TRICS® Research & Development
Servicing Vehicle Requirements

Technical Note

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1 Introduction

General

1.1 This Technical Note on servicing vehicle requirements has been prepared to provide a useful supplement to the usual first principles approach of establishing servicing needs and should be used alongside other existing guidance. It can also be used as a guide where developers and occupiers may have more detailed information on their own needs.

1.2 TRICS® is continuously undertaking research that supports and complements the application of the TRICS® database in development related projects. This note considers servicing requirements for developments, an important area which has been identified to be in need of further research.

1.3 TRICS® provides servicing data information for some sites in the form of proportion of light goods vehicles to all vehicles and trip rates for heavy goods vehicles. TRICS® also provides loading bay information for some sites. However, this data does not provide sufficient information to directly derive servicing requirements.

1.4 Currently, servicing bays for developments are generally provided on an ad-hoc basis which often leads to over or under provision which results in ineffective use of space and can have an impact on the highway network.

1.5 It has also been found that the estimation of service vehicle trips and required bays for developments using conventional methods of applying trip rates have been proven to yield unrealistic results. Additionally, there is currently limited guidance in assessing the required number of service bays for developments.

1.6 PPG13 notes the importance of providing for efficient servicing requirements, particularly within urban areas as follows:

> *46. Freight movements, particularly those serving developments near to residential areas and in town centres, are often restricted in their hours of operation, through the imposition of conditions, because of concerns over disturbance to residents. However, these restrictions can have the effect of exacerbating congestion during peak times, increasing local pollution, and discouraging further investment in central urban locations. Policies need to strike a balance between the interests of local residents and those of the wider community, including the need to protect the vitality of urban economies, local employment opportunities and the overall quality of life in towns and cities. Local authorities, freight operators, businesses and developers should work together, within the context of freight quality partnerships, to agree on lorry routes and loading and unloading facilities and on reducing vehicle emissions and vehicle and delivery noise levels, to enable a more efficient and sustainable approach to deliveries in such sensitive locations.*

Aim of Assessment

1.7 The aim of this assessment is to develop a robust assessment methodology for servicing bay requirements based on observed influential factors. Site observations indicate that two key factors that influence servicing requirements are dwell times, often related to vehicle size or type and the random arrival patterns of service vehicles.

1.8 The assessment set out in this Technical Note tests the methodology using available information within the TRICS® database, presents the findings of the assessment and judges its suitability for wider use.

Servicing Requirements

1.9 There are a variety of potential servicing requirements associated with various land uses, which can have a significant impact on access layout, service yard arrangements and general vehicle circulation within a site. Potential servicing requirements for various land use groups include:

- Retail stock to shops;
- Supplies to restaurants and public houses;
- Fuel for garage forecourts;
- Equipment and supplies to offices and commercial premises;
- Supplies to hospitals, schools and public buildings;
- Refuse collection and disposal, street cleaning and maintenance;
- Domestic deliveries and furniture removal;
- Document collection and delivery by courier services; and
- Home deliveries from supermarkets, mail order deliveries etc.

1.10 In addition to providing a sufficient number of servicing bays, it is important that servicing areas are well located because if goods/refuse have to be trolleyed significant distances or man-handled within service areas, this will affect the turnover time and hence the average number of bays in use at one time.

Scope of Assessment

1.11 This Technical Note focuses on assessing servicing bay requirements for shopping centres with a typical mix of land uses i.e. retail/leisure/food & drink, using available retail development sites within TRICS® as working examples.

1.12 The structure of this Technical Note is as follows:

- Section 2 provides a brief summary of reviewed literature.
- Section 3 outlines the assessment methodology.
- Section 4 details the assessment of service vehicle trips and estimated servicing bays.
- Section 5 discusses the management of servicing areas.
- Section 6 concludes with a summary of the assessment.

2 Literature Review

General

2.1 An important initial element of this assessment involved a review of previous research that looked at the planning and assessment of servicing areas. The following two documents cover different but relevant aspects of servicing and have been reviewed to assist in verifying this assessment:

- Servicing Areas for Shopping Areas, A Research Study, British Council of Shopping Centres (BCSC), 1995
- Moving Freight, How to Balance Economy and Environment, The Institution of Highways & Transportation, 2005.

Research Study, BCSC, 1995

2.2 The BCSC Research Study report summarises the results of a research study carried out at the end of 1994, into the space requirements for shopping centre service areas. Surveys were undertaken as part of the study. The surveys were undertaken at established, medium sized shopping centres in town centre locations and distributed geographically across the UK. The majority of the selected shopping centres are served from a clearly defined service area, preferably with single points of access and egress. The sizes ranged from 15,000 sq ft to 450,000 sq ft gross leasable area (GLA), also known as gross floor area (GFA). The study identified periods of greatest servicing activity and confined the surveys to these times.

2.3 The BCSC Research Study conclusions include the following:

- There is scope for reducing the size of service areas in shopping centres, as compared with the level of provision typically adopted hitherto.
- Adoption of lower space standards will require tighter control of service areas by centre management, and will reduce opportunities for ancillary activities such as refuse compactors and delivery cage storage and staff parking. The advantages and disadvantages will need to be weighed carefully for each scheme.
- It would seem reasonable that a provision of 5.5 to 6.5 spaces per 100,000 sq ft GLA could sensibly be adopted as a guideline when designing shopping centre service areas.
- The proportion of servicing deliveries by articulated vehicles is small, typically around 6%, although this can vary dependent on scheme/development mix. Three spaces suitable for articulated and large rigid trucks per 100,000 sq ft GLA will normally suffice, or at least 2 per service zone if the area served by the zone is less than 50,000 sq ft GLA.
- The data given above will need to be reviewed periodically, to take account of changing delivery patterns.

2.4 On the issue of deliveries being undertaken by articulated vehicles, our observations have revealed that the proportion may be significantly higher than that noted in the BCSC report, at around 16%.

Moving Freight, IHT, 2005

2.5 The IHT Moving Freight document provides guidance specifically concerned with planning for freight distribution. It provides guidance ranging from strategic freight

movement, freight in rural areas as well as freight in urban areas. On the subject of freight in urban areas, the document summarises the following:

- There is widespread guidance on good practice for freight distribution in urban areas.
- Direction signing for goods vehicles, supported by a map of access routes for freight generators/attractors, can substantially assist the management of goods vehicle traffic in urban areas.
- IHT Guidelines on Urban Safety Management recommend that Heavy Goods Vehicles (HGVs) be directed to use only primary and district distributor roads in urban areas, except for access to specific destinations.
- Since 1990, the mileage travelled by HGVs on major built-up roads in urban areas has fallen by 35% and on minor roads (mainly in urban areas) by about 30%.
- On major built-up roads about 60% of all HGVs are two axle rigid goods vehicles, only about 15% are articulated vehicles.
- Where bus lanes are lightly used, they can be successfully converted to 'no car' lanes to give goods vehicles priority.
- Local Authorities should regularly review access curfews and size and weight restrictions, to determine whether they can be relaxed to improve the efficiency of businesses and freight operators, or need to be made more stringent to better protect the environment.
- Decriminalised parking enforcement can create problems if it leads to regulations being strictly enforced without understanding the implications for freight deliveries.
- Schemes to consolidate deliveries are successfully reducing goods vehicle traffic to manufacturing sites, single sites such as Heathrow Airport and Bluewater Shopping Centre, and for groups of retailers in city centres.
- Operating centres and distribution centres should be located in industrial or warehousing areas at the edge of towns. Existing centres near residential areas should be encouraged to relocate to more suitable sites, to provide previously used land for residential or other development.
- Provision for lorry parks should be included in Regional Transport Strategies, as the current situation is unsatisfactory in many areas. Dual use of Park and Ride sites or retail parks should be considered.
- Freight Quality Partnerships are a key element of strategies for managing freight in urban areas. They provide a mechanism for resolving some of the issues listed above.

