVD installations offer extremely good value for money and typically pay for themselves in less than 18 months. Since the inception of SVD, overall bus delays have reduced by approximately one third at the SVD signal priority installations within London."[12]

5.6 Selective Vehicle Detection at Multiple Signal Sets – SCOOT, SPRINT & IBUS

5.6.1 SCOOT, SPRINT and iBUS are three examples of traffic signal control techniques across a network of linked signal installations that can be used to provide bus priority.

SCOOT

5.6.2 SCOOT (Split Cycle and Offset Optimisation Technique) queue relocation is a traffic management tool that limits and manages traffic volumes across a concentrated controlled road network. The SCOOT system controls traffic flow by managing traffic signal wait times across the controlled road network area to minimise overall delays to road users.

5.6.3 The SCOOT system makes the best use of limited road infrastructure, and maximises the capacity of urban road networks. A SCOOT system has been in place in Worcester since the autumn of 1984, although the system was recently upgraded to a newer version that permits bus priority.

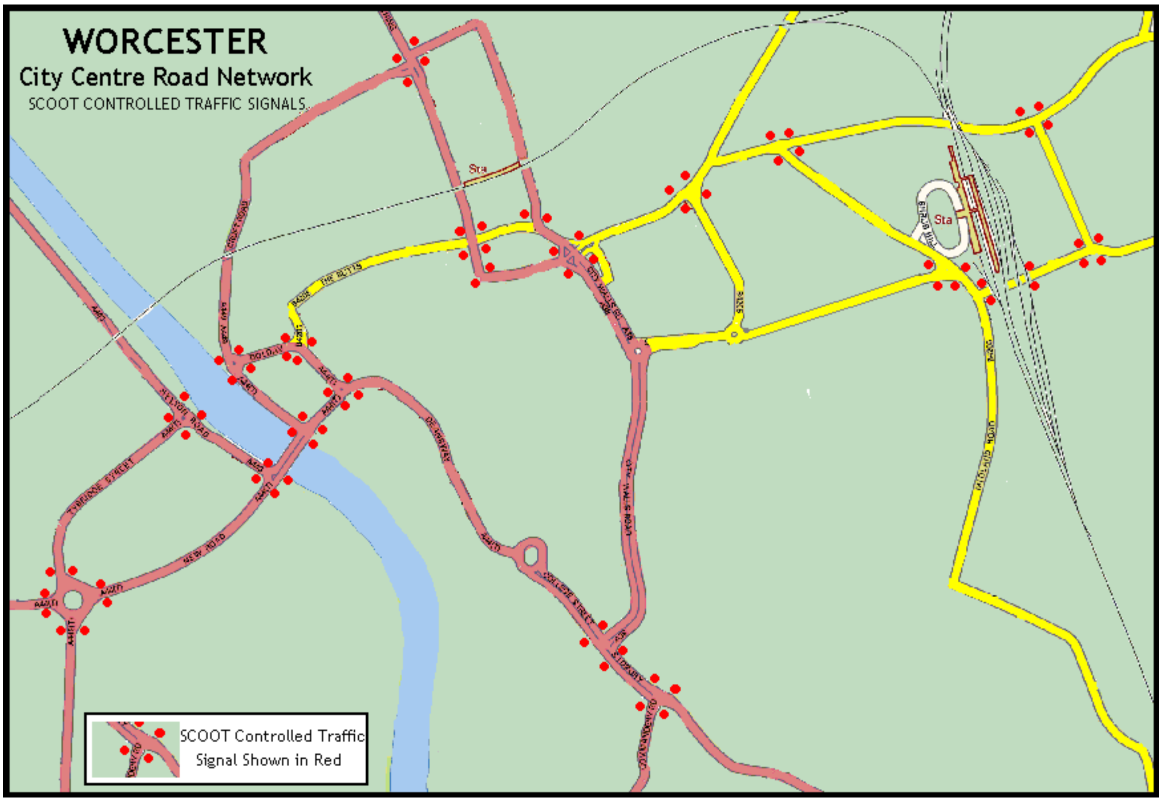
5.6.4 At present, the Worcestershire SCOOT system is used exclusively in Worcester City, as the other major urban centres (the Wyre Forest & Redditch) have fewer traffic signal controlled junctions and more roundabouts. However, as traffic grows, there may be a case for introducing traffic signals and possibly SCOOT systems to manage congestion and provide priority for buses. A map showing the extent of the Worcester city SCOOT system is shown in Figure 5.1.

