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WP3.4: Trial Area Case Studies

Mervyn Hallworth, and Stuart Auty (Leeds City Council)
Howard Saffer and Peter Bull (Sheffield City Council)
Simon Jones (Oscar Faber)

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Mervyn Hallworth, and Stuart Auty (Leeds City Council)
Peter Bull and Howard Saffer (Sheffield City Council)
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Authorised by:	:	Mervyn Hallworth
Signature	:	

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1. Introduction

These Trial Area Case Studies are an output of the Department of Environment, Transport and the Regions (DETR) funded project UTMC-01 - Selected Vehicle Priority in the Urban Environment (SPRUCE). The main purpose of the Case Studies is to determine the characteristics of the trial areas with regard to their aims, requirements and constraints, in order to help determine how representative they are of other parts of the UK.

The trial areas in Leeds and Sheffield have been selected so as to be complementary to one another, in that they cover a wide range of site conditions and vehicle priority needs. The Leeds area is the larger of the two, and the trials will concentrate on priority measures for tidal PSV movements in the morning peak. The smaller Sheffield network, in addition to affording the opportunity to test a different system architecture, will allow examination of the interaction between bus, tram and emergency vehicle priorities in the pm peak period.

2. Leeds Trial Area: Description

2.1 Location and infrastructure

2.1.1 Introduction

The Leeds Trial area is located immediately to the north of Leeds City Centre (see Drawing number DF/991764/17/01) in an area known as Sheepscar, where several radial routes from the north converge at a signal controlled intersection. All radials serve the mainly residential areas in the northern sector of Leeds, the A61 and A58 being the main routes from Harrogate and Wetherby respectively. A brief description of the routes follows, reference being made to junction numbers contained in Drawing number DF/991764/17/02:

2.1.2 A61 Scott Hall Road

This is a dual two lane carriageway between the A6120 Outer Ring Road and Sheepscar, carrying 30,000 vehicles per day. The 6Km long corridor has, since 1995, been progressively upgraded as a quality bus corridor with four sections of guided busway, and a park and ride site beyond the Outer Ring Road.

2.1.3 Meanwood Road

At Sheepscar this single carriageway road operates as a one way system with inbound traffic joining Scott Hall Road via Junction 2 (see Drawing number DF/991764/17/02).

2.1.4 Chapeltown Road

This is a single carriageway route which acts as an alternative to Scott Hall Road, and which carries over 20,000 vehicles per day. The two roads converge just south of the Outer Ring Road, and also at Sheepscar at Junction 4. An inbound bus lane of approximately 0.35 Km length terminates at this junction.

2.1.5 A58 Barrack Road/Roundhay Road

The A58 route splits on the approach to the intersection. Barrack Road, which enters the intersection at Junction 4, is the main route for through traffic to the City Centre, and the motorway network to the south west of Leeds (via the Inner Ring Road). Roundhay Road, which enters the intersection at Junction 7, carries predominantly local traffic and all bus services from the A58.

On the south and west sides of the Sheepscar intersection, three main routes exit to the City Centre as follows.

2.1.6 A58 Clay Pit Lane

This dual carriageway road provides the link to the A58(M) Inner Ring Road for traffic to/from the south and west sides of Leeds, and longer distance traffic to the M621 and M62. It carries over 55,000 vehicles per day but only a very few buses.

2.1.7 A61 North Street

The 0.4 km long contra-flow inbound bus lane is the major bus route into Leeds City Centre from the northern sector of Leeds. This was introduced in 1995 when an outbound bus lane was removed. Inbound buses join the bus lane through a "bus gate" at its northern end at Junction 9, and pass through two further signal-controlled junctions (Junctions 10 & 11) before entering the City Centre onto Vicar Lane via a second " bus gate" at Junction 12. Several inbound bus routes join North Street at one of these junctions (Junction 11) from Byron Street.

2.1.8 Sheepscar Street North

This carries general traffic which is travelling around the eastern side of the City Centre, as well as some bus services. This traffic exits from the Sheepscar intersection via Regent Street on a parallel route to North Street.

Drawing number DF/991764/17/02, in addition to showing the configuration of the Sheepscar intersection and the 12 main signal controlled junctions, also shows the direction of traffic flow and bus priority measures.

2.2 Bus routes and frequencies

Drawing number DF/991764/17/03 shows the bus routes, services and frequencies. North Street carries over 50 buses per hour in the inbound direction throughout the day, operating on over 25 different services. Scott Hall Road, Chapeltown Road and Roundhay Road carry approximately equal numbers of buses, each feeding about a third of the buses onto North Street. All buses on Scott Hall Road are guided buses (17 per hour), 4 per hour of which are an express service (X35) entering the City Centre via Clay Pit Lane - the only service to do so. Bus stops within the trial area are sufficiently used to cause buses to stop unpredictably, but are not heavily used as most passengers are travelling to/from the City Centre

2.3 Emergency vehicles

It is understood that Police and Ambulance vehicles pass through the area in various random directions. Fire appliances on call-outs are normally travelling in an outbound (northwards) direction on North Street or Claypit Lane.

2.4 Existing network control strategy

With the exception of two pelican crossings on the Scott Hall Road radial which operate in isolated mode, all signals are controlled by a Fixed Time UTC control system, consisting of a Peek *Alpha* (installed 1998). Control is effective twenty four hours a day, with three different plans in operation appropriate to *morning* peak, *evening* peak and *off-peak*. The UTC fixed time plans currently operating (as in the whole of the City Centre) are as follows:

am peak -	72 seconds cycle
off-peak -	60 seconds cycle
pm peak -	72 seconds cycle

The timing of the signals are subject to a number of constraints, relating to both *safety* and *efficiency* of the local highway network, these constraints being applicable to both the existing control strategy and to any more flexible strategy aimed at improving delays to buses:

Safety constraints:

- the proximity of junctions within Sheepscar is such that particular offsets need to be fixed (or severely restricted) so as to maintain co-ordination which is both safe and consistent
- queuing across closely-spaced junctions cannot be allowed to occur when opposing traffic movements are receiving green
- stage-skipping at signals is not to be employed so as to maintain overall sequence consistency
- inbound bus movements on the contra-flow lane must occur at the same time as outbound traffic movements so as to avoid confusion for pedestrians

Efficiency constraints:

- the offsets of Sheepscar junctions relative to the City Centre are restricted due to the need to keep inter-connecting traffic links operating efficiently.
- nominal cycle time of all signals to be as the City Centre (i.e. 72 seconds in the peak)
- in any revised control system the existing balance of delays to general traffic should not be significantly worsened.

3. Leeds Trial Area: Problem Evaluation

3.1 *Bus journey times/delays*

3.1.1 Scott Hall Road

The introduction of the guided busways on Scott Hall Road, 1.3 Km north of the Sheepscar intersection, has reduced journey times significantly. In the morning peak hour, inbound savings up to 4 minutes have been achieved. Additional savings on North Street bus lane has reduced a pre-construction bus journey of 20-25 minutes between the Outer Ring Road and the City Centre by up to 10 minutes in total.