Review Summary

2.6 Although guidance information for designing service areas is available, information on determining the number of required bays is limited. Apart from the BCSC report which provides guidance for servicing space requirements for shopping centres, there is currently no available assessment methodology that could be applied to other land uses.

2.7 This assessment has therefore been undertaken with a view to developing a methodology that could be applied across the board to all land uses, focusing on retail developments as test sites so the BCSC report could be used for verification purposes.

3 Methodology

Outline Approach

3.1 The O2 Centre on Finchley Road in North London is a site which has been surveyed for inclusion within the TRICS® database and has been selected as the comparator site for estimating servicing requirements for this study. The O2 Centre was selected because it represents a typical mixed-use development, including A1 retail, A3 food & drink and D1/D2 leisure uses. As the O2 Centre attracts varying sizes of servicing vehicles, it is therefore expected to provide a wider view on servicing requirements.

3.2 Initial site observations indicated service vehicle types and their dwell times affect service bay requirements significantly. Dwell time surveys were therefore undertaken at the O2 Centre for different vehicle types including vans, rigid vehicles and articulated vehicles to add to existing TRICS® data. The survey findings are outlined in the next sub-section.

3.3 The selection process for a comparator site (i.e. the O2 Centre) has focused on servicing rather overall trip generation factors. Usually, the selection criteria for overall trips include locations and accessibility of selected sites. In the case of servicing trips, location and accessibility have not been given the usual weighting as it is considered that servicing requirements are more dependent on land-use types and not necessarily on location and accessibility.

3.4 With respect to quantum, it is considered that servicing needs may vary slightly if a site is small or large but not significantly. For example, servicing needs for a small restaurant compared to a large restaurant would be expected to be more or less the same, with variations more likely to be in the sizes of packages, servicing vehicle types and an increase in service vehicle dwell times.

3.5 Test sites have also been selected from the TRICS® database. These have been selected from the 'Mixed Shopping Malls' and 'Mixed Use' land use groups. The selected sites are those for which loading bays information is provided. A total of 13 sites have been selected and are listed in **Table 4.1** in the next section.

3.6 Vehicle arrival trip rates for Heavy Goods Vehicles (HGVs) i.e. greater than 7.5T (both rigid and articulated vehicles), have been extracted for a weekday daily profile for the O2 Centre. Arrival information for Light Goods Vehicles (LGVs) i.e. 7.5T or less has also been extracted for a weekday daily profile for the O2 Centre.

3.7 It is noted that TRICS® provides specific trip rates for HGVs but not for LGVs. In the case of LGVs, TRICS® provides surveyed LGVs as a proportion of all surveyed vehicles. This information therefore assumes the arrival and departure times of LGVs are the same as those of all vehicles. It is also noted that the use of the LGV trip rate information infers that all surveyed LGVs are servicing vehicles. As a result, the provided LGV trip rates can be considered as an extreme case.

3.8 The HGV arrival trip rates and LGV arrival information has been used to estimate the arrival and departure numbers of servicing vehicles of the test sites.

3.9 Site observations have indicated that in addition to dwell times, the random arrival pattern of service vehicles, with some peak clusters, affect servicing requirements. To account for random arrivals, adjustment factors have been determined and applied to provide 95% confidence on the likely maximum accumulation of service vehicles. The adjustment factors are discussed later in this section.

3.10 A verification exercise of the estimated servicing requirements has been undertaken against the BCSC Research report findings discussed in Section 2 as well as against the actual provisions at each of the test sites.

Dwell Time Surveys & Observations

O2 Centre, Finchley Road

3.11 Dwell time surveys for different servicing vehicle types were undertaken at the O2 Centre on Finchley Road on Thursday 09 February 2006 and Friday 10 February 2006. Literature review has indicated that Thurdays and in particular Fridays, are generally busiest in terms of service vehicle movements for mixed-use complexes.

3.12 The O2 Centre is 27,500 m^2 GFA in size and has 532 parking spaces. The Centre consists of the following uses; Sainsburys (the largest in London), Homebase, Optique 20/20, Books etc, Vue cinemas (8 screen mulitplex), Yo Sushi, JD Wetherspoon, Pizza Hut, Zuccato, Nando's, Old Orleans, Walkabout, Starbucks, Esporta, Gymboree (child play facility), London International Gallery of Childrens Art, Fine Burger Company, China Red Restaurant, Cumin Indian Restaurant. There is also a conferencing and corporate venue for hire at the Centre.

3.13 The O2 Centre has a dedicated service road with dedicated main service yard for the centre and a separate servicing area for Homebase which is located in a stand alone building. The main service yard has 6 bays for HGVs and a communal area for around 6 LGVs. Homebase has a servicing area for 2 HGVs.

3.14 The dwell time survey results used in this analysis are those undertaken for the main service yard only as this is considered to best represent the operation of a mixed-use development. It is expected that the standard TRICS surveys would have included all vehicles to the Centre including Homebase. As such, it is anticipated that an estimation of servicing bays for the O2 Centre is likely to yield a slight over-estimation of number of bays.

3.15 The average and 85th percentile dwell times for the different servicing vehicle types for the two survey days are summarised in **Table 3.1**. Survey results for each day are included in **Appendix A**.

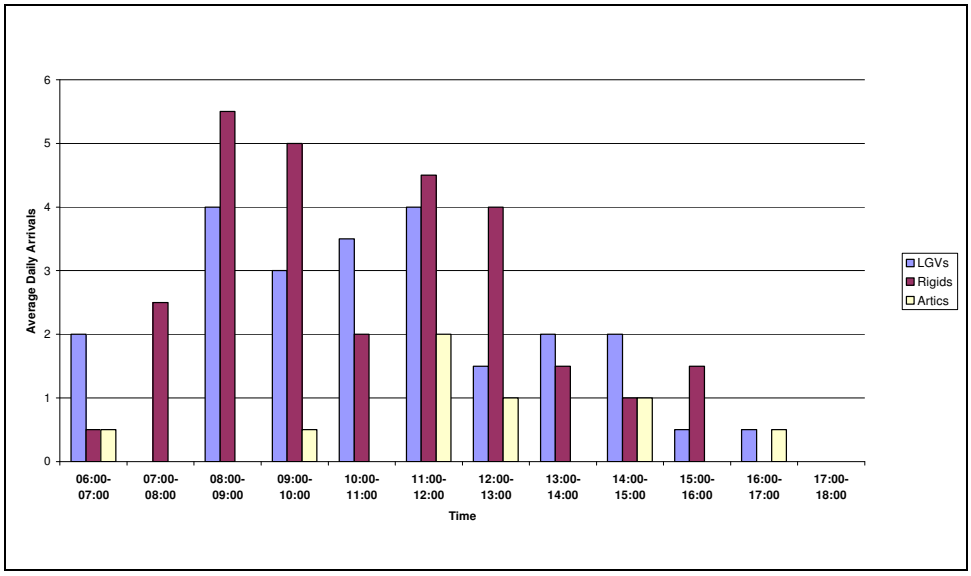
T 3.1 Average and 85th Percentile Dwell Times (9th & 10th February 2006)

