Department of the Environment, Transport & the Regions

Methods for Determining Parking in New Developments

DRAFT FINAL REPORT (ANNEXES)

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Contents

1 *Introduction*

1.1.1 This set of papers includes specific items of work undertaken during the course of the DETR national research into methods of devising parking standards. Some of the items were undertaken within the terms of the original study brief, while other additional pieces of work were undertaken in response to separate requests from by the DETR.

2 *Accessibility mapping*

2.1 *Overview*

2.1.1 The study has explored methods of measuring and displaying accessibility, with a view to testing their usefulness in developing parking provision techniques. Here we provide a non-technical summary of the work done and the conclusions reached.

2.1.2 The first stage of the work was to examine the feasibility of measuring accessibility in a way that could assist in the definition of accessibility zones. (The context of this is explained in the main report.) This was tested using Eastbourne as an example location. In addition some similar work was undertaken for Leeds city centre.

2.1.3 A second stage of the work looked more closely at the impact on accessibility measurement of different assumptions about threshold journey times (catchments), and the inclusion or otherwise of the non-motorised modes. These "sensitivity tests" and the

2.1.4 The overall conclusion that may be drawn from this work is that accessibility measurement and mapping, both in terms of absolute measures, and relative measures to produce accessibility indices, can be undertaken using proprietary GIS and other software. Moreover, the work can be undertaken within a fairly short timescale and at reasonable cost.

2.1.5 A further conclusion is that such accessibility measurement can be undertaken both to map areas or zones of varying accessibility, and to establish the accessibility of a particular location or development site.

2.2 *Initial accessibility mapping tests*

2.2.1 The initial work was related to the production of maps showing zones of varying accessibility. This assumed that urban areas and their surrounding areas would be divided into four zones. The accessibility criteria that were assumed for each of the four zones are shown in the table below.

2.2.2 The zone definitions use accessibility by walk, cycle and public transport explicitly. Accessibility by car (or other road vehicles) is involved implicitly in the notion of "intended catchment". The work therefore included accessibility by private transport, public, transport, and non-motorised modes.

2.2.3 The aim was to test the feasibility and usefulness of accessibility measures as aides in defining the four land-use Zones, and to comment on the practicalities involved.

Accessibility Criteria and Zone Definitions

	Zone Type 1	Zone Type 2	Zone Type 3	Zone Type 4
Walk/cycle access	Very good to good range of activities including specialised and regional facilities	Range of employment, retail, leisure and other services	Mostly residential, with local centres, services and employment	Some local facilities and employment
Public transport access	Serves wide catchment. Service frequency very good to good	Catchment covers much of urban area. Service frequency good to moderate	Connected to town centre. Service frequency moderate to low	Service frequency moderate to sparse
Intended catchment (of non-residential activities in the Zone)	Inter/national, regional, urban	Urban	Local urban	Rural

2.2.4 *Technology and test location*

2.2.5 All the measures have been constructed using a widely available Geographic Information System (GIS) called MapInfo. This is a fairly typical GIS package, in that it provides detailed mapping information that can be linked to population databases. The population data is linked to areas that can be disaggregated spatially as far down as Enumeration Districts (EDs). The population information is based on the Census, updated with more recent survey work.

2.2.6 GIS has been used as the analysis tool for two reasons. First, it provides a substantial database of population and infrastructure information, which can be used to make objective and verifiable assessments, and second, it can be used to plot the results pictorially as an effective aid to interpretation and use.

2.2.7 Eastbourne was used as a test case. The town was chosen because it was judged to be large enough to be a useful test case, without being overwhelmingly complex, and the consultants already had detailed knowledge of the bus services operating there.

2.2.8 *Zones and EDs*

2.2.9 The GIS handles population data down to ED level, or larger groupings may be defined as needed. This study was carried out at the ED level of detail, although, as will be seen, one conclusion was that in some cases larger zones might be used. However to avoid confusion between "Zones" in the sense of the Zone Matrix, and "zones" in the sense of the GIS, we refer to EDs in the remainder of this text, recognising that in other applications larger aggregations of spatial data might be appropriate.

2.2.10 *Measuring access times*

2.2.11 Although several definitions of accessibility are available, they all depend upon a measure of access time between an origin and destination. There are differences in how this time is measured for the different modes.