However, on the southern section of Scott Hall Road from the end of the guideways at Potternewton Lane to the start of North Street bus lane, the guided buses have no priority and experience the same peak period delays as other traffic. Traffic queues/delays are variable but queues of slow moving traffic occur at times over the stretch of Scott Hall Road approaching Sheepscar. Over the 2.7 Km between Potternewton Lane and the far end of the North Street inbound bus lane (Junction 12), the average bus journey time in the morning peak period (07.30 - 09.30) is of the order of 10 minutes. However, most delay is experienced over the last 1.6 Km in the vicinity of the signals, the average journey speed over that section being less than 9 mph.

A City Council proposal to add a conflicting traffic movement into Junction 12, scheduled to occur during 1999 as part of City Centre development proposals, is likely to increase delays to buses as they exit from the contra-flow bus lane on North Street. It may be possible to compensate for the major part of the additional delay as part of this project.

3.1.2 Meanwood Road

Buses on Meanwood Road experience similar delays to those on Scott Hall Road. There are only 6 per hour passing through Sheepscar, as many of the buses serving this corridor take a route into the City Centre away from Sheepscar.

3.1.3 Chapeltown Road/Roundhay Road

Buses entering the intersection from Chapeltown Road, in addition to the benefits afforded by the North Street contra-flow system, also have the benefit of an inbound bus lane which brings them to the front of the traffic queue approaching the intersection. This facility essentially eliminates most of the delay experienced by general traffic on that radial.

Overall traffic flows on Roundhay Road are light compared to the other radials (most traffic from the A58 uses Barrack Road) and therefore bus delays on this route into Sheepscar are also small.

3.2 Bus service problems

Delays to buses are confined almost entirely to am peak period, and also to inbound (tidal) bus services. From the above it can be seen that on two of the three main radial routes (Chapeltown and Roundhay Road), inbound buses do not experience any significant delays on their approach to the Sheepscar intersection. However, with regard to the two radials which converge onto Scott Hall Road (Meanwood Road and Scott Hall Road), despite journey times being reduced considerably with the recent introduction of priority measures, there are still significant delays which adversely affect the efficiency and reliability of the guided bus services. Furthermore there

is little opportunity to rectify this situation by construction of additional sections of guideway or bus lane.

Having entered the intersection from the various radials, buses suffer additional delays as they progress through the various traffic signals, the delays being variously due to the following:

- interaction with general traffic (mainly confined to the Meanwood Road and Scott Hall Road radials)
- difficulties of co-ordinating buses, from different radials, which enter the intersection at different times
- difficulties of co-ordinating buses, with variable cruise times caused by bus stops, through signals controlled as part of a fixed time UTC system
- provision of short green times to buses on the North Street approach to Junction 12 (to be exacerbated following implementation during 1999 of the proposal discussed above, when average greens to buses will be reduced and only provided as demanded by buses)

3.3 Delays to emergency vehicles

The emergency services have no particular problems regarding access through the Sheepscar area at any time of day. Police vehicles and ambulances use routes through the junctions which are too variable to consider implementing any special priority for their vehicles. Fire appliances tend to be travelling in the outbound direction, which minimises their problems because of the large number of lanes available for them to weave through (i.e. *four* on Claypit and *five* on North Street).

4. Leeds Trial Area: Possible SVD Priority Measures

4.1 Proposed bus priority

The problems identified in the Leeds trial area, including local consultations, point towards the selected detection of the guided buses operating on Scott Hall Road, in preference to other buses operating in the Sheepscar area. Any such benefits given to this class of bus would have to be set against the background constraint of ensuring no worsening of other bus services - in this way the issue of conflicting priorities can be addressed. It would also be beneficial to select a particular class of buses (X35 express guided buses) for special priority, this service taking a different route through the Sheepscar intersection. In summary the objectives of the trial would be:

- to provide reduced journey times to guided buses (17/hour)
- to provide specific discrimination of a sub-set of these guided buses (4/hour)
- to provide no worsening of delays to the remaining buses (34/hour)

Detection of the guided buses from Scott Hall Road, would involve equipping the guided bus fleet with transponders, and the need to detect a particular sub-set of these vehicles (express buses) making it necessary to use "active" transponders. The programme for equipping other buses with similar transponders is unlikely to be compatible with the timescale of the Trial, but because of the presence of dedicated bus lanes/gates, an alternative form of detection is likely to prove adequate.

The trial will be centred on the am peak period, for inbound buses. Samples of actual bus journey times, both guided and non-guided, will be monitored prior to and during the trials.

4.2 Proposed infrastructure

SVD readers will be situated at selected points on the Scott Hall radial. These will be linked to the SPRUCE system via OTUs and BT lines, or other cost-effective alternative (e.g. radio). On dedicated lengths of bus lanes, other detection such as 'bus profile' or 'long-vehicle' detectors will be used.

The proposed alterations to Junction 12 discussed above, is such as to make it short of capacity. It is possible that this can be corrected for by the installation of local detectors (for general traffic), allied to a version of BALANCE (MicroBALANCE) installed locally. Consideration will be given to expanding the trial by coupling any such local MicroBALANCE system to the SPRUCE system (via 'UTMC08' type data transmission or similar).

5. Sheffield Trial Area: Description

5.1 Location and Infrastructure

5.1.1 Introduction

The Sheffield Trial Area is located at the Manor area of Sheffield, which lies about 2 miles to the south-east of the City Centre (see Drawing number DF/991764/17/04). The group of signalled junctions referred to as Manor Top, which will be the subject of this trial, lie at the intersection the A6102 - Sheffield Outer Ring Road (Prince of Wales Road / Ridgeway Road), and the A616 - City Road / Mansfield Road, and Hurlfield Road, as shown on Drawing number TS/YD183/10. [Note: All the traffic flows indicated below for various roads in this area were recorded during the summer period, and can therefore be regarded as conservative.]

5.1.2 A6102 Outer Ring Road - North (Prince of Wales Road)

This road is part of the outer ring road around the East side of Sheffield, and lies to the north of the Manor Top junction. The road is 2 lane dual carriageway, carrying about 2300 vehicles per hour (2-way) in the am peak, and 2500 vph (2-way) in the pm peak in the vicinity of the Manor Top junctions.

5.1.3 A6102 Outer Ring Road - South (Ridgeway Road)

This road is also part of the outer ring road around the East side of Sheffield, but lies to the south of the City Road junction. This section of the Outer Ring Road is multi-lane dual carriageway and carries over 3000 vph (2-way) in both the am and pm peaks . The Sheffield LRT system operates on this section of road - running in segregated track travelling northbound, and in the fast lane travelling southbound.

5.1.4 A616 City Road / Mansfield Road

This road is a radial into the city from the south-east. Prior to the introduction of LRT about 4 years ago, traffic travelled directly across Manor Top (previously a roundabout) in both directions from City Road to Mansfield Road. Under current traffic arrangements, vehicles travelling towards the City Centre are diverted via Hurlfield Road and A6102 Ridgeway Road (around the signalised gyratory) before returning to City Road. This, together with other measures recently introduced, have reduced traffic flows on this corridor. Typical traffic flows on City Road are of the order of 1100 vph (2-way) in the am peak, and 1300 vph (2-way) in the pm peak. Traffic flows on Mansfield Road just east of Manor Top are over 1500 vph (2-way) in the am peak, and over 2100 vph (2-way) in the pm peak.