Vehicle Class	Vehicle Type	No. of Arrivals	Average Dwell Times (hh:mm)	85th Percentile Dwell Times (hh:mm)
LGV (≤ 7.5T)	Transit/Box	46	00:20	00:35
HGV (>7.5T)	Rigid	56	00:22	00:40
HGV (>7.5T)	Artic	11	01:07	01:49
Total		**113**		

3.16 The average and 85th percentile dwell times have been calculated for use in determining the most likely requirements and the worst case requirements.

3.17 Average arriving servicing vehicles by type and time are shown on **Figure 3.1**.

F 3.1 O2 Centre Average Service Vehicles by Time



3.18 The survey results show that a total of 113 servicing vehicles arrived at the O2 Centre over the two days, with 46 LGVs, 56 rigid lorries and 11 articulated vehicles. The peak arrival time is noted to be 11:00am to 12:00pm

Adjustment Factors (Poisson Distribution)

3.19 The Poisson distribution has been used to develop adjustment factors to provide 95% confidence on the likely maximum accumulation of service vehicles.

3.20 The Poisson distribution is a mathematical rule that assigns probabilities to the number occurrences. It expresses the probability of a number of events occurring within a given time interval, if these events occur with a known average rate, and are independent of the time since the last event.

3.21 In our case, the service vehicle arrivals have been determined using O2 Centre trip rates and the average arrivals at any one time have been determined using the surveyed dwell times.

3.22 For simplicity, a relationship has been determined between average arrivals and the adjustment factors to get a 95% confidence interval. This relationship was determined to be as follows; a factor of 1.4 for averages over 10, a factor of 1.6 for averages between 5-10, and a factor of 2 for averages less than

3.23 Further information on the Poisson Distribution is provided in **Appendix B**.

4 Servicing Vehicles Assessment

General

4.1 As noted previously, test sites have been selected from TRICS® for the purpose of undertaking this assessment. These have been selected from the 'Mixed Shopping Malls' and 'Mixed Use' land use groups. Sites with available loading bays information have been selected for comparison purposes. The test sites are listed in **Table 4.1**.

T 4.1 TRICS® Test Sites

Site	Description	Area	GFA m^2	No. of Business Units	HGV Loading & Parking Bays
Retail - Mixed Shopping Malls					
GL-01-M-01	Shopping Centre, Edgware	Greater London	20,625	40	13
ES-01-M-02	Shopping Centre, Eastbourne	East Sussex	14,693	26	8
Mixed - Mixed use					
GM-16-B-03	Retail/Leisure Park, Bolton	Greater Manchester	62,892	48	47
TW-16-B-02	Retail/Leisure, Newcastle	Tyne & Wear	21,635	19	15
DC-16-B-02	Leisue/Tesco, Poole	Dorset	19,546	12	9
GL-06-B-01	Retail/Leisure, Greenwich	Greater London	26,701	8	4
LE-16-B-01	Retail/Leisure, Leicester	Leicestershire	16,580	6	2
KC-16-B-01	Retail/Leisure, Gravesend	Kent	12,770	9	16
NT-16-B-01	Leisure/Retail, Mansfield	Nottinghamshire	10,250	4	2
GL-16-B-02	O2 Centre, Swiss Cottage	Greater London	27,500	18	6
ES-16-B-02	Retail/Hotel/Pub-Restaurant	East Sussex	10,173	3	1
DS-16-B-02	Retail/Business, Belfer	Derbyshire	8,690	7	2
IR-16-B-01	Leisure/Retail, Dublin	Republic of Ireland	8,500	4	2

Servicing Vehicle Trips

4.2 Service vehicle arrival trip rates identified for the test sites for a weekday daily profile for LGVs and HGVs for the purpose of this assessment are summarised in **Appendix C** for information.

4.3 The arrival trip rates have been applied to the test sites to estimate the hourly arrivals of LGVs and HGVs for each of the test sites. These are also contained in Appendix C.

4.4 The arrival trip rates from TRICS® are provided on a floor area basis. Generally, it would be expected that a relationship exists between the number of business units within each site and service vehicle trips and not necessarily between floor area and service vehicle trips (see paragraph 3.4). It would therefore be expected that if trip rates were available in relation to business units, the estimated number of service trips may be more accurate.

Servicing Bays

4.5 The estimation of number of service bays has been undertaken by estimating the maximum accumulation (i.e. coinciding arrivals) of service vehicles at any given time. This has been done by applying the surveyed dwell times for the different vehicle types and an adjustment factor to account for the random arrival pattern. A calculation example is provided Appendix B, paragraph 1.7.

4.6 **Table 4.2** provides average service vehicle dimensions for information. It should be noted that service bays and area dimensions would also need to provide for manoeuvring space, which would largely depend on entry and exit arrangements.

T 4.2 Average Service Vehicle Dimensions

Vehicle Class	Vehicle Type	Length (m)	Width (m)	Height (m)
LGV (≤ 7.5T)	Transit/Box	7.2	2.3	3.6
HGV (>7.5T)	Rigid	10.0	2.5	3.6
HGV (>7.5T)	Artic	15.4	2.5	3.7

4.7 The estimated average and 85th percentile dwell times for vans, rigid vehicles and articulated vehicles (see Table 3.1) have been used as a sensitivity test on the degree of variation in estimated service bays as a result of variations in dwell times.

4.8 **Table 4.3** and **4.4** summarise the estimated maximum accumulation for vans, rigid vehicles and articulated vehicles for the test sites. Table 4.3 summarises the estimated maximum accumulation when the average dwell times are applied and Table 4.4 summarises the estimated maximum accumulation when the 85th percentile dwell times are applied.

4.9 Detailed tables of the estimated maximum accumulations for each test site for each hour throughout the day are contained in **Appendix D** for information.

4.10 It has been noted that HGVs generally require dedicated servicing bays and so the number of bays for articulated vehicles required for each site have been estimated. This is because these larger vehicles generally need to be located at specific docks/areas for efficient loading and unloading. LGVs however, would not require dedicated bays for each individual vehicle, but a communal servicing area for these smaller vehicles would generally be sufficient.

4.11 The numbers of articulated vehicles and required bays have been estimated using the dwell time survey information which indicates that the proportion of HGV deliveries by articulated vehicles to the O2 Centre is 16%. This concurs with the IHT report reviewed in Section 2.

4.12 The HGV total bays (i.e. rigid and articulated vehicles) have been calculated for the purpose of making comparisons with the actual provisions on site.