[10] http://ieeexplore.ieee.org/iel3/3639/10764/00496832.pdf?arnumber=496832

[11] Pg 2, http://www.tfl.gov.uk/assets/downloads/businessandpartners/svd-brochure-2006.pdf

[12] Pg 2, http://www.tfl.gov.uk/assets/downloads/businessandpartners/svd-brochure-2006.pdf

Figure 5.1 – Map showing extent of Worcester SCOOT system



5.6.5 The SCOOT system has the functionality to be used as an effective bus priority tool, by affording buses priority through a series of traffic signals, controlled junctions and crossings. Fixed timetable bus routes can benefit from increased automatic priority at SCOOT controlled signals.

SPRINT

5.6.6 SPRINT (Selective PRIority Network Technique) is, in effect, a modification of the SCOOT system for buses. This system has been widely used by Transport for London across its fixed signal network (excluding temporary signals used for roadworks, services etc) in the urban area to maximise bus efficiency across the network. Table 6.1 shows the effects on bus journey times of isolated Selective Vehicle Detection, SPRINT and Bus SCOOT systems in London.

iBUS

5.6.7 iBUS is Transport for London's exciting and innovative technological solution for bus travel signal management. The iBUS system will involve fitting all buses and traffic signals with GPS communicators, in place of any existing transponders (tags). This will bring about substantial savings, in that signals can be controlled remotely (via satellite), without the need for roadside beacons and/or detection loop installation in the highway.

5.6.8 The accuracy that can be achieved with GPS tracking, means that it is expected that the iBUS system will deliver exceptionally high quality network management, and will eventually be developed so that most buses will automatically pass all signals with a green light, which will significantly reduce bus journey times, whilst improving reliability and driving down the cost of these technological measures. The main benefits of the new iBUS system are:

- *Reduced cost of roll-out per SVD junction*
- *More SVD junctions can be delivered for the same money*
- *Increased speed of roll-out*
- *Decreased maintenance costs*
- *Less requirement for roadside furniture*
- *Increased performance information for SVD system*[13]

5.6.9 Table 5.1 summarised the results of a Transport for London trial of SCOOT, SPRINT and MOVA selective vehicle detection at isolated junctions in terms of benefits to bus users and operators.

Table 5.1 - Intelligent Transport System Trial Results in Central London

Bus Priority Systems	Test Sites	Average Journey Time Savings/Bus/Junction (secs)	Average Delay Savings	System Payback Period
SVD at isolated junctions	Widespread rollout	9	32%	15 months
SVD at MOVA junctions	Hanworth	4-6	x	x
SPRINT	Uxbridge Road	2	x	x
Bus SCOOT	Edgware Road	3	33%	15 months
	Camden Road	5	22%	15 months
	Uxbridge Road	4	19%	5 months
	Twickenham Town Centre	2-5	6%	18 months
	Bromley	3-5	19%	10 months
	Kennington	3-5	16%	10 months
Metering in Bus SCOOT with bus lanes (a.m. peak)	Twickenham Town Centre	5	13%	7 months

X = not available
MOVA Allows more flexible control of isolated junctions
SPRINT Allows active bus priority within a fixed-time Urban Traffic Control network
Bus SCOOT Allows active bus priority within SCOOT (a traffic-responsive Urban Traffic Control system)

5.6.10 This table shows that selective vehicle detection technologies are very effective (reducing delays by up to 33% in the case of Bus SCOOT), whilst having relatively short payback periods (less than 2 years).