5.1.5 Hurlfield Road

This road crosses the A6102 at Manor Top. Traffic on Hurlfield Road (East), which is one-way westbound towards the junction with the A6102, can cross to Hurlfield Road (West). Traffic from Hurlfield Road (West) can only turn left at the junction, and is required to turn right at the junction with City Road / Mansfield Road to travel to the south-east of the City.

Typical traffic flows on Hurlfield Road (East) are over 1100 vph in the am peak, and about 950 vph in the pm peak.

5.2 Bus and Supertram Movements

5.2.1 LRT Operation - Supertram

The Sheffield LRT system, known as Supertram, has two services which take the same path through the City Road / Ridgeway Road and the Ridgeway Road / Hurlfield Road junctions, in each direction. There are a total of 8 trams per hour in each direction - consisting of 6 trams per hour on the main route to Halfway (Mosborough); and 2 trams per hour to Herdings. The service patterns are currently a 10 minute service and a 30 minute service respectively. There is one tram stop in each direction, both of which are located between these two signalled junctions.

5.2.2 Buses

There is a complex pattern of buses through this area. This is partly related to the requirement for certain buses to stop in the bus interchange (sometimes referred to as Elm Tree Interchange) immediately behind the outbound tram stop, even though this often requires that buses make a loop turn through the interchange.

The main bus movements involve buses travelling along City Road (about 49 per hour in each direction); and along Mansfield Road (about 36 hour per hour in each direction). Many of these movements are *between* City Road and Mansfield Road. Other bus movements are small by comparison.

The complete (two-way) pattern of current Bus movements (on a typical weekday hour) is too complex to show clearly on a plan, but is summarised in the table below:-

To / From	City Rd	Mansfield Rd	Prince of Wales Rd	Ridgeway Rd	Hurlfield Rd	TOTAL
City Rd	-	33	8	8	-	49
Mansfield Rd	33	-	-	-	3	36
Prince of Wales Rd	8 (4*)	-	2 (2*)	4 (4*)	-	14
Ridgeway Rd	8	-	4 (4*)	-	-	12
Hurlfield Rd	-	3	-	-	3 (3*)	6
TOTAL	49	36	14	12	6	117

Bus Movements - vehicles per hour (typical weekday)

* [Note: no. in brackets above indicates no. of buses using Bus Interchange]

5.3 Emergency Vehicle Operations

There is a Fire Station on Mansfield Road close to the junction with Hurlfield Road, which is part of the Manor Top signalled gyratory system. The station currently has only one pump vehicle, although it is proposed to provide an additional fire appliance at this station in the near future.

The station is one of the busiest in South Yorkshire with around 3000 callouts per annum. A large percentage of these calls involve travelling along Hurlfield Road to the A6102 Ridgeway Road and thereafter down either the A616, City Road or across on the A6102 to Prince of Wales Road to access the Manor area. This route requires fire appliances to negotiate through all three Manor Top junctions, the busiest turnout period being normally during the evening peak.

It is understood that Police vehicles pass through the area in various random directions, as there is no Police Station locally. Similarly, Ambulances take various routes through the area, although the A6102 is a major route to and from the Northern General Hospital, the main accident and emergency unit for Sheffield, which lies to the North of the City Centre.

5.4 Existing network control strategies

The signalled junctions in the Manor Top area operate under UTC Fixed Time control throughout the day. The UTC fixed time plans currently operating are as follows:-

am peak -	65 Seconds cycle
off-peak -	50 Seconds cycle
pm peak -	70 second cycle

The current UTC system is a PEEK (previously GEC) TMS system. Whilst the UTC plans currently in operation are Fixed Time based, they include some demand dependent windows and other limited vehicle actuated facilities, which allow alternative stages to be called, and stages to ‘gap out’ to the following stage at some points in the signal cycle.

The Supertram system passes through three of the junctions on the A6102 Outer Ring Road in the proximity of Manor Top. Two of these junctions, at City Road / Ridgeway Road and Ridgeway Road / Hurlfield Road have special demand dependent windows (for trams only) within the UTC plans to allow more flexibility for trams passing through the system. The third junction, in the vicinity of Ridgeway Crescent, also operates under UTC, but allows early tram detection to interrupt UTC operation to provide greater tram priority. However this has been set up to co-ordinate well with the Manor Top junctions, and minimise tram delays at the tram stops. Whilst alternative stages are employed with some tram movements, stage skipping (completely missing some traffic phases) is not allowed.

The current UTC timings of the signals in this area reflect the close proximity of the junctions to each other, and in particular the requirement to maintain a throughput of traffic along the Outer Ring Road at all times, and especially at peak times. The signal offsets are therefore fairly critical, although some variations are deemed to be acceptable (for priority purposes), as long as these do not occur every cycle. Effectively the UTC timings incorporate some degree of (static) compensation to allow for when some traffic streams

are disrupted by the passage of trams through the junctions, although no specific compensation strategy is employed.

The UTC timing plans also adopt the principle that, where necessary, vehicles should queue on the outer approaches to the signalised gyratory rather than within the internal stoplines. This 'gating' technique is very effective, and whilst queuing does occur at various times on all five main approaches to the system (Prince of Wales Road, Mansfield Road, Ridgeway Road, Hurlfield Road and City Road), the system continues to operate satisfactorily at these times. This is because additional green time is given to the internal stoplines within the system, which as a result are kept free running and traffic clears through on most cycles.

There have been some trials in recent months to synchronise UTC offsets with other traffic signal junctions over a longer distance down the A6102 Outer Ring Road. These have shown some benefits, in particular to prevent traffic queuing where this would have caused additional delays to Supertram. These initiatives are continuing. As a result the ability to maintain relatively fixed offsets with other parts of the UTC system will be of benefit in the Sheffield field trials.

The timing of the signals are subject to a number of constraints, relating to both *safety* and *efficiency* of the local highway network, these constraints being applicable to both the existing control strategy and to any more flexible strategy aimed at improving delays to priority vehicles:

Safety constraints:

- the proximity of the Manor Top junctions is such that particular offsets need to be fixed (or severely restricted) so as to maintain co-ordination which is both safe and consistent
- queuing across closely-spaced junctions cannot be allowed to occur when opposing traffic movements are receiving green
- stage-skipping at signals is not to be employed so as to maintain overall sequence consistency, although suitable alternative stage sequences are allowed

Efficiency constraints:

- the offsets of the Manor Top junctions relative to the other parts of the A6102 Outer Ring Road are restricted due to the need to keep inter-connecting traffic links operating efficiently
- nominal cycle time of all signals to be as low as possible so as to minimise delay for pedestrians
- in any revised control system the existing balance of delays to general traffic should not be significantly worsened
- in any revised control system there should be no significant degradation of existing Supertram journey times

5.5 Existing Tram Detection

The Supertram system through the Manor Top area is already equipped with selective vehicle detection. Typically multiple detection loops are positioned on the approach to each signalled junction or pedestrian crossing. Trams are detected sufficiently far in advance to allow the signals to respond before they reach their critical braking point. The detection is linked by cable to the traffic signal controllers and monitored by the existing UTC system. Some detection information is passed between controllers, either by direct cable or through the UTC system.