T 4.3 Maximum Accumulation for Each Site (Average Dwell Times)

Site	GFA m^2	No. of Business Units	Maximum Accumulation				Provided HGV Loading & Parking Bays
			LGVs	Rigids	Artics	HGV Total	
GL-01-M-01	20,625	40	6	5	3	8	13
ES-01-M-02	14,693	26	5	4	2	6	8
GM-16-B-03	62,892	48	16	12	9	21	47
TW-16-B-02	21,635	19	7	5	3	8	15
DC-16-B-02	19,546	12	6	5	3	8	9
GL-06-B-01	26,701	8	8	7	4	10	4
LE-16-B-01	16,580	6	5	4	2	6	2
KC-16-B-01	12,770	9	4	3	2	5	16
NT-16-B-01	10,250	4	3	3	1	4	2
GL-16-B-02	27,500	18	9	7	4	11	6
ES-16-B-02	10,173	3	3	3	1	4	1
DS-16-B-02	8,690	7	3	2	1	3	2
IR-16-B-01	8,500	4	3	2	1	3	2

4.13 Table 4.3 indicates that the estimated HGV bays for 9 of the sites are within 5 bays of those actually provided on site. The calculated bays for the 3 out of the 13 test sites are less than those provided, with the estimated bays for one of the sites being more than those provided.

T 4.4 Maximum Accumulation for Each Site (85th Percentile Dwell Times)

Site	GFA m²	No. of Business Units	Maximum Accumulation				Provided HGV Loading & Parking Bays
			LGVs	Rigids	Artics	HGV Total	
GL-01-M-01	20,625	40	10	9	5	14	13
ES-01-M-02	14,693	26	8	7	3	10	8
GM-16-B-03	62,892	48	24	20	12	31	47
TW-16-B-02	21,635	19	9	10	5	15	15
DC-16-B-02	19,546	12	10	9	5	13	9
GL-06-B-01	26,701	8	12	10	6	16	4
LE-16-B-01	16,580	6	9	7	4	11	2
KC-16-B-01	12,770	9	7	6	3	9	16
NT-16-B-01	10,250	4	6	5	2	7	2
GL-16-B-02	27,500	18	12	10	6	16	6
ES-16-B-02	10,173	3	6	5	2	7	1
DS-16-B-02	8,690	7	5	4	2	6	2
IR-16-B-01	8,500	4	5	4	2	6	2

4.14 Table 4.4 indicates that the estimated HGV bays for 7 sites are within 5 bays of those actually provided on site. The calculated bays for the 2 out of the 13 test sites are less than those provided, with the estimated bays for 4 of the sites being more than those provided.

4.15 Tables 4.3 and 4.4 suggest that the use of average dwell times in estimating servicing bays requirements is perhaps more accurate than the use of 85th percentile dwell times, although the use of the two sets of dwell times to estimate a range of servicing bays would be more reasonable and is therefore recommended. These variations suggest that dwell times have a significant impact on servicing requirements.

4.16 It should be noted that these findings are indicative only and as noted in paragraph 3.7, there are issues to consider when applying the extracted trip information for LGVs for example. It is also noted that articulated vehicles have a greater variability in terms of dwell times than smaller vehicles given their size, i.e. an articulated vehicle could deliver only a single pallet of goods to one site and perhaps 10 pallets or an entire lorry to another.

Verification

4.17 The BCSC Research Report 1995, (see Section 2) has been used to verify the estimated service bays for the test sites. While this report is noted to be somewhat dated, it does give an indication of estimated servicing requirements for shopping centres. A comparison has also been made with the provided bays on site.

4.18 Although the provided bays may not necessarily meet requirements, they do provide a baseline for this assessment.

4.19 **Table 4.5** provides a comparison summary table for the estimated servicing bays using average dwell times and 85th percentile dwell times along with estimated bays using the BCSC Report, all against the actual provisions on site.

T 4.5 Estimated Service Bays compared with BCSC Report Estimates

Site	GFA m^2	No. of Business Units	Provided HGV Loading & Parking Bays	Estimated Bays (Average)	Estimated Bays (85th Percentile)	BCSC Estimates
GL-01-M-01	20,625	40	13	8	14	7
ES-01-M-02	14,693	26	8	6	10	5
GM-16-B-03	62,892	48	47	21	31	20
TW-16-B-02	21,635	19	15	8	15	7
DC-16-B-02	19,546	12	9	8	13	6
GL-06-B-01	26,701	8	4	10	16	9
LE-16-B-01	16,580	6	2	6	11	5
KC-16-B-01	12,770	9	16	5	9	4
NT-16-B-01	10,250	4	2	4	7	3
GL-16-B-02	27,500	18	6	11	16	9
ES-16-B-02	10,173	3	1	4	7	3
DS-16-B-02	8,690	7	2	3	6	3
IR-16-B-01	8,500	4	2	3	6	3

4.20 **Table 4.6** shows the difference between the number of estimated bays and those estimated using the BCSC Report.

T 4.6 Difference between Estimated Service Bays and BCSC Bays

Site	GFA m^2	No. of Business Units	Estimated Bays (Average) - BCSC	Estimated Bays (85th Percentile) - BCSC
GL-01-M-01	20,625	40	1	7
ES-01-M-02	14,693	26	1	5
GM-16-B-03	62,892	48	1	11
TW-16-B-02	21,635	19	1	8
DC-16-B-02	19,546	12	2	7
GL-06-B-01	26,701	8	1	7
LE-16-B-01	16,580	6	1	6
KC-16-B-01	12,770	9	1	5
NT-16-B-01	10,250	4	1	4
GL-16-B-02	27,500	18	2	7
ES-16-B-02	10,173	3	1	4
DS-16-B-02	8,690	7	0	3
IR-16-B-01	8,500	4	0	3

4.21 Table 4.6 indicates that the estimated service bays using average dwell times are generally within one or 2 of those estimated using the BCSC publication. Those estimated using the 85th percentile dwell times are generally higher than those estimated using the BCSC publication. These findings generally concur with the comparisons made by actual site provisions in that; the use of average dwell times provides results that are closer to actual requirements.

4.22 As discussed in paragraph 3.14, the estimated bays for the O2 Centre [GL-16-B-02] are likely to be a slight over-estimation due to the fact that the standard TRICS survey would have included all trips including those to Homebase, whereas the dwell time surveys excluded Homebase, which has its own servicing area.

5 Management of Servicing Areas

General

5.1 Site observations and reviewed research indicates that generally, the more control measures which can be applied to servicing operations, the more efficiently the available space will be used.

5.2 A number of control measures are available which can be used at developments which could potentially significantly reduce the number of required service bays. This management system would be best developed through the implementation of Freight Quality Partnerships for large developments or groups of small developments.

5.3 It has been noted that Freight Quality Partnerships are increasingly forming the basis of local authorities' approaches to management of freight distribution in urban areas, and it is considered that the large developments or groups of small developments would also greatly benefit through such partnerships albeit on smaller, more localised scales.