[13] Pg 2, http://www.tfl.gov.uk/assets/downloads/businessandpartners/svd-brochure-2006.pdf

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Other Complementary Measures

6 OTHER COMPLEMENTARY MEASURES

Vehicle Design

6.1 Modern vehicle design has dramatically improved accessibility for passengers. Best practice suggests that there are significant positive benefits of low floor, higher capacity buses. These can improving bus access and egress thereby reducing bus stop dwell times,, and thus improving overall journey times and service reliability. More detailed recommendations on vehicle design will be developed in the proposed Vehicle and Rolling Stock Strategy for Worcestershire.

Fares and Ticketing Systems

6.2 A Fares and Ticketing strategy is currently being developed as part of Worcestershire's Integrated Passenger Transport Strategy. Best Practice suggests that there are significant bus stop dwell time, overall journey time, service reliability and cash handling costs benefits associated with increasing the proportion of bus passengers purchasing tickets off-bus. This can be achieved through a combination of off-bus ticket sales outlets or ticket machines and, increasingly, the use of smartcard technologies.

6.3 Transport for London's Oyster card has reduced bus journey times by minimising on-bus ticket purchase and promoting rapid access and egress through pre-payment. The card also offers truly integrated passenger transport ticketing, which has helped to make passenger transport particularly attractive in the capital, and has been credited as a major factor in bus patronage growth.

Bus Stop Spacing

6.4 Bus stop infrastructure planning is also vital to improving bus journey times. It is logical that the provision of fewer, well-located, high quality bus stops supported by accessible buses and off-bus ticketing systems will reduce journey times and increase service reliability. Best Practice suggests that promoting fixed spacing of bus stops wherever appropriate, in conjunction with excellent bus stop design will facilitate optimum access and egress times on arterial routes. Clearly there is a balance to be struck between bus journey times and the accessibility of the network in terms of walk distances and times.

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Enforcement Measures

7 ENFORCEMENT MEASURES

7.1 As mentioned in Section 6, some bus priority measures are, unfortunately, prone to violation by non-priority traffic. As a result, wherever bus priority measures are implemented, there will be a requirement to enforce them effectively. The ideal scenario with bus priority measures is that they are self-enforcing; that is, they do not require further enforcement. In the majority of cases, however, this is not possible to achieve and additional enforcement measures are required.

7.2 There are a number of enforcement devices that can be used to protect bus priority measures from infringements.

Physical Measures, including:

- Rising Bollards (See Figure 7.1)
- Arm Barriers (See Figure 7.2)
- Rising Step Barriers (See Figure 7.3)

Technological Measures, including:

- Enforcement Cameras

Parking Restrictions Enforcement:

- Traffic Wardens

7.3 Physical Enforcement Measures

7.3.1 Rising Step Barriers and rising bollards are primarily used for bus gates or bus ways, to restrict access to specific vehicles. Vehicles are fitted with transponders, which activate the barriers/bollards and permit access. If a vehicle tries to tailgate a bus or other vehicle not fitted with a transponder, then serious damage is often incurred to the vehicle and sometimes also to the bollard/barrier. (See Figure 7.1)

Figure 7.1 – Violation of a Rising Bollard

Figure 7.2 – Rising Arm Barrier on Busway at Worcester Perdiswell Park and Ride Site

Figure 7.3 – Rising Step Barrier at Worcestershire County Hall, Worcester

7.4 Technological Enforcement Measures

7.4.1 Bus Lane Enforcement (BLE) Cameras have been extensively used in the city of London, and more recently in Manchester and some other major conurbations. BLE cameras can be bus mounted, static or CCTV and record footage[14]. In London, if you are caught in violation of a bus lane, you are issued with a £100 fixed penalty charge notice. The London BLE scheme, which has been implemented in partnership with local borough councils, has significantly reduced the amount of bus lane infringements across the metropolitan area, and thus maximised the benefits to bus journey times and service reliability.