The existing detection system will be used in the trial. Facilities provided by the existing UTC system will have to be duplicated by the BALANCE system. A principal aim of the trial will be to provide benefits to the other selected priority vehicles without any significant degradation of existing Supertram journey times.

6. Sheffield Trial Area: Problem Evaluation

6.1 Bus Journey Times and Delays

The main service patterns for buses, as indicated above, are between City Road and Mansfield Road. Although there is limited quantitative journey time information for buses along this corridor, it is clear that buses on these routes can suffer considerable delays at peak times. Average bus frequencies on this corridor can be close to one per minute.

The main causes of these delays are congestion on Mansfield Road travelling inbound in the morning peak, and congestion on City Road travelling outbound in the evening peak. Actual delays tend to vary across the year, with much higher delays between September and March. In worst case conditions, delays of several minutes can occur at these times.

It is anticipated that samples of actual bus journey times along this corridor will be monitored both prior to and during the trials. One of the bus operators has agreed in principle to assist with this process by installing a GPS based time and location monitoring system on its buses which use the route covered by the trial. This is based on a system which is currently in use by this operator to monitor bus journey times on various routes throughout the City.

Currently, there are no bus lanes operating in this area, although there are proposals for an inbound bus lane on Mansfield Road which could be implemented at any time over the next two years. It is possible that this proposal could be introduced at a timescale to complement this trial.

Buses using the bus interchange at Manor Top exit under signal control, at a fixed point in the signal cycle. As part of this trial, provision of some priority to buses detected leaving the interchange would be desirable.

6.2 Tram Journey Times and Delays

The Supertram system is equipped with an AVL system, which is based on the tram detection loops which are mostly positioned around signalled junctions along the route. The majority of this data is now stored and archived on a regular basis (on CD ROMs), and as such would be available to the project.

In addition, a journey time analysis system is available which uses this information to check journey times between various user-definable points on the tram network. It is therefore possible to analyse current and previous tram detection data, which (allowing for intermittent tram non-detection at some loops) records in excess of 99% of all tram movements at all times of day. This data will be used extensively both before and during the trials to monitor variations in tram delays arising from any changes introduced.

AVL analysis graphs for the two approaches to the Manor Top tram stops for a week in November 1997 (weekdays only) are shown in the attached appendix, which relates to :

i) travelling outbound along City Road, A616, from City
ii) travelling inbound along Ridgeway Road, A6102, from Gleadless

The first graph (Hillcrest Crossover to Manor Top - O/B) demonstrates that tram journey times on City Road travelling outbound in the evening peak are subject to some delay. This delay can typically be about 1.5 minutes in addition to the average off-peak journey time of about 2.5 minutes in the section indicated. It is also worth noting that other service disruptions (indicated by the maximum journey time line) are more likely at this time of day. This is mainly due to the tram being subjected to traffic congestion in a mixed tram and traffic lane on City Road, despite the tram receiving a high degree of priority at the signals on the approach to Manor Top.

By contrast, tram journey times on the inbound route (Gleadless Townend to Manor Top) are relatively unaffected by traffic flows during both the morning and evening peaks. Typically journey times in the morning can be slightly longer, but this is mainly due to longer dwell times at the tram stops on this section (which are busier earlier in the day).This reflects the nature of this section of the route which is part fast-lane operation in relatively free-flow conditions, and part segregated operation.

Supertram AVL graphs for these approaches at other times of the year show a similar pattern, although tram delays are less pronounced especially during the summer period.

It is clear from this analysis, and from views given by the Supertram operator, that attention to the evening peak problem would provide the greatest benefits to Supertram operations.

6.3 Delays to Fire Appliances

More callouts from the Manor Top Station occur during the evening period, especially after the end of school, although the most difficult time to access through the Manor Top signals tends to be in the morning peak.

This is similar to the situation for buses coming up Mansfield Road to the signals, where any delays are largely the result of traffic congestion.

Whilst the Fire Service enjoy considerable assistance from the public, by vehicles moving aside to let their appliances through, the main problems tend to occur where there is insufficient road space for this to occur. In particular, one-way roads with only one or two lanes and which are congested at peak times are difficult to negotiate. Hurlfield Road (East) is a road that falls into this category.

Control facilities that would assist the Fire Service are those which clear traffic ahead of Fire Appliances on a turnout, particularly on roads where traffic is otherwise unable to clear a path for their vehicles. ‘Green Waves’ and similar techniques are an example of this type of facility.

The fire service carry out random checks on their journey times to monitor compliance with Home Office response time requirements. They have agreed that additional checks could be

arranged both prior to and during the trial to monitor the effect of any control changes on their journey times.

6.4 Delays to Police Cars and Ambulances

The Police have indicated that they have no particular concerns about access through the Manor Top area at any time of day, as their vehicles are sufficiently small and manoeuvrable to negotiate most traffic problems without much delay. Additionally their routes through the junctions are too variable to consider implementing any special priority for their vehicles on any particular route.

Ambulances also have variable requirements in this area. It is left to ambulance drivers attending a call to select a different route, using their local knowledge, if they believe they are likely to suffer significant delays on the main roads. Therefore their approach to the signals is not predictable, and special control facilities are unlikely to be very helpful. However, bus lanes are used considerably to avoid traffic queues, and particularly if there is likely to be any additional queuing around the signal junctions at Manor Top as a result of any control changes, additional bus lanes would assist ambulances to negotiate these queues.

It is noted that Ambulances in South Yorkshire are likely to be fitted with an AVL system during the coming year, so that additional information about their journey times and routing may be available prior to and during the trials.

7. Sheffield Test Area: Possible SVD Priority Measures

7.1 Proposed bus priority

For cost reasons it will not be possible to provide transponder-based selective vehicle detection for buses within the Sheffield trial. However, there are three areas where other forms of detection will be considered to provide priority vehicle information to the trial system:

- The exit from the Elm Tree Bus Interchange is currently controlled by fixed-time traffic signals under UTC control. If the signals are only activated when buses are waiting to leave, greater priority could be given to this non-tidal bus movement (17/hour).
- The high bus frequency on the outbound (tidal) City Road approach, limits the amount of priority that can be given without considerable additional delay to other road users. It therefore may only be realistic to provide priority to buses which are behind schedule - by timing the interval between buses it would be possible to provide priority only for those which had fallen more than a preset time behind the normal expected headway (< 18/hour).
- A similar option, possibly utilising this headway technique, will also be considered for the Mansfield Road approach (<36/hour).

The trial for buses (and also for Fire Appliances - see below) will be centred on the pm peak.

7.2 Proposed Fire Appliance priority

The fire station on Mansfield Road already has push-buttons within the station which are linked to the part-time signals outside, and to the Mansfield Road/Hurlfield Road junction. The buttons are used to activate the part-time signals and to request a hurry call at the downstream junction. The indication can be monitored by the existing UTC system (this facility will have to be duplicated in the proposed BALANCE system) and could be used to activate priority at junctions further downstream.

The limited number of vehicles used at the station mean that it would also be practicable for them to be fitted with transponders as part of the trial. Consideration will be given to the use of a transponder reader to re-synchronise any priority sequence as the appliances moves further away from the station.