2.2.12 For private transport it is relatively straightforward. MapInfo contains information about the roads, but is not capable of estimating travel times from one point to another through a network. Add-on products are available to do this, however, and the one we have used is called Drivetime. More details about Drivetime are given in the technical Annex. For now we only note that it is fully integrated with MapInfo, contains detailed information about driving speeds on different categories of road, and can search through a network to find the minimum drive time between any pair of points on that network.

2.2.13 For walk and cycle a similar process can be used, because Drivetime will generate the distances between any pair of points in the network, and by making assumptions about average walk and cycle speeds, it is straightforward to generate information about travel times. There is a limitation here in that Drivetime only includes roads longer than 100 metres and does not include footpaths and cyclepaths that are separate from the road network. This may introduce some coarseness for the walking measures, but we did not judge this to be too significant, for 100 metres is not large in comparison to the size of the EDs from which population data is drawn.

2.2.14 The situation is more complex for public transport[1]. A useful measure of accessibility by public transport might include:

- The walk time to and from the bus stops;
- The wait time;
- The time spent travelling;
- The time spent at interchanges, plus perhaps an interchange "penalty".

2.2.15 A single measure of travel time (the "generalised time") can be constructed from the sum of these components. There are complications when services run in parallel for part of their length for then the traveller may have a choice of service, and the apparent service frequency available will be higher than that offered by any of the individual services. On the other hand if the services diverge further down the road, this may not be the case.

2.2.16 Public transport modelling software is available to handle this type of situation. It is however rather specialised, and we would not expect all local authorities to have access to it. We have therefore attempted two ways of handling public transport accessibility. One is based on an accurate calculation of the travel time components using the modelling package TRIPS. The other was to construct a simplified representation of the public transport services in a format that can be handled entirely by the GIS software.

2.2.17 The technical Annex (3) describes more precisely how these representations of the bus network were constructed. The TRIPS model is an accurate representation of the network that can provide generalised times for trips between any pair of EDs, taking into account interchanges, parallel running and service frequencies. The simplified model uses the subset of the road network on which buses operate, with travel times adjusted to reflect the typically slower bus drive speeds. Service frequencies are only recognised in terms of the total frequencies available at the bus stops. It does not recognise individual routes, and assumes in effect that people can travel through the bus network in a similar way as they travel

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[1] For the sake of simplicity we only considered bus in this exercise, although Eastbourne does of course have a railway station. The principles tested here would also apply to rail.

through the road network by car. In circumstances where frequencies are low, this assumption is unlikely to reflect travel behaviour and allowance needs to be made for this. Both models include walk times to and from the bus network.

2.2.18 Map 1 shows the roads on which buses run in Eastbourne. This is the "sub-network" used in the simplified representation of public transport.

2.2.19 *Number of EDs*

2.2.20 It was decided to base the study on EDs in the first place, on the grounds that this would provide the maximum level of detail. There are approximately 220 EDs in the Eastbourne study area. However the Drivetime software we used could only provide travel time matrices for approximately 100 areas at a time (an upgrade is available that can handle more than this). For this reason we took a random sample of 100 EDs out of the 220 available. This has some implications for the data plots, which are discussed later.

2.2.21 *Results*

2.2.22 Maps 2 to 10 plot the results obtained, beginning with the simplest measures.

2.2.23 Map 2 shows the accessibility of one particular ED (shaded blue, in the centre of Eastbourne) by public transport. The generalised access time to the ED, based on the more detailed TRIPS model, has been colour coded into five-minute bands. The map provides a clear visual presentation of the time taken to reach the target ED by bus.

2.2.24 The same type of plot can be produced for car access, or any other mode. Sometimes however it is necessary to compare the accessibility offered by different modes. One way of doing this is shown in Map 3. In this case the access times to the same target ED by public transport and car have been calculated and the ratios calculated and coded into bands represented by colours. EDs with high ratios, coloured in red, have relatively poor public transport access to the target ED compared to car. The yellow EDs are those for which public transport does better. It is striking that the areas closest to the target zone have some of the poorest scores. This arises because the walk times to and from bus stops are a large proportion of the public transport access time for these areas, but do not appear in the car access time. Walk times to public transport are less important proportionally among the outer areas.