7.4.2 It is important to note that all revenues received from Bus Lane Enforcement Cameras are subject to revenue hypothecation, so the revenues go directly towards supporting passenger transport and highway improvements.

7.4.3 Parking and waiting in bus lanes and on key routes can have detrimental effects on bus journey times. In Worcestershire, parking offences have been decriminalised, and so are policed by local authorities. Traffic Wardens can be used to ensure that bus priority measures are not ignored by motorists, and can issue fixed penalty notices for infringements. It is recommended that the Bus Priority Strategy state minimum traffic warden requirements for effective policing of bus lane infrastructure.

7.4.4 Figures 7.4 and 7.5 show a bus stop cage and a busway access point respectively. These road markings provide clear indication to motorists about intended road use, and improve enforcement, by providing greater clarity to road users and traffic wardens.

Figure 7.4 – A Bus Stop Cage

[14] http://www.tfl.gov.uk/assets/downloads/trafenf-TR050788-Say-Cheese.pdf

Figure 7.5 – Redditch Busway Access Point

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Appraisal Methods for Bus Priority Measures

8 APPRAISAL METHODS FOR BUS PRIORITY MEASURES

8.1 Introduction

8.1.1 It is important that the benefits (and costs) of bus priority (and other passenger transport infrastructure) schemes are properly evaluated. This helps to ensure that:

- Funders are fully aware of the direct and indirect benefits of investment in bus priority measures
- Decisions on the prioritising of scarce funding resources can be made on a rational and equitable basis
- When consulting on bus priority proposals with key stakeholders and the general public, Worcestershire County Council officers are fully informed of the benefits and costs of the scheme(s)
- Bus operators are made fully aware of the benefits that they are likely to accrue from bus priority (which can be an important bargaining tool when seeking service enhancements)

8.1.2 There are a number of criteria used to appraise the effectiveness of bus priority measures, which can broadly be split into the following categories:

- User benefits
- Operator benefits
- Non-User benefits (costs)
- Wider benefits (costs)
- Capital costs

8.1.3 Some of the key components of these benefits (costs) and methods of calculation are summarised in the following sections.

8.2 User Benefits

8.2.1 The implementation and effective enforcement of bus priority measures brings a range of benefits to bus users (both existing and new users). The benefits include:

- Reduction in average waiting times due to the increased reliability of the bus services and the consequent delivery of more consistent service intervals (the “gap” between bus arrivals at a bus stop). This is a significant benefit as it is calculated that bus users ‘weight’ their waiting times at bus stops/stations by a factor of 2-2.5 more than in-vehicle travel time.
- Reduction in journey (in-vehicle) time due to protection from traffic congestion, reduced dwell times at bus stops and provision of more direct (usually bus and cycle and pedestrian-only) access to key locations (e.g. city centres, business parks etc.)
- Convenience – users can reduce the allowance they make for the unreliability of a bus service, e.g. not having to allow 60 minutes for a journey that should take 30 minutes if the service is reliable.

8.2.2 The value of user benefits are quantified by calculating:

- Passenger journey times in the *Do-Minimum Scenario,* taking account of deteriorating traffic speeds and service reliability, and weighted by usage
- Passenger journey times in the *Do-Something* (with scheme) *Scenario,* weighted by usage and taking account of changes to bus passenger:
    - o Access times to the bus service (usually weighted at 2 – 2.5 more than in-vehicle time)
    - o Wait times, at the bus stop (usually weighted at 2 – 2.5 more than in-vehicle time)
    - o In-vehicle times
    - o Egress times to destination (usually weighted at 2 – 2.5 more than in-vehicle time)
- Applying a value of time (standard value provided by Department for Transport and updated on a regular basis) to the Do-Minimum and Do-Something passenger journey times
- Calculating the value of the journey time saving to existing users delivered through the scheme

8.2.3 The bus priority should also lead to increased demand, either through additional use by existing users or mode switching from "competing modes", principally the private car. The "rule of a half" is used for this additional use, i.e. apply 50% of the unit value of benefits to these new users.