7.3 Proposed Infrastructure

The existing LRT detection system is linked by cable to the traffic signal controllers, where it is also monitored by the UTC system. This method of connection will generally be used for other forms of detection in the trial, but the use of radio links will also be considered to avoid the cost of any long cable runs.

The installation of above-ground detection at the exit from the Elm Tree Interchange will be investigated, with a view to detecting exiting buses (there are practical difficulties in siting due to variable approach angles). It is further intended to utilise some existing local traffic

detection in the Manor Top area to facilitate the achievement of some degree of green-split variability, as a means of achieving compensation for priority vehicle demands.

The presence of the tram tracks may restrict the installation of sub-surface selected-vehicle detectors on the outbound City Road approach. On the Mansfield Road approach, the proposed bus lane could allow the installation of a sub-surface 'long vehicle' or 'bus profile detector' sufficiently far in advance of the signals to provide useful priority information for all conventional buses on this approach.

8. Relevance of problems to other areas

8.1 Leeds and Sheffield trial areas

The Leeds and Sheffield trial areas can be considered to be representative of other parts of these cities, and to other areas in towns and cities across the UK in many respects, and consequently typify a substantial sector of the market. Both the range of public transport priority, and the characteristics of the trial areas themselves, are sufficiently wide as to ensure good representation of other networks:

With regard to public transport priority, the following apply:

- public transport journey speeds on the corridors are consistent with other Leeds and Sheffield radials
- networks have a mixture of public transport running including dedicated public transport lanes and mixed-traffic running
- PSV delays caused by a variety of problems including congestion and co-ordination problems
- PSV stops lead to variable journey times and hence difficulties in co-ordination
- PSV frequencies on junction approaches range from under 5 to over 50 per hour
- more than one mode of public transport is represented

The trial areas also cover a wide range of characteristics found in other networks:

- junction efficiency ranging from *under-saturated* to *moderately-congested*
- junction traffic movements ranging from *two* to *five* main stages
- green time to public transport ranging from less than 10% to over 70% of cycle time
- junction offsets ranging from *rigidly-fixed* to *unrestricted*
- interaction with emergency vehicles sometimes requiring priority over PSVs

Inevitably, the trial areas cannot be considered totally representative of all conditions, and in consequence consideration will need to be given to supplementing them with modelling work. The following site conditions are thought to be somewhat under-represented by the trial areas:

- high levels of congestion
- high PSV stopping times

9. Outline Of Trial Proposals: Leeds And Sheffield

9.1 Proposed priority system

Detection of priority vehicles in the network will need to effect changes to the signal timings, within the constraints set out in sections 2.4 and 5.4. This is to be achieved by controlling most signals in the Trial Areas from a central point using the existing data transmission network, using the strategy BALANCE as a basic control 'kernel'.

It is likely that the central element of BALANCE (MacroBALANCE) will be installed as an additional strategy module, connected to the existing Peek systems. In Sheffield, MicroBALANCE will be installed at each local controller, and the data transmission will be upgraded to 'UTMC08' (or similar) type, in theory enabling the achievement of a 'stand-alone' system architecture. As in practice some element of the existing 'legacy' system will need to be retained, the degree to which such an architecture is achievable will depend on progress made in the development of the system.

The achievement of particular control enhancements aimed at addressing the above objectives will depend on the practicality of modifying/supplementing the BALANCE strategy within the project timescale. However, it is envisaged that a number of additional facilities will be provided to the users of fixed time systems. These, consistent with discussions with users indicating the desirability of a 'toolkit approach', are here referred to as 'tools' which have been placed into the following groupings:

Discrimination tools:
These would provide the ability to discriminate between classes of priority vehicles, in addition to attributes of those vehicles (e.g. 'lateness' or 'headway' as a proxy for this).

Priority tools:
These would provide the direct means of achieving priority for particular vehicles.

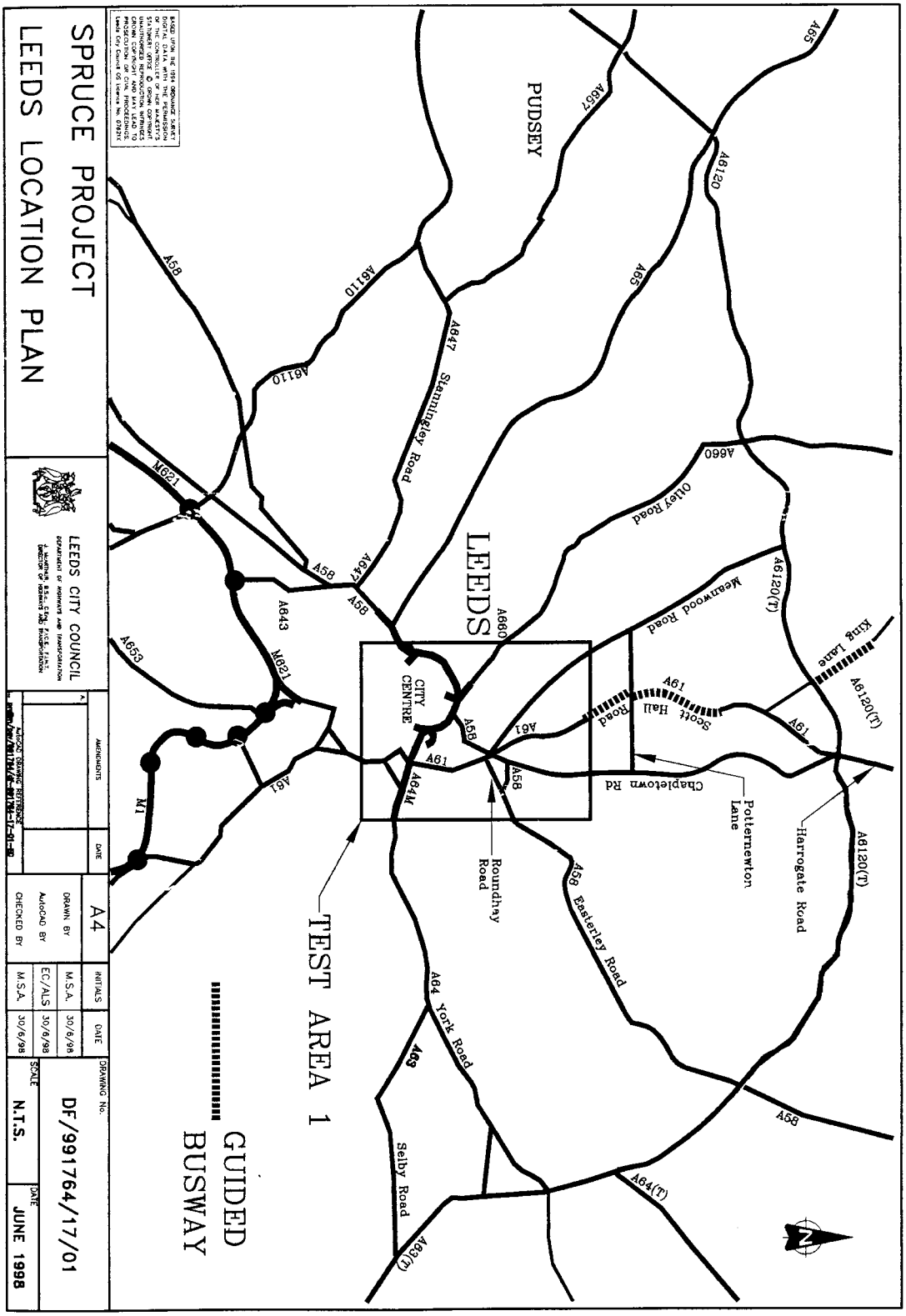
Compensation tools:
These would provide the means of compensating other traffic for the priority provided.