5.4 Initial proposals on servicing management include:

- Considering the new development layouts in relation to possible accesses and delivery points so that the coordination of deliveries can be maximised.
- Specifying set delivery times for units/land uses in order to make maximum use of provided spaces.
- Considering consolidating refuse collection points as far as possible, therefore minimising refuse vehicles movements and service bays.
- Considering the use of smaller size refuse vehicles to reduce dwell times.
- Ensuring the use of waste compactors to minimise waste volume and hence requirements for waste collection.
- Ensuring centre management is present during core hours to ensure efficient operation of the yard.
- Allowing a reservoir area for vehicles to queue off the highway to allow for any unexpected 'peaks' of demand.
- Preventing the use of service yards as parking areas for operational vehicles, employees and visitors by eliminating lengthy layovers.
- Preventing the use of service yards as dumping grounds for pallets, cages, trolleys etc.

5.5 The implementation of a servicing management system, developed through a partnership group is considered essential to ensure the efficient operation of service areas.

6 Summary

General

6.1 This Technical Note develops a methodology for estimating servicing bay requirements based on the premise that servicing requirements are influenced by two key factors i.e. vehicle dwell times (itself a product of vehicle size) and arrival patterns.

6.2 The methodology has been tested by estimating the number of servicing vehicles and scale of servicing facilities for shopping centres with a mix of uses i.e. retail/leisure/food & drink.

6.3 The test has used existing TRICS® data in addition to undertaking service vehicle dwell time surveys for the O2 Centre in North London; a typical retail/leisure/food & drink complex. The dwell time surveys have been undertaken for different vehicle types including light goods vehicles, rigid and articulated heavy goods vehicles to add to existing TRICS® data

Methodology

6.4 The developed methodology can be summarised as follows:

- Select a comparable site in terms of servicing within the TRICS® database and extract trip rates for HGVs and trip information for LGVs;
- Calculate service vehicle trips for the proposed site;
- Observe or survey a comparable land use to determine average and 85th percentile dwell times for the various service vehicle types;
- Calculate the average arrivals of service vehicles by applying the dwell times to the estimated trips for each vehicle type (e.g. if 6 HGV trips are estimated for a particular hour and the average dwell time for HGVs has been observed to be 30 minutes then the average arrivals at any given time during that hour would be expected to be 3);
- Calculate the maximum accumulation (i.e. coinciding arrivals) of vehicle by applying the appropriate adjustment factor to average arrivals to get a 95% confidence interval. Apply an adjustment factor of 1.4 for average arrivals greater than 10, and adjustment factor of 1.6 for average arrivals between 5 and 10 and an adjustment factor of 2 for average arrivals less than 5.

Findings

6.5 The test assessment of servicing bays requirements indicates that when the estimated lower range dwell times are applied, the estimated number of dedicated service bays for HGVs (both rigid and articulated) are generally closer to those estimated using the BCSC Research report, i.e. the verification publication.

6.6 It has been noted that LGVs generally do not require dedicated service bays, but instead require communal servicing areas for these smaller vehicles. Furthermore, LGVs can utilise available HGV service bays, with multiple vans being accommodated in each bay.

6.7 It is noted that the average dwell times for service vehicles significantly affect the number of required service bays.

6.8 It is concluded that, the discussed methodology could be applied to other land use mixes or specific land uses to determine servicing requirements, once dwell time and servicing vehicle type information is known for those land uses.

6.9 Overall, it is important that servicing needs are clearly understood, level of bay provision comprehensively assessed and service yards well managed to ensure efficient operation.

Appendix A

O2 Centre Service Vehicles Dwell Time Surveys

O2 Centre Delivery Vehicle Survey Summary

Thursday 9 February 2006

	No. of Arrivals	Vehicle Class	Type	Average Dwell Times
	31	LGV (≤ 7.5T)	Transit/Box	00:21
	24	HGV (<7.5T)	Rigid	00:21
	6	HGV (<7.5T)	Artic	01:04
Total	**61**			

Friday 10 February 2006

	No. of Arrivals	Vehicle Class	Type	Average Dwell Times
	15	LGV (≤ 7.5T)	Transit/Box	00:15
	32	HGV (<7.5T)	Rigid	00:23
	5	HGV (<7.5T)	Artic	01:10
Total	**52**			

Thursday & Friday Average

	No. of Arrivals	Vehicle Class	Type	Average Dwell Times	85th Percentile Dwell Times
41%	46	LGV (≤ 7.5T)	Transit/Box	00:20	00:35
50%	56	HGV (<7.5T)	Rigid	00:22	00:40
10%	11	HGV (<7.5T)	Artic	01:07	01:49
Total	**113**				

Rigid/Artic split

67	Rigid	84%
	Artic	16%

Appendix B
Poisson Distribution

Appendix B - Poisson Distribution

1.1 In order to account for random arrivals, an adjustment factor has been determined using the Poisson Distribution to provide 95% confidence on the likely maximum accumulation of service vehicles.

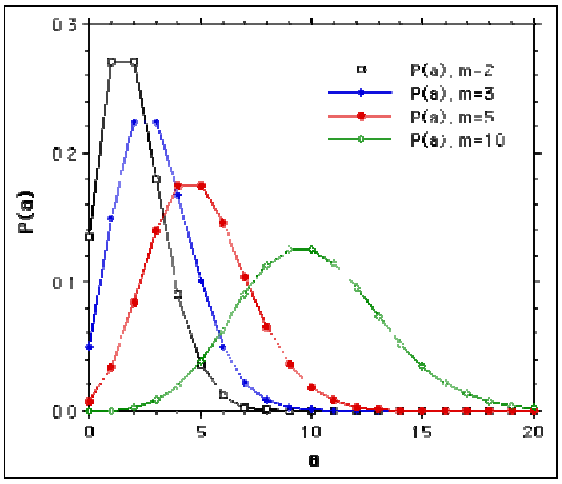
1.2 The Poisson Distribution which describes the probabilities of random occurrences can be described as follows:

If the average number of random occurrences per interval = m, the probability P of a occurrences in the interval is:

$$P(a) = e^{-m}\frac{m^a}{a!}$$

1.3 The graph below illustrates an example of the application of the Poisson Distribution where the intervals (i.e. average arrivals), m, are 2, 3, 5 and 10.

Poisson Distribution Example



1.4 The following are key points noted:

- As m increases, the distribution of probabilities moves to the right and broadens.
- For each of these m values, the sum of all probabilities = 1.0.
- The distribution shown for m = 10 resembles the "bell-shaped-curve". For high values of m the Poisson distribution and the normal distribution are the same.

1.5 For the purposes of this assessment, service vehicle arrivals have been determined using O2 Centre trip rates and average arrivals at any one time, m, have been determined using the surveyed dwell times. These average values have been used to calculate the probabilities of random arrivals and their respective adjustment factors for obtaining to a 95% confidence interval.

1.6 A simplified relationship has been determined between average arrivals and the adjustment factors to get a 95% confidence interval as follows:

- A factor of 1.4 for averages over 10,
- A factor of 1.6 for averages between 5-10, and
- A factor of 2 for averages less than 5.

1.7 As an example, if 5 LGV arrivals an hour are estimated, the arrivals would be divided by 3 to provide an estimate of the number of vehicles arriving within 20 minutes (the average dwell time for LGVs). This provides the average accumulation of vehicles. A statistical factor of 2 is then applied to estimate the maximum accumulation with 95% confidence. In this case, the maximum accumulation would be calculated as (5 / 3)*2 = 3.33.