8.3 Operator Benefits

8.3.1 Bus operators benefit from bus priority schemes in a number of ways, principally through a reduction in resource requirements and costs due to:

- Absolute reduction in journey time
- Increase in journey time reliability
- Easier to plan robust timetables

8.3.2 These cost savings can be re-invested in the service, e.g. increase service frequency without increasing resource requirements.

8.3.3 The reduction in journey times and increase in reliability delivered through the bus priority measures should also have a positive impact on passenger demand and hence revenue. Both of these effects must be assessed for the scheme.

8.3.4 The value of the benefits to bus operators are quantified by calculating:

- Resource costs of operating the bus service in the *Do-Minimum Scenario,* taking account of deteriorating traffic speeds and service reliability
- Resource costs of operating the bus service in the *Do-Something* (with scheme) *Scenario,* taking into account:
    - o Journey time and reliability benefits
    - o Any increases in service frequencies associated with the scheme
    - o Any increases in operating costs associated with enhancing service capacity to cater for predicted demand growth
- Passenger demand and associated farebox and concessionary travel reimbursement revenue in the *Do-Minimum Scenario*
- Passenger demand and associated farebox and concessionary travel reimbursement revenue in the *Do-Something* (with scheme) *Scenario*

- Calculating the net change in costs and revenues delivered through the scheme

8.4 Non-User Benefits (costs)

8.4.1 Non-user costs and benefits relate primarily to the impact of bus priority measures on other traffic using the highway network. In particular it is important to understand and quantify the impact on the journey times of those who do not use the improved bus service.

8.4.2 In some cases the bus priority measures may be implemented without changing highway capacity, thereby minimising the impact on journey times. However, in other cases a bus priority scheme may involve reductions in highway capacity (perhaps as part of a strategy to discourage use of the private car for certain journeys, e.g. the daily commute into a town or city centre). There is often a net increase in costs for non-users attributable to the scheme, but these should be outweighed by the scheme benefits.

8.4.3 The value of non-user benefits are quantified by calculating:

- Non-priority traffic user journey times in the *Do-Minimum Scenario,* taking account of deteriorating traffic speeds and service reliability, and weighted by usage
- Non-priority traffic user journey times in the *Do-Something* (with scheme) *Scenario,* weighted by usage and taking account of changes in highway capacity and mode switching from car to bus
- Applying a value of time (standard value provided by Department for Transport and updated on a regular basis) to the Do-Minimum and Do-Something passenger journey times
- Calculating the value of the journey time saving to existing users delivered through the scheme

8.5 Wider Benefits (Costs)

- Passenger Transport Supportive Land Development – Development of urban areas around key transport corridors promotes excellent accessibility to services and increases the value of properties and communities surrounding these investments.
- Environmental Quality – as patronage increases on bus services, overall congestion is reduced, which halts environmental degradation in urban areas.
- Economic Vitality – providing improved transport corridors can enhance accessibility to employment opportunities that a population can pursue. Retail establishments and other businesses benefit from increased sales and labour force availability.

8.6 In the past, minimum frequency approaches were used in the implementation of bus priority measures (for example, a minimum of 10 buses per hour in each direction). However, it has now been recognised that these approaches are not always relevant, in that lower frequency buses (i.e. express interurban buses) can also benefit from bus priority measures, and can justify the expense, despite not adhering specifically to this approach. Schemes are now appraised according to the Department for Transport's WEBTAG (Web Based Transport Analysis Guidelines), which specify fixed cost and benefit parameters for assessing bus priority scheme viability. WEBTAG assesses transportation improvement schemes and demands that all schemes are **affordable**, **deliverable**, and offer **value for money**.[15]