Specific tools:
These address specific issues, such as the need for network synchronisation, or to maintain a particular queue within defined limits

The characteristics of the two test areas lend themselves to focusing on different SVD 'tools'. This is shown in the table below, which indicates the focus ('primary focus' or 'secondary focus') currently envisaged as being given to particular 'tools' in the two test areas. It can be seen that although there is some degree of overlap of primary focus between the two areas (e.g. 'priority by green extensions and/or recalls'), in at least one case the focus will be on different categories of vehicle (e.g. 'differential priority'), and in the majority of cases the focus will be different. As such, the two test areas are seen as being quite complementary. The tools actually employed for use in the trial areas are likely to a sub-set of those ultimately offered as part of UTMC systems, but are likely to include the basic ones. Also the focus ultimately placed on each 'tool' in the trials can only be determined once the practicality of achievement (using BALANCE) has been investigated in detail.

SVD Toolkit	Focus of testing	
	Leeds	**Sheffield**
Discrimination tools:		
discrimination between vehicle class	**B, GB, XB**	**B, L, F**
discrimination of late-running vehicles (headway maintenance)	secondary	**primary**
Priority tools:		
priority by green extensions and/or recalls	**primary**	**primary**
differential priority (vehicle class, late-running etc.)	**primary**	**primary**
priority by routing through several nodes	**primary**	secondary
absolute priority by green-wave generation through several nodes (applicable to emergency vehicles)	secondary	**primary**
Compensation tools:		
direct compensation for priority	**primary**	secondary
compensation by split variation determined by general traffic flows	secondary	**primary**
Specific tools:		
synchronisation of cycle time with local UTC network	**primary**	secondary
dynamic queue management (queue clearance for priority vehicles)	**primary**	**primary**
specific queue management (critical queue limits etc.)	secondary	**primary**

key: **B** = all buses; **GB** = guided buses; **XB** = express guided buses; **L** = LRT;
F = fire-appliance