Appendix C

Service Vehicle Trip Rates & Estimated Servicing Arrival Trips

appendix C

SERVICING ARRIVAL TRIP RATES

	LGVs	HGV
Time	**A1, A3 & D1/D2**	**A1, A3 & D1/D2**
00:00-01:00	0.00	0.00
01:00-02:00	0.00	0.00
02:00-03:00	0.00	0.00
03:00-04:00	0.00	0.00
04:00-05:00	0.00	0.00
05:00-06:00	0.00	0.00
06:00-07:00	0.00	0.00
07:00-08:00	0.01	0.01
08:00-09:00	0.02	0.01
09:00-10:00	0.05	0.04
10:00-11:00	0.04	0.01
11:00-12:00	0.04	0.01
12:00-13:00	0.04	0.03
13:00-14:00	0.04	0.01
14:00-15:00	0.03	0.00
15:00-16:00	0.04	0.00
16:00-17:00	0.03	0.01
17:00-18:00	0.03	0.00
18:00-19:00	0.04	0.00
19:00-20:00	0.03	0.00
20:00-21:00	0.03	0.00
21:00-22:00	0.02	0.00
22:00-23:00	0.00	0.00
23:00-24:00	0.00	0.00
Total	**0.49**	**0.13**

TRICS TEST SITES

ARRIVALS ONLY

GL-01-M-01

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	2	2
08:00-09:00	5	2
09:00-10:00	10	8
10:00-11:00	9	2
11:00-12:00	9	2
12:00-13:00	8	6
13:00-14:00	8	2
14:00-15:00	7	0
15:00-16:00	8	0
16:00-17:00	7	2
17:00-18:00	6	0
18:00-19:00	8	0
19:00-20:00	7	0
20:00-21:00	6	0
21:00-22:00	4	0
22:00-23:00	1	0
23:00-24:00	1	0
Total	102	27

ES-01-M-02

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	1	1
08:00-09:00	3	1
09:00-10:00	7	6
10:00-11:00	6	1
11:00-12:00	6	1
12:00-13:00	6	4
13:00-14:00	5	1
14:00-15:00	5	0
15:00-16:00	5	0
16:00-17:00	5	1
17:00-18:00	4	0
18:00-19:00	5	0
19:00-20:00	5	0
20:00-21:00	4	0
21:00-22:00	3	0
22:00-23:00	1	0
23:00-24:00	0	0
Total	73	19

GM-16-B-03

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	6	6
08:00-09:00	15	6
09:00-10:00	29	25
10:00-11:00	27	6
11:00-12:00	27	6
12:00-13:00	26	19
13:00-14:00	23	6
14:00-15:00	20	0
15:00-16:00	23	0
16:00-17:00	20	6
17:00-18:00	19	0
18:00-19:00	23	0
19:00-20:00	20	0
20:00-21:00	17	0
21:00-22:00	11	0
22:00-23:00	3	0
23:00-24:00	2	0
Total	310	82

TW-16-B-02

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	2	2
08:00-09:00	5	2
09:00-10:00	10	9
10:00-11:00	9	2
11:00-12:00	9	2
12:00-13:00	9	6
13:00-14:00	8	2
14:00-15:00	7	0
15:00-16:00	8	0
16:00-17:00	7	2
17:00-18:00	6	0
18:00-19:00	8	0
19:00-20:00	7	0
20:00-21:00	6	0
21:00-22:00	4	0
22:00-23:00	1	0
23:00-24:00	1	0
Total	107	28

DC-16-B-02

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	2	2
08:00-09:00	5	2
09:00-10:00	9	8
10:00-11:00	8	2
11:00-12:00	8	2
12:00-13:00	8	6
13:00-14:00	7	2
14:00-15:00	6	0
15:00-16:00	7	0
16:00-17:00	6	2
17:00-18:00	6	0
18:00-19:00	7	0
19:00-20:00	6	0
20:00-21:00	5	0
21:00-22:00	3	0
22:00-23:00	1	0
23:00-24:00	1	0
Total	96	25

GL-06-B-01

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	3	3
08:00-09:00	6	3
09:00-10:00	12	11
10:00-11:00	12	3
11:00-12:00	11	3
12:00-13:00	11	8
13:00-14:00	10	3
14:00-15:00	9	0
15:00-16:00	10	0
16:00-17:00	8	3
17:00-18:00	8	0
18:00-19:00	10	0
19:00-20:00	9	0
20:00-21:00	7	0
21:00-22:00	5	0
22:00-23:00	1	0
23:00-24:00	1	0
Total	132	35

LE-16-B-01

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	2	2
08:00-09:00	4	2
09:00-10:00	8	7
10:00-11:00	7	2
11:00-12:00	7	2
12:00-13:00	7	5
13:00-14:00	6	2
14:00-15:00	5	0
15:00-16:00	6	0
16:00-17:00	5	2
17:00-18:00	5	0
18:00-19:00	6	0
19:00-20:00	5	0
20:00-21:00	4	0
21:00-22:00	3	0
22:00-23:00	1	0
23:00-24:00	0	0
Total	82	22

KC-16-B-01

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	1	1
08:00-09:00	3	1
09:00-10:00	6	5
10:00-11:00	6	1
11:00-12:00	5	1
12:00-13:00	5	4
13:00-14:00	5	1
14:00-15:00	4	0
15:00-16:00	5	0
16:00-17:00	4	1
17:00-18:00	4	0
18:00-19:00	5	0
19:00-20:00	4	0
20:00-21:00	3	0
21:00-22:00	2	0
22:00-23:00	1	0
23:00-24:00	0	0
Total	63	17

NT-16-B-01

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	1	1
08:00-09:00	2	1
09:00-10:00	5	4
10:00-11:00	4	1
11:00-12:00	4	1
12:00-13:00	4	3
13:00-14:00	4	1
14:00-15:00	3	0
15:00-16:00	4	0
16:00-17:00	3	1
17:00-18:00	3	0
18:00-19:00	4	0
19:00-20:00	3	0
20:00-21:00	3	0
21:00-22:00	2	0
22:00-23:00	0	0
23:00-24:00	0	0
Total	51	13

GL-16-B-02

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	3	3
08:00-09:00	6	3
09:00-10:00	13	11
10:00-11:00	12	3
11:00-12:00	12	3
12:00-13:00	11	8
13:00-14:00	10	3
14:00-15:00	9	0
15:00-16:00	10	0
16:00-17:00	9	3
17:00-18:00	8	0
18:00-19:00	10	0
19:00-20:00	9	0
20:00-21:00	7	0
21:00-22:00	5	0
22:00-23:00	1	0
23:00-24:00	1	0
Total	136	36

ES-16-B-02

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	1	1
08:00-09:00	2	1
09:00-10:00	5	4
10:00-11:00	4	1
11:00-12:00	4	1
12:00-13:00	4	3
13:00-14:00	4	1
14:00-15:00	3	0
15:00-16:00	4	0
16:00-17:00	3	1
17:00-18:00	3	0
18:00-19:00	4	0
19:00-20:00	3	0
20:00-21:00	3	0
21:00-22:00	2	0
22:00-23:00	0	0
23:00-24:00	0	0
Total	50	13