[15] http://www.brtuk.org/downloads/BRTSymposiumUniversityofWarwick6-7thDecemberPresentations_03.pdf

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Partnership Working for Bus Priority

9 PARTNERSHIP WORKING FOR BUS PRIORITY

9.1 South Yorkshire PTE and Sheffield City Council signed the first Statutory Quality Partnership (SQP) earlier this year, using powers given by the Transport Act 2000. In return for the Council and Transport Executive improving bus infrastructure, including bus priority measures, and information in an area of North Sheffield, bus operators have agreed to improve service standards including vehicle quality and driver training.

9.2 The Transport Act (2000) created Statutory Quality Partnerships for Buses as a means of re-regulating bus services to ensure that standards remain high and services are not subject to attrition in off-peak periods. However, these Statutory Quality Partnerships have proved to be difficult to implement.

9.3 Punctuality Improvement Partnerships (PIPs) have been implemented in a number of areas where bus punctuality is a major concern. These partnerships involve operators and local authorities working together to improve bus service punctuality. These are normally undertaken via a series of Route Audits, which build a profile of the impact of:

- Road works
- Pinch points
- End to end running times
- Intermediate running times
- Traffic signals
- Current priority measures
- Traffic hotspots (when & how frequent)
- Lost mileage

Measures undertaken by the bus operators can include:

- Extra bus resource
- Schedule alterations
- Drop back/layover
- Route alteration
- Withdrawal
- Tightening of staff discipline
- Ensuring routes are fully staffed
- Ensuring routes are fully bussed

Measures undertaken by the local authorities can include:

- Provision of bus lanes
- Bus lane enforcement
- Bus only zones
- Measures and cooperation from DfT, Highways Agency
- Traffic light priority and sequences
- Bus only turns, bus gates etc

9.4 There is scope for the consolidation of partnership working between residents, operators, Districts and the County Council, to set standards on key corridors to improve bus services and make them more attractive to the travelling public. Such partnership working may be particularly valuable in Worcestershire's urban areas of Worcester City, Redditch and the Wyre Forest.

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Recommendations

10 RECOMMENDATIONS

10.1 The examples of bus priority best practice given in this report are by no means exhaustive. This report has, however, highlighted the key methods of prioritising bus services and the associated supporting measures, such as traffic management, vehicle design and fares and ticketing systems. The research is sufficiently wide ranging to provide the basis for the development of a Bus Priority Strategy for Worcestershire.

10.2 It is proposed that any prospective strategy must be constructed in such a way so that the County Council is sufficiently prepared to apply a consistent approach to all bus priority projects across the county.

10.3 A bus priority strategy must, as a minimum, provide clear guidance on the following topics:

- **Bus Network Hierarchy** and its relationship with the level of bus priority provided
- **Operating Speed and Reliability Targets** and their relationship with the **Bus Network Hierarchy**
- **Bus Priority in Central Business Districts**
- **Bus Priority on Urban Arterial Corridors** (including Park and Ride routes)
- **Bus Priority at Key Junctions**
- **Appraisal of Bus Priority Schemes**
- **Bus Priority Enforcement**
- **Delivery Methods for Bus Priority Schemes**

10.3.1 Identifying a Bus Network Hierarchy for Worcestershire

This section would develop a bus network hierarchy for Worcestershire. In particular, this would provide detail on any prospective sites for developing premium quality Bus Rapid Transit and/or Partnership schemes in the county, to create a fully commercial (non-subsidised) core network that will form the basis of the bus network in Worcestershire. Potential urban and interurban schemes could include:

URBAN

- Redditch – BRT Eastern (Matchborough) Circular
- Redditch – BRT Western (The Crosses) Circular
- Worcester – EAST-WEST BRT (Grove Farm P&R, City, Hospital, Sixways/Parkway P&R)
- Worcester – NORTH-SOUTH BRT (St Peters, City, Barbourne & Perdiswell P&R)
- Worcester – Eastern Orbital (Sixways P&R, Hospital, St Peters)
- Wyre Forest – Bewdley, Hospital, Kidderminster, Rail Station & Spennells.
- Wyre Forest – Stourport, Kidderminster & Rail Station