2.2.25 Map 4 shows an alternative assessment of relative accessibility. For each zone we have calculated the number of people living within 20 minutes drive time and 20 minutes access time by bus, and taken the ratio of the two. Again the ratios have been coded into bands represented by colours. High values indicate areas with substantially higher car-based catchment populations than public transport. In general these tend to be on the outside of the study area. (The ratio values are often very large: the upper band is for ratios of 26 or more.)

2.2.26 The remaining plots are for area-wide measures of accessibility. These combine information about access times and populations. The measures are based on those described by Jones and discussed in the review of accessibility techniques. Destination accessibility is a measure of the catchment for a particular destination, and is weighted by population:

2.2.27 Destination Accessibility (A) for zone j is given by

$$A_j = \sum_i P_i f(c_{ij})$$

where j is the destination zone (or ED), c_{ij} is the cost or time between the two points, P is population of the origin, and the function f allows for the fairly obvious notion that accessibility should be high where the cost is low, and decline to zero as the cost rises.

2.2.28 The plots look at every other ED in turn, looks up its population, multiplies that by an "accessibility function" of the generalised time to zone i, and sums. The accessibility function $f(time_{ij})$ is an explicit statement of how we wish to relate accessibility to access time. The function takes the value 1 when the access time is zero, meaning the best possible accessibility, and falls as time rises, to a minimum of zero, meaning "no access". We can choose the shape of this function to reflect priorities about accessibility and the modes being considered. In this study three accessibility functions have been tested.

1 Function 1 takes the value 1 when the access time is zero, and declines smoothly passing through 0.5 when the time is 10 minutes, 0.2 when the access time is 20 minutes, and falls towards zero thereafter. This measure gives weight to fairly short journeys, and expresses the view that above 20 minutes should be considered as poor accessibility. It might be most suited to measures of walking accessibility.

2 Function 2 declines more slowly, so it gives greater weight to longer journeys. At 20 minutes it gives the value 0.6, and declines to about 0.13 at a journey time of 40 minutes. This might be appropriate for car or bus journeys.

3 Function 3 takes the value one for all journeys up to 15 minutes, then falls linearly, reaching zero when the access time is 55 minutes. In practice this might be suited to rail access, where short journeys of less than 15 minutes are infrequent, and the trips of interest lie in the range 15 to 55 minutes. The catchment limit is taken to be 55 minutes.

2.2.29 The result is, for each ED, a measure of accessibility that reflects access times and the catchment populations. Large values occur in areas where large numbers of people have good access to the zone. Small values indicate a low population in the vicinity, poor transport links, or both.

2.2.30 The scale for the access measure is not easy to interpret directly. What matters however is the relative score for each ED. For this reason we have ranked the scores for each ED, and divided them into five bands with roughly equal numbers of EDs in each. The top band, coloured in dark red, therefore represents the top 20% of the EDs tested. The yellow EDs are the bottom 20% where accessibility is poorest.

2.2.31 Map 5 plots the area wide accessibility measure for access by car, using the first of the accessibility functions discussed above.

2.2.32 The picture is fairly clear. The highest scoring areas are those in the central area, to which large numbers of people have good access by car[2]. The outer areas have poorer accessibility, because of lower

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[2] We used total ED populations in this work, but the GIS database contains information about numbers of households with and without cars in each ED. It is straightforward

adjacent populations and/or longer drive times to significant populations.

2.2.33 There are two distorting effects we note here. The first is that the measures for the outer areas will tend to be artificially reduced because no populations are available outside them. It is as if Eastbourne is located in a void with no surrounding population. In any real use of this measure attention would have to be given to boundary effects of this type[3]. The second distortion arises because of the sampling process we used. Areas that have no contiguous populations because no adjacent areas happen to have been sampled will also have their measures artificially reduced. In a real application, a zone structure must be selected which allows full coverage of the study area, with no gaps.

2.2.34 Maps 6 and 7 show the same type of measure, but using accessibility functions two and three. The visual pattern conveyed is essentially the same. In a few cases areas have moved up or down one band, but the picture of high accessibility in the more central EDs and lower accessibility elsewhere is preserved.

2.2.35 Map 8 shows the area wide accessibility measure for public transport, using the TRIPS model of the bus network, and the second accessibility function. The highest service frequencies were along the coastal corridor, and this is clearly reflected in the colouring of the EDs. As with car, the visual impression conveyed by the plots does not vary significantly when either of the other two accessibility functions is used (not shown here).