DS-16-B-02

Time GFAm2	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	1	1
08:00-09:00	2	1
09:00-10:00	4	3
10:00-11:00	4	1
11:00-12:00	4	1
12:00-13:00	4	3
13:00-14:00	3	1
14:00-15:00	3	0
15:00-16:00	3	0
16:00-17:00	3	1
17:00-18:00	3	0
18:00-19:00	3	0
19:00-20:00	3	0
20:00-21:00	2	0
21:00-22:00	1	0
22:00-23:00	0	0
23:00-24:00	0	0
Total	43	11

IR-16-B-01

Time	LGVs TOTAL ARRIVALS	HGVs TOTAL ARRIVALS
GFAm2		
00:00-01:00	0	0
01:00-02:00	0	0
02:00-03:00	0	0
03:00-04:00	0	0
04:00-05:00	0	0
05:00-06:00	0	0
06:00-07:00	0	0
07:00-08:00	1	1
08:00-09:00	2	1
09:00-10:00	4	3
10:00-11:00	4	1
11:00-12:00	4	1
12:00-13:00	3	3
13:00-14:00	3	1
14:00-15:00	3	0
15:00-16:00	3	0
16:00-17:00	3	1
17:00-18:00	3	0
18:00-19:00	3	0
19:00-20:00	3	0
20:00-21:00	2	0
21:00-22:00	1	0
22:00-23:00	0	0
23:00-24:00	0	0
Total	42	11

Appendix D
Estimated Maximum Accumulations (Servicing Bays)

appendix D

TRICS SITES TEST

MAXIMUM ACCUMULATIONS

GL-01-M-01

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	1	2	2	1
08:00-09:00	3	1	1	6	2	1
09:00-10:00	6	5	3	9	9	5
10:00-11:00	6	1	1	8	2	1
11:00-12:00	6	1	1	8	2	1
12:00-13:00	6	4	2	10	7	4
13:00-14:00	5	1	1	9	2	1
14:00-15:00	4	0	0	8	0	0
15:00-16:00	5	0	0	9	0	0
16:00-17:00	4	1	1	8	2	1
17:00-18:00	4	0	0	7	0	0
18:00-19:00	5	0	0	9	0	0
19:00-20:00	4	0	0	8	0	0
20:00-21:00	4	0	0	7	0	0
21:00-22:00	2	0	0	4	0	0
22:00-23:00	1	0	0	1	0	0
23:00-24:00	0	0	0	1	0	0
Total	**6**	**5**	**3**	**10**	**9**	**5**

ES-01-M-02

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	1	2	2	1
08:00-09:00	2	1	1	4	2	1
09:00-10:00	5	4	2	8	7	3
10:00-11:00	4	1	1	7	2	1
11:00-12:00	4	1	1	7	2	1
12:00-13:00	4	3	2	7	5	3
13:00-14:00	4	1	1	6	2	1
14:00-15:00	3	0	0	6	0	0
15:00-16:00	4	0	0	6	0	0
16:00-17:00	3	1	1	5	2	1
17:00-18:00	3	0	0	5	0	0
18:00-19:00	4	0	0	6	0	0
19:00-20:00	3	0	0	6	0	0
20:00-21:00	3	0	0	5	0	0
21:00-22:00	2	0	0	3	0	0
22:00-23:00	0	0	0	1	0	0
23:00-24:00	0	0	0	0	0	0
Total	**5**	**4**	**2**	**8**	**7**	**3**

GM-16-B-03

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	4	4	2	7	7	4
08:00-09:00	10	4	2	14	7	4
09:00-10:00	16	12	9	24	20	12
10:00-11:00	14	4	2	22	7	4
11:00-12:00	14	4	2	22	7	4
12:00-13:00	14	9	7	21	15	9
13:00-14:00	13	4	2	19	7	4
14:00-15:00	11	0	0	17	0	0
15:00-16:00	12	0	0	19	0	0
16:00-17:00	11	4	2	16	7	4
17:00-18:00	10	0	0	15	0	0
18:00-19:00	12	0	0	19	0	0
19:00-20:00	11	0	0	17	0	0
20:00-21:00	9	0	0	16	0	0
21:00-22:00	7	0	0	10	0	0
22:00-23:00	2	0	0	3	0	0
23:00-24:00	1	0	0	2	0	0
Total	**16**	**12**	**9**	**24**	**20**	**12**

TW-16-B-02

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	1	2	2	1
08:00-09:00	3	1	1	6	2	1
09:00-10:00	7	5	3	9	10	5
10:00-11:00	6	1	1	9	2	1
11:00-12:00	6	1	1	9	2	1
12:00-13:00	6	4	2	8	7	4
13:00-14:00	5	1	1	9	2	1
14:00-15:00	5	0	0	8	0	0
15:00-16:00	5	0	0	9	0	0
16:00-17:00	5	1	1	8	2	1
17:00-18:00	4	0	0	7	0	0
18:00-19:00	5	0	0	9	0	0
19:00-20:00	5	0	0	8	0	0
20:00-21:00	4	0	0	7	0	0
21:00-22:00	2	0	0	4	0	0
22:00-23:00	1	0	0	1	0	0
23:00-24:00	0	0	0	1	0	0
Total	**7**	**5**	**3**	**9**	**10**	**5**

DC-16-B-02

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	1	2	2	1
08:00-09:00	3	1	1	5	2	1
09:00-10:00	6	5	3	9	9	5
10:00-11:00	6	1	1	10	2	1
11:00-12:00	5	1	1	10	2	1
12:00-13:00	5	4	2	9	7	3
13:00-14:00	5	1	1	9	2	1
14:00-15:00	4	0	0	7	0	0
15:00-16:00	5	0	0	8	0	0
16:00-17:00	4	1	1	7	2	1
17:00-18:00	4	0	0	7	0	0
18:00-19:00	5	0	0	8	0	0
19:00-20:00	4	0	0	7	0	0
20:00-21:00	4	0	0	6	0	0
21:00-22:00	2	0	0	4	0	0
22:00-23:00	1	0	0	1	0	0
23:00-24:00	0	0	0	1	0	0
Total	**6**	**5**	**3**	**10**	**9**	**5**

GL-06-B-01

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	2	2	1	3	3	2
08:00-09:00	4	2	1	7	3	2
09:00-10:00	8	7	4	12	10	6
10:00-11:00	8	2	1	11	3	2
11:00-12:00	8	2	1	11	3	2
12:00-13:00	7	5	3	10	9	5
13:00-14:00	7	2	1	9	3	2
14:00-15:00	6	0	0	8	0	0
15:00-16:00	7	0	0	9	0	0
16:00-17:00	6	2	1	10	3	2
17:00-18:00	5	0	0	9	0	0
18:00-19:00	6	0	0	9	0	0
19:00-20:00	6	0	0	8	0	0
20:00-21:00	5	0	0	8	0	0
21:00-22:00	3	0	0	5	0	0
22:00-23:00	1	0	0	1	0	0
23:00-24:00	0	0	0	1	0	0
Total	**8**	**7**	**4**	**12**	**10**	**6**