SPRUCE PROJECT
LEEDS LOCATION PLAN
LEEDS CITY COUNCIL
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
A. HEATHCLIFF B.Sc., C.Eng., F.I.C.E., F.I.H.T.
DIRECTOR OF HIGHWAYS AND TRANSPORTATION
AMENDMENTS
DATE
A4
DRAWN BY
M.S.A.
30/6/98
INITIALS
DATE
AutoCAD BY
EC/ALS
30/6/98
CHECKED BY
M.S.A.
30/6/98
SCALE
N.T.S.
DATE
JUNE 1998
DRAWING No.
DF/991764/17/01
PUDSEY
LEEDS
CITY CENTRE
TEST AREA 1
GUIDED BUSWAY
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A647
A6110
A643
A653
M621
M1
A61
A660
A6120
A6120(T)
A65
A64(T)
A63(T)
A64M
Stanningley Road
Otley Road
Meanwood Road
Scott Hall Road
King Lane
Chapletown Rd
Potternewton Lane
Harrogate Road
Roundhay Road
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A64 York Road
Selby Road
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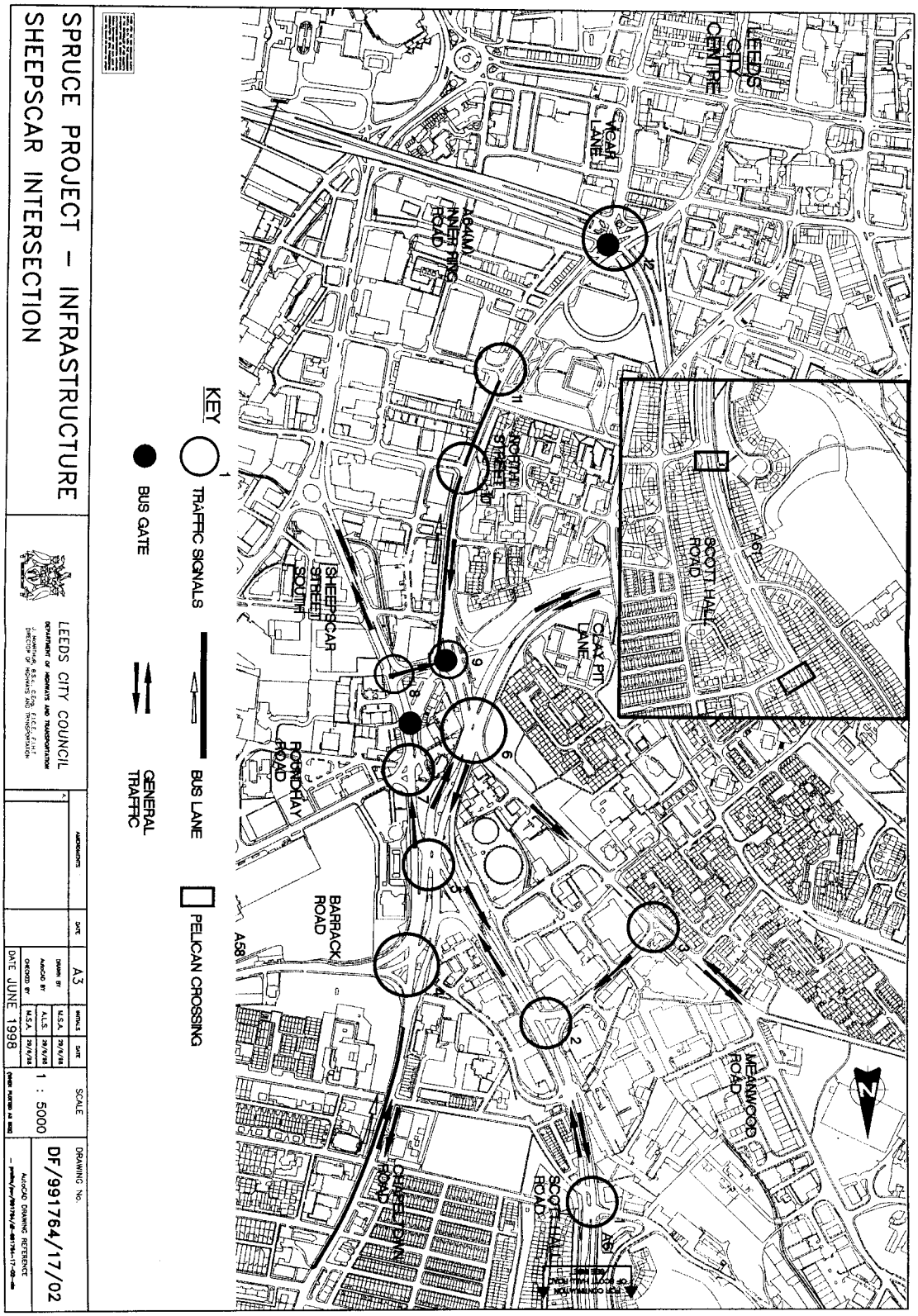
SPRUCE PROJECT – INFRASTRUCTURE
SHEEPSCAR INTERSECTION
LEEDS CITY COUNCIL
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
DIRECTOR OF HIGHWAYS AND TRANSPORTATION
KEY
TRAFFIC SIGNALS
BUS LANE
PELICAN CROSSING
BUS GATE
GENERAL TRAFFIC
A3
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DATE JUNE 1998
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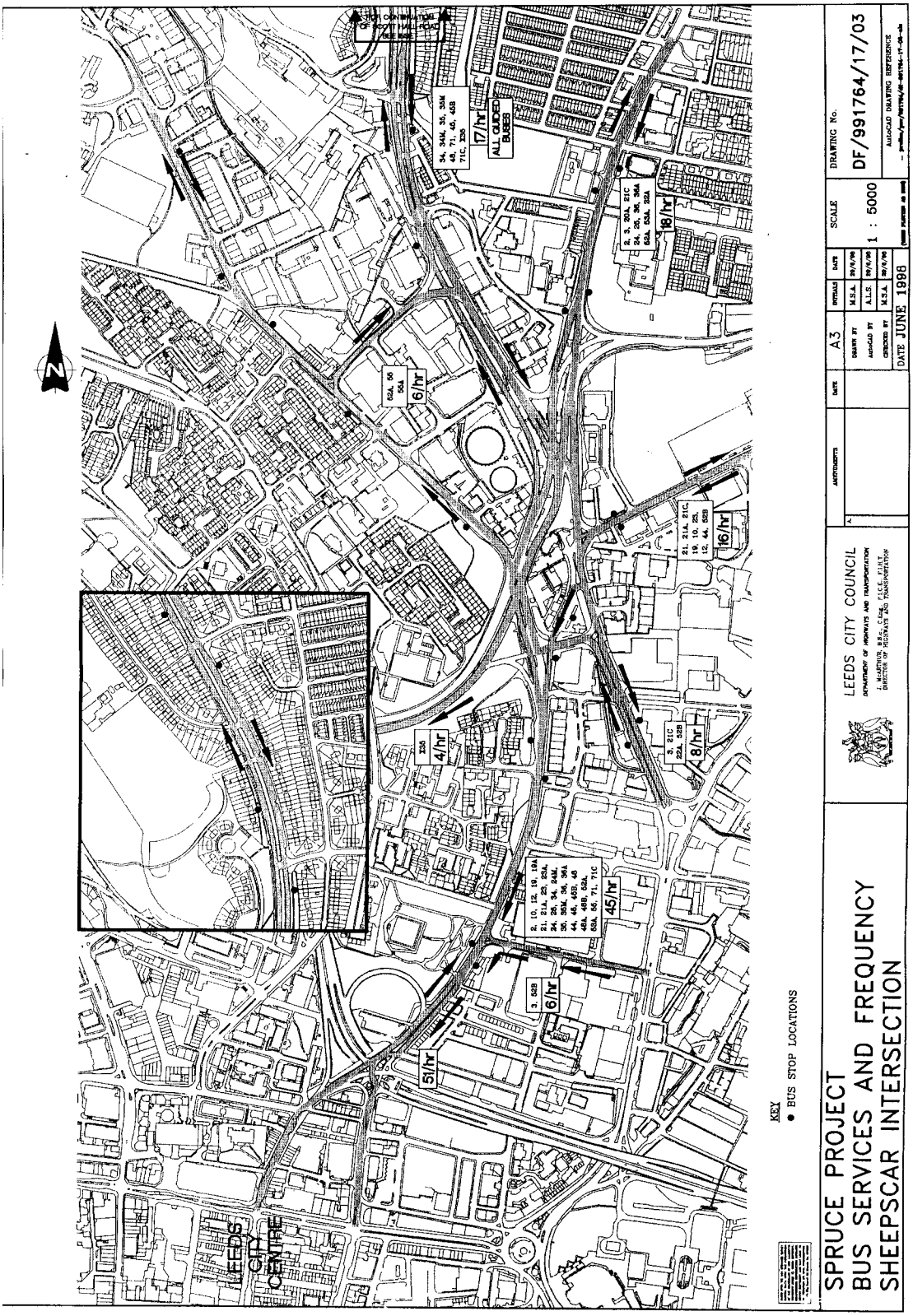
DF/991764/17/02
AUTOCAD DRAWING REFERENCE
A61
A58
A64(M)
INNER RING ROAD
YEAR LANE
NORTH STREET
SHEEPSCAR SOUTH STREET
ROUNDHAY ROAD
BARRACK ROAD
CLAY PIT LANE
SCOTT HALL ROAD
MEANWOOD ROAD
QUEENSLEY DRIVE
FEEDS CITY CENTRE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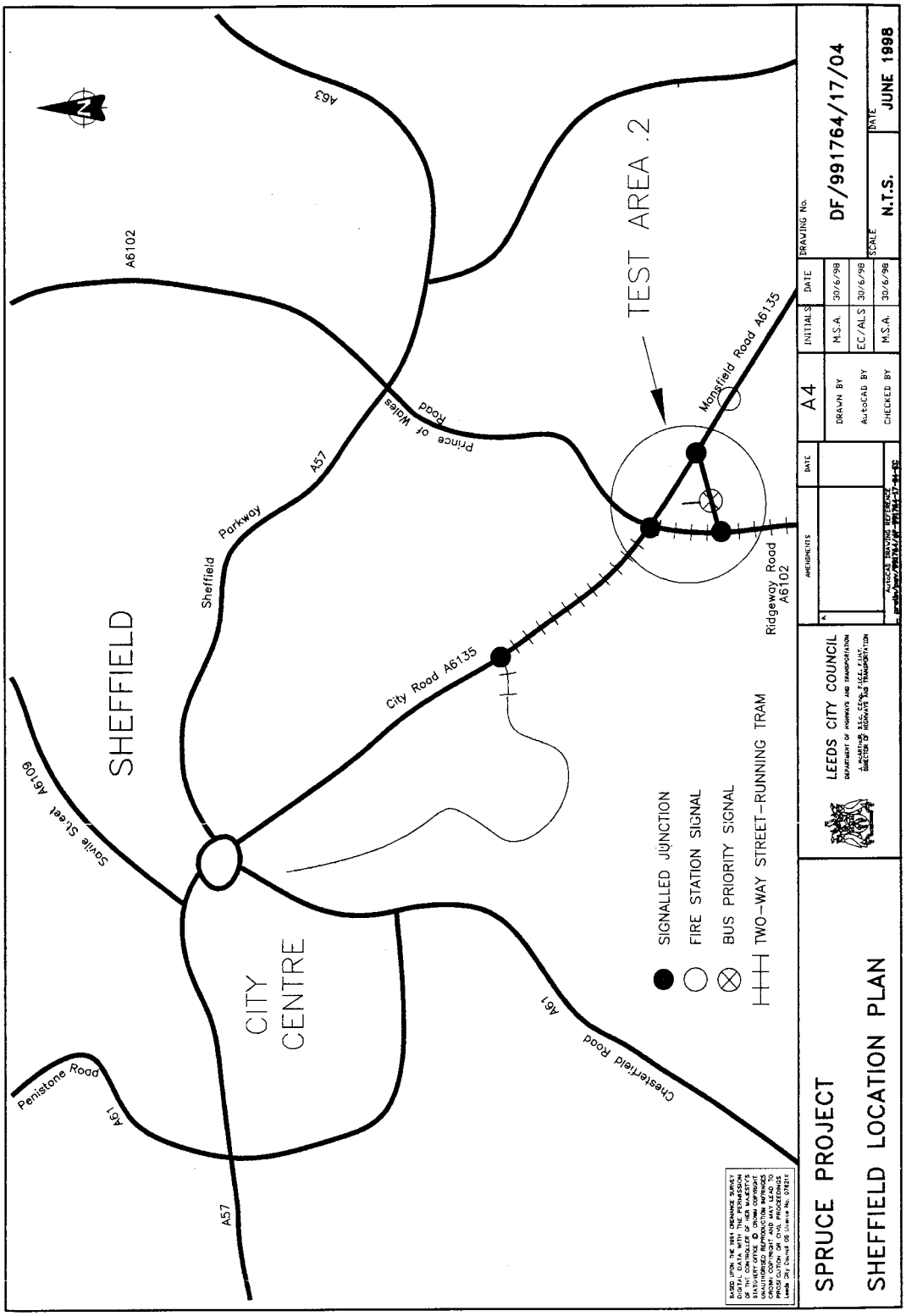
BUS SERVICES AND FREQUENCY
SHEEPSCAR INTERSECTION
LEEDS CITY COUNCIL
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
A3
SCALE
1 : 5000
DRAWING No.
DF/991764/17/03
DATE JUNE 1998
KEY
• BUS STOP LOCATIONS
LEEDS CITY CENTRE
17/hr
ALL GUIDED BUSES
6/hr
16/hr
4/hr
8/hr
45/hr
6/hr
51/hr