2.2.36 Map 9 shows the area wide measure for public transport using the simplified GIS model of the bus network, and the first accessibility function. Although in general the pattern is similar, there are some EDs that have changed their relative position by more than one band. The ED near the centre of the picture, on the west of the railway line and below the Hampden Park label has moved up from the fourth band to the second. This occurs because the simplified model overstates the quality of the bus service available to this zone.

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therefore to restrict any of these measures and plots to car owners, or those without access to cars.

[3] The zones along the coast really do have no population beyond them, yet still have some of the best scores, so perhaps the effect is not too severe.

2.2.37 Finally Map 10 is a plot of area wide accessibility for walking. This has been calculated in the same way as for car, in that routes through the network have been identified between each pair of EDs, and the accessibility measure calculated, using assumed walking speeds of 5 kph and the first accessibility function.

2.2.38 *Using these measures to define Location Zones*

2.2.39 One of the motives for this work was to develop accessibility measures that could be used to help define four location Zones as already described.

2.2.40 Taking public transport first, the criteria refer to the catchments served by public transport, and the service frequencies. Map 2 shows how the catchment for any given location can be assessed and displayed. It presents an assessment of one ED such as may be helpful in considering a particular development application. However if the zone boundaries are to be defined consistently we have to distinguish between levels of accessibility by public transport throughout the study area, and for this the area wide measures such as in Maps 8 and 9 are needed. Both maps show clearly where public transport accessibility is good, and where not, using the term "good" in a relative sense. Although we chose to use five colour bands to display this data, the obvious thing to do would be to use four bands to provide an immediate outline plot of where the location zone boundaries may lie.

2.2.41 The ranking of EDs was not particularly sensitive to the choice of accessibility function (although the actual scores obtained were, of course). This is useful, because it suggests that where relative assessments are being made the choice of function is not too critical.

2.2.42 The GIS we used contained no information about the types of facility located in the area, other than numbers of houses. This is probably fairly typical of the lower cost GIS packages, although local authorities could add this information if they wished.

2.2.43 What is clear however is that for both walk and cycle it is possible to assess the catchment of any given location, much as in Map 2, or to produce area wide accessibility measures as in Map 10. Map 10 classifies EDs according to the populations within walking range, and as with public transport, a good start would be to use four colour bands to provide an initial assessment of where the locational zone boundaries might lie, based on walking catchments. Interpreting the map in terms of types of facility requires additional information that the local authority users would have to bring.

2.2.44 One qualification is that this method says nothing about the quality of the walking or cycling environment. It is based strictly on shortest walk times through the road network, with no qualitative information.

2.2.45 Accessibility measures only indicate what is possible, but do not say anything about what will actually happen. They are not forecasting tools, and will not forecast mode shares, for example. However some indication of the relative advantages of competing modes can be gained from the relative accessibility measures such as Maps 3 and 4. It is thus possible to present the percentage of the catchment population that potentially can access by non-car modes.

2.2.46 *Overview of accessibility measurement*

2.2.47 From the point of view of practicality, GIS provides a relatively straightforward means of calculating and presenting a variety of accessibility measures. It is possible to provide an initial classification of EDs into the four locational Zones on the basis of area-wide accessibility measures for any mode.

2.2.48 There are some difficulties. Boundary problems can artificially lower the area wide accessibility measure of EDs on the outer edge of a study area. To reduce this, the coverage of the GIS would have to be larger than the target study area. In this test study we had to sample EDs because of restrictions in the software used. This introduced error in the accessibility measures for some EDs. In practice it will be necessary to avoid gaps in the coverage, either by using an upgraded version of the software, capable of handling more EDs, or by clustering EDs together.

2.2.49 The simplified representation of the public transport network used here provided a reasonable approximation, but it was clear that sufficient error was introduced to misallocate some EDs to locational Zones. Many local authorities will not have public transport modelling software available, and the simplified approach would have to be used in such cases. It would be wise to review by hand the results obtained in these cases.

Maps relating to the initial accessibility measurement exercise

3 *Accessibility measures – sensitivity tests*

3.1 *Introduction*

3.1.1 Steer Davies Gleave was commissioned by DETR in October 1998 to carry out sensitivity tests on the accessibility measures produced in the main contract for 'Methodologies for Devising Parking Standards' research.