LE-16-B-01

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	1	2	2	1
08:00-09:00	3	1	1	5	2	1
09:00-10:00	5	4	2	9	7	4
10:00-11:00	5	1	1	8	2	1
11:00-12:00	5	1	1	8	2	1
12:00-13:00	5	3	2	8	6	3
13:00-14:00	4	1	1	7	2	1
14:00-15:00	4	0	0	6	0	0
15:00-16:00	4	0	0	7	0	0
16:00-17:00	3	1	1	6	2	1
17:00-18:00	3	0	0	6	0	0
18:00-19:00	4	0	0	7	0	0
19:00-20:00	4	0	0	6	0	0
20:00-21:00	3	0	0	5	0	0
21:00-22:00	2	0	0	3	0	0
22:00-23:00	1	0	0	1	0	0
23:00-24:00	0	0	0	1	0	0
Total	**5**	**4**	**2**	**9**	**7**	**4**

KC-16-B-01

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	0	1	1	1
08:00-09:00	2	1	0	3	1	1
09:00-10:00	4	3	2	7	6	3
10:00-11:00	4	1	0	6	1	1
11:00-12:00	4	1	0	6	1	1
12:00-13:00	3	2	1	6	4	2
13:00-14:00	3	1	0	6	1	1
14:00-15:00	3	0	0	5	0	0
15:00-16:00	3	0	0	5	0	0
16:00-17:00	3	1	0	5	1	1
17:00-18:00	3	0	0	4	0	0
18:00-19:00	3	0	0	5	0	0
19:00-20:00	3	0	0	5	0	0
20:00-21:00	2	0	0	4	0	0
21:00-22:00	1	0	0	3	0	0
22:00-23:00	0	0	0	1	0	0
23:00-24:00	0	0	0	0	0	0
Total	**4**	**3**	**2**	**7**	**6**	**3**

NT-16-B-01

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	0	1	1	1
08:00-09:00	2	1	0	3	1	1
09:00-10:00	3	3	1	6	5	2
10:00-11:00	3	1	0	5	1	1
11:00-12:00	3	1	0	5	1	1
12:00-13:00	3	2	1	5	3	2
13:00-14:00	3	1	0	4	1	1
14:00-15:00	2	0	0	4	0	0
15:00-16:00	2	0	0	4	0	0
16:00-17:00	2	1	0	4	1	1
17:00-18:00	2	0	0	4	0	0
18:00-19:00	2	0	0	4	0	0
19:00-20:00	2	0	0	4	0	0
20:00-21:00	2	0	0	3	0	0
21:00-22:00	1	0	0	2	0	0
22:00-23:00	0	0	0	1	0	0
23:00-24:00	0	0	0	0	0	0
Total	**3**	**3**	**1**	**6**	**5**	**2**

GL-16-B-02

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	2	2	1	3	3	2
08:00-09:00	4	2	1	7	3	2
09:00-10:00	9	7	4	12	10	6
10:00-11:00	8	2	1	11	3	2
11:00-12:00	8	2	1	11	3	2
12:00-13:00	8	5	3	11	9	5
13:00-14:00	7	2	1	10	3	2
14:00-15:00	6	0	0	8	0	0
15:00-16:00	7	0	0	9	0	0
16:00-17:00	6	2	1	8	3	2
17:00-18:00	5	0	0	9	0	0
18:00-19:00	7	0	0	9	0	0
19:00-20:00	6	0	0	8	0	0
20:00-21:00	5	0	0	9	0	0
21:00-22:00	3	0	0	5	0	0
22:00-23:00	1	0	0	1	0	0
23:00-24:00	1	0	0	1	0	0
Total	**9**	**7**	**4**	**12**	**10**	**6**

ES-16-B-02

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	0	1	1	1
08:00-09:00	2	1	0	3	1	1
09:00-10:00	3	3	1	6	5	2
10:00-11:00	3	1	0	5	1	1
11:00-12:00	3	1	0	5	1	1
12:00-13:00	3	2	1	5	3	2
13:00-14:00	3	1	0	4	1	1
14:00-15:00	2	0	0	4	0	0
15:00-16:00	2	0	0	4	0	0
16:00-17:00	2	1	0	4	1	1
17:00-18:00	2	0	0	4	0	0
18:00-19:00	2	0	0	4	0	0
19:00-20:00	2	0	0	4	0	0
20:00-21:00	2	0	0	3	0	0
21:00-22:00	1	0	0	2	0	0
22:00-23:00	0	0	0	1	0	0
23:00-24:00	0	0	0	0	0	0
Total	**3**	**3**	**1**	**6**	**5**	**2**

DS-16-B-02

Time	AVERAGE DWELL TIMES LGVs	RIGIDS	ARTICS	85th PERCENTILE DWELL TIMES LGVs	RIGIDS	ARTICS
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	0	1	1	1
08:00-09:00	1	1	0	2	1	1
09:00-10:00	3	2	1	5	4	2
10:00-11:00	2	1	0	4	1	1
11:00-12:00	2	1	0	4	1	1
12:00-13:00	2	2	1	4	3	2
13:00-14:00	2	1	0	4	1	1
14:00-15:00	2	0	0	3	0	0
15:00-16:00	2	0	0	4	0	0
16:00-17:00	2	1	0	3	1	1
17:00-18:00	2	0	0	3	0	0
18:00-19:00	2	0	0	4	0	0
19:00-20:00	2	0	0	3	0	0
20:00-21:00	2	0	0	3	0	0
21:00-22:00	1	0	0	2	0	0
22:00-23:00	0	0	0	0	0	0
23:00-24:00	0	0	0	0	0	0
Total	**3**	**2**	**1**	**5**	**4**	**2**

IR-16-B-01	AVERAGE DWELL TIMES			85th PERCENTILE DWELL TIMES		
Time	**LGVs**	**RIGIDS**	**ARTICS**	**LGVs**	**RIGIDS**	**ARTICS**
00:00-01:00	0	0	0	0	0	0
01:00-02:00	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0
03:00-04:00	0	0	0	0	0	0
04:00-05:00	0	0	0	0	0	0
05:00-06:00	0	0	0	0	0	0
06:00-07:00	0	0	0	0	0	0
07:00-08:00	1	1	0	1	1	0
08:00-09:00	1	1	0	2	1	0
09:00-10:00	3	2	1	5	4	2
10:00-11:00	2	1	0	4	1	0
11:00-12:00	2	1	0	4	1	0
12:00-13:00	2	2	1	4	3	1
13:00-14:00	2	1	0	4	1	0
14:00-15:00	2	0	0	3	0	0
15:00-16:00	2	0	0	4	0	0
16:00-17:00	2	1	0	3	1	0
17:00-18:00	2	0	0	3	0	0
18:00-19:00	2	0	0	4	0	0
19:00-20:00	2	0	0	3	0	0
20:00-21:00	2	0	0	3	0	0
21:00-22:00	1	0	0	2	0	0
22:00-23:00	0	0	0	0	0	0
23:00-24:00	0	0	0	0	0	0
Total	**3**	**2**	**1**	**5**	**4**	**2**

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