SHEFFIELD
CITY CENTRE
TEST AREA .2
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A63
A57
Sheffield Parkway
Prince of Wales Road
Mansfield Road A6135
City Road A6135
Ridgeway Road A6102
Penistone Road A61
A57
Chesterfield Road A61
Sovvie Street A6109
SIGNALLED JUNCTION
FIRE STATION SIGNAL
BUS PRIORITY SIGNAL
TWO-WAY STREET-RUNNING TRAM
LEEDS CITY COUNCIL
SPRUCE PROJECT
SHEFFIELD LOCATION PLAN
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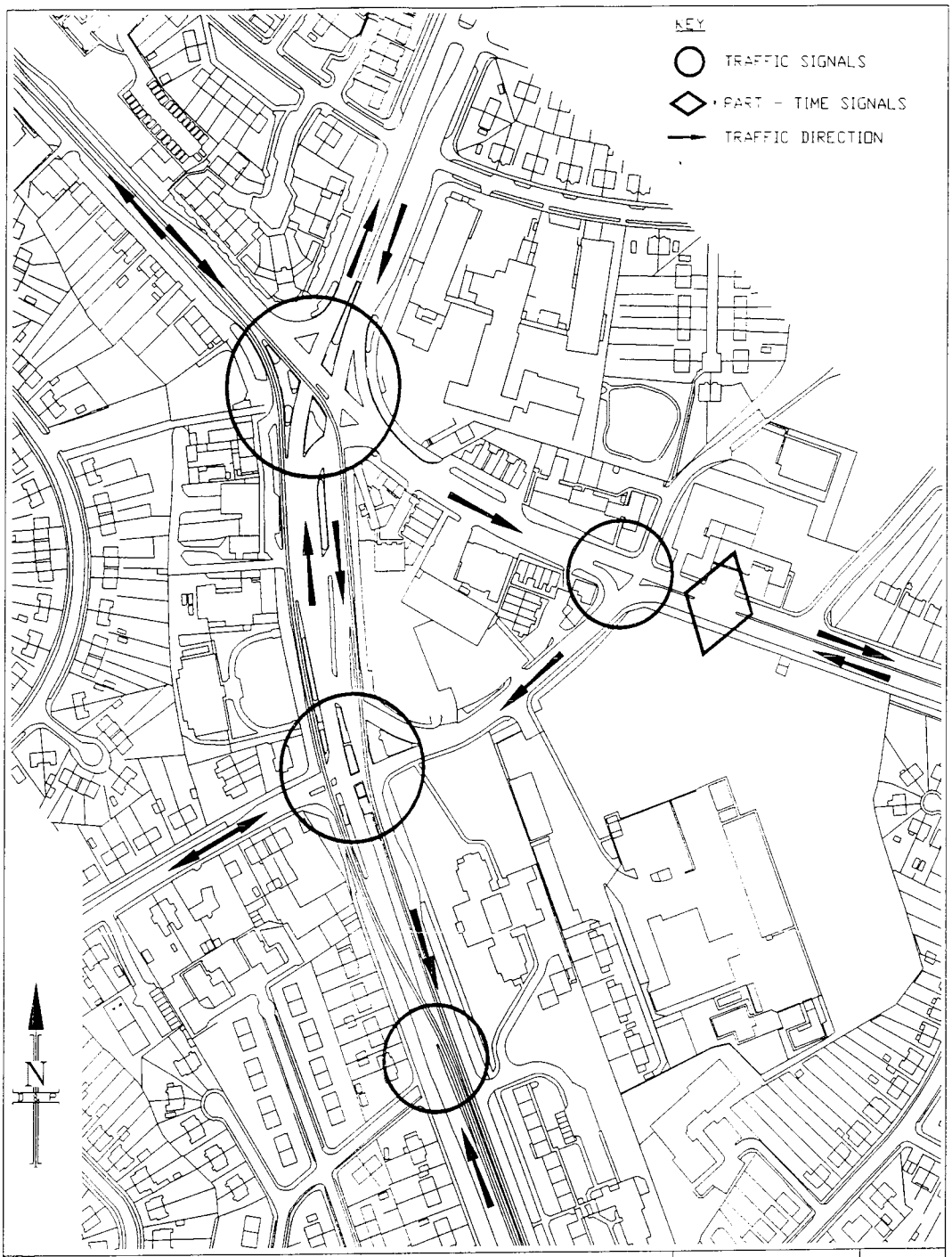

D&P ENGINEERING DIVISION

2-10 CARBROOK HALL ROAD
SHEFFIELD S9 2DB

Tel. (Reception) 0114-273-6320 Fax. 0114-273-6182

M R LATHAM BSc CEng MICE
Chief Engineer

A Division of Design & Property, Directorate of Development, Environment & Leisure, Sheffield City Council
Head of Service. I R Stubbs ARICS

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- Any errors/omissions to be reported immediately
- If in doubt, ask

Client: DETR

Scheme: UTMC01 SPRUCE PROJECT

Drawing Title: MANOR TOP AREA

Drawing No: TS/YD183/10

Scale: 1:2500 A4

0 Millimetres 30

Date: JULY 1998

Sheffield City Council
Development Environment & Leisure
ENGINEERING DIVISION

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