INTERURBAN

- Malvern, Worcester, County Hall & Worcester Hospitals
- Worcester, Droitwich, Bromsgrove & Birmingham (in partnership with Network WM)
- Worcester, Worcester Hospitals, Pershore & Evesham

- Worcester Hospitals, Worcester, Stourport, Kidderminster & Kidderminster Hospital
- Kidderminster, Stourbridge, Dudley (in partnership with Network WM)
- Kidderminster, Bromsgrove, Redditch (Connecting hospitals and rail stations)
- Redditch, Solihull, Birmingham International (in partnership with Network WM)

It would be expected that this core network would be afforded the highest levels of bus priority on congested sections, to improve the sustainability of the commercial network, and to ensure a prestigious image. Other services (such as rural and urban feeder services) would receive bus priority as and when funding permits. The core network will largely complement the existing heavy rail network, and promote inter-modal competition between Bus & Rail, which will have the potential to drive down fares, whilst improving modal choice.

10.3.2 Operating Speeds and Reliability Targets

This section would specify operating speeds and reliability targets for bus corridors in the county. It is proposed that the following target operating speeds be established:

- Premium Network: Operating Speeds of 30km/hr on average (excluding bus stop dwell times)
- Core Network: Operating Speeds of 25km/hr on average (excluding bus stop dwell times)
- Other Bus Services: Operating Speeds of 20 km/hr on average (excluding bus stop dwell times)

These targets will permit effective assessment of key routes, to identify whether bus priority measures are required to drive down journey times, and to enable effective monitoring of bus services countywide. Operating speeds and reliability targets will be directly linked with the bus network hierarchy, with the core services (including Park and Ride) subject to the most stringent targets.

10.3.3 Bus Priority in Central Business Districts

This section would specify the levels of bus priority that should be delivered in town/city centre environments, to ensure optimum operating conditions in these areas for buses. It is likely that the Bus Priority Strategy will be required to provide specific targets for each CBD. This section will be heavily influenced by the outcomes of the Traffic Management & Land Use Strategies. The operating speeds and reliability targets set out above will also be used for bus priority in CBDs.

10.3.4 Bus Priority on Urban Arterial Corridors (including Park & Ride routes)

This section would specify the levels of bus priority that should be delivered on key urban arterial corridors, to ensure optimum bus operating environments, including optimum bus speeds. This section will be largely focussed on Kidderminster and Worcester, where congestion is negatively impacting on bus service quality, and attractiveness of the area to potential new operators. The level of priority to be expressed in terms of the targets set out above.

10.3.5 Bus Priority at Key Junctions

This section would specify optimum bus priority at key junctions (particularly motorway junctions, where buses can suffer from heavy congestion at peak periods.) It is suggested that key junctions that suffer from poor bus priority are identified, with a view to installation of Selective Vehicle Detection (MOVA) schemes at these sites to improve bus priority.

10.3.6 Appraisal of Bus Priority Schemes

This section will formalise a specific appraisal process for Bus Priority Schemes, which will specify the following:

- Maximum permitted payback periods
- Bus Average Speed Targets
- Preferred Options
- Costing Framework

This section will allow cost effective appraisal of appropriate bus priority infrastructure installations in Worcestershire, and will ensure that the County Council is suitably informed to be able to develop these schemes quickly and cost effectively.

10.3.7 Bus Priority Enforcement

This section would formalise the policing of bus priority schemes. It is recommended that the strategy propose the installation of an integrated countywide enforcement scheme, which would include Bus Lane Enforcement Cameras (both mobile and static), CCTV and traffic wardens to monitor use of bus priority installations. It is likely that the proposed Traffic Management Strategy will heavily influence this section.

10.3.8 Delivery Methods for Bus Priority Schemes

This section will formalise a specific delivery process for approved Bus Priority Schemes, including the following elements:

- A formal consultation process (please see the Passenger Transport Consultation Best Practice Report)
- Accessibility requirements (please see the Passenger Transport Accessibility Best Practice Report)
- Expected project delivery timescales
- Expected project delivery costs
- Resource requirements

10.4 As a result of the negative impact these installations have on dwell times and overall journey times, it is recommended that most existing bus lay-bys should be removed as part of the bus priority strategy for Worcestershire, and should be replaced with bus stop borders where appropriate to enhance the prestigious image of passenger transport in the county, and to reduce bus stop dwell and journey times. There are isolated cases where retaining bus lay-bys may be appropriate for safety reasons. This should be clarified in the Bus Priority Strategy for Worcestershire.

10.5 The SCOOT urban traffic management system in Worcester city has the potential to be programmed to afford further bus priority across the city centre. It is recommended that a review of the city centre bus route system take place, to ascertain how this might be modified to make better use of limited city centre road space to ensure rapid access and egress to and from the Crowngate Bus Station.

10.6 It is recommended that the Bus Priority and Development Control Strategies provide clear guidance as to how Worcestershire can develop to include passenger transport supportive developments.

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Appendices

APPENDIX A – SOURCES OF INFORMATION

Sources of Information:

- Adelaide Metro, Southern Australia – O-Bahn
- Amsterdam, Nederlanden – Zuidtangent
- Auckland, New Zealand – The Northern Busway
- Corás Iompair Éireann – Dublin Bus Strategy
- Cambridgeshire County Council – Bus Strategy
- Characteristics of Bus Rapid Transit for Decision Making – United States Department of Transportation
- Cheshire County Council Bus Strategy
- Cheshire County Council Infrastructure Strategy
- Cheshire County Council Interchange Strategy
- Cidade de Curitiba – Rede Integrada de Transporte
- Ciudad de Bógota, Colombia – Transmilenio
- Devon County Council Bus Strategy
- East Riding of Yorkshire Bus Strategy
- Gloucestershire County Council Bus Strategy
- Greater Manchester PTE Bus Strategy
- Greater Nottingham Bus Strategy
- Hull City Council Bus Strategy
- Isle of Wight Bus Strategy
- Kent County Council Bus Strategy
- Lancashire County Council Bus Strategy
- Leicester City Council Bus Strategy
- Leicestershire County Council Bus Strategy
- Lincolnshire County Council Bus Strategy
- Merseyside PTE Bus Strategy
- Nantes Métropole, France – Le Busway
- Norfolk County Council Bus Strategy
- North Yorkshire County Council Bus Strategy
- Nottingham City Council Bus Strategy
- Oxfordshire County Council Bus Strategy
- Peterborough City Council Bus Strategy
- South East Wales Transport Association (SEWTA) Bus Strategy
- Somerset County Council Bus Strategy
- Staffordshire County Council Bus Strategy
- Staffordshire County Council Interchange Strategy
- Suffolk County Council Bus Strategy
- South Yorkshire PTE Bus Strategy
- Swansea, Wales – Metro Abertawe
- Transport for London – Accessible Bus Stop Guidance
- Transport for London – Bus Pre-Signals Document
- Transport for London – Interchange Strategy
- Transport for London – Selective Vehicle Detection
- Transport for London – Traffic Calming Measures for Bus Routes
- Transports en Commun pour l'Agglomération de Rouen, France – TEOR
- Tyne & Weir PTE Bus Strategy
- Warwickshire County Council Bus Strategy
- Warwickshire County Council Interchange Strategy
- West Midlands PTE Interchange Strategy
- West Midlands PTE Bus Strategy
- West Yorkshire PTE Bus Strategy
- West Yorkshire PTE Infrastructure Strategy
- York City Council Bus Strategy