3.1.2 The results of sensitivity tests of measures of relative accessibility, based on ratios of catchment populations are described here. The sensitivity analysis included a series of tests to explore the importance of catchment times and other variations in the definition of relative accessibility. Conclusions on the suitability of the ratio model are given.

3.2 *Method*

3.2.1 In the original accessibility work, two main types of accessibility measures were discussed: area wide measures of accessibility and assessments of relative accessibility. This additional work concentrates on measures of relative accessibility, designed to compare accessibility between different modes.

3.2.2 Measures of relative accessibility are based on a comparison of catchment populations for zones in a study area. When calculating the catchment population of a particular destination, people are included if they live within a predefined access-time threshold. Access times vary between modes and therefore population catchments will vary as well. For example, some people might live within a 20 minutes drive and within a 30 minutes bus trip from a shopping centre. If the time threshold were defined as 25 minutes, these people would be included in the 25 minutes 'car' catchment of that shopping centre but not in the 25 minutes 'bus' catchment. An indication of the relative accessibility for a zone for public transport vs. car would be obtained by taking the ratio of the public transport catchment population and the car catchment population. Population data is based on the Census and available in a widely available Geographic Information System (GIS), called MapInfo.

3.3 *Access times and the ratio model*

3.3.1 All measures of accessibility used are based upon a measure of access time between origins and destinations. There are differences in how this access time is measured for the different modes.

3.3.2 For private transport it is relatively straightforward. Access times are based upon the time it takes to get onto the road network, the time it takes to drive to the destination and the time to find a parking space. In some cases a distance based cost element is included to reflect the operational costs of driving a car (i.e. fuel costs); in others parking charges are included. In both cases these costs are converted into a time element by using an appropriate Value of Time.

3.3.3 For public transport the situation is more complex. A useful measure of travel time might include:

- The walk time to and from the bus stop;
- The wait time (usually taken as half the headway between buses);
- The in-vehicle time;
- Time spent at interchanges, plus perhaps an interchange penalty;
- The walk time from the bus stop to the destination.

Sometimes fares are included and these are converted into a time element by using an appropriate Value of Time.

3.3.4 A number of sensitivity tests included walk and cycle access. For these modes access times were based on the distance cycled or walked, with a uniform walk and cycle speed applied.

3.3.5 These measures of access times are similar to those used in the previous work. However a number of sensitivity tests carried out additionally included the 'monetary elements' bus fare, parking charge and car operational cost. These elements were not included in previous work.

3.4 *Test Locations*

3.4.1 *Eastbourne*

3.4.2 Eastbourne was used as a test case in the earlier work. The previous accessibility study of Eastbourne was carried out at the Enumeration District (ED) level of detail and a random sample of 100 ED's was reviewed. Car access times were based on the Drivetime function in the GIS package MapInfo. Public transport access times were based on a network in TRIPS. All access times were based on a typical inter peak period only.

3.4.3 In this exercise all ED's were included, because using a sample as previously was found to cause small distortions in the analysis. Software limitations prevented the further use of the Drivetime function in MapInfo. Therefore the network as used by Drivetime was converted for use by the transport-modelling package TRIPS. This software was then used to determine the access time between zone pairs. The same public transport network in TRIPS was used in this study as in the original exercise. The network was updated to include all ED's in the Eastbourne study area.

3.5 *Leeds*

3.5.1 The city of Leeds was used as a test case, as it was one of the case studies in the 'Methods for Devising Parking Standards' programme of research. The Leeds transport model was used to provide access times for public transport and highway modes. As opposed to Eastbourne access times for Leeds were based on the AM peak period and all included the 'monetary' elements in their access time definitions. There are almost 400 zones in the model, going out of the city centre as far as Bradford and Harrogate.

3.5.2 The Leeds transport model was originally developed for the evaluation of the Leeds Supertram system. Travel times were mainly validated along the future Supertram corridors. Radial and other non-city centre trips might not necessarily be represented accurately. Therefore catchment populations and accessibility ratios were just calculated for zones in Leeds city centre, although taking into account access from zones further out.

3.6 *Sensitivity Tests*

3.6.1 For any zone the accessibility ratio is defined as:

$$\frac{\text{Population living within X minutes access by public transport}}{\text{Population living within X minutes by car}}$$

The values obtained depend upon the value selected for X. The aim of these tests was to examine how different choices for X affect the overall results.

3.6.2 In the base case the entire population of a zone is considered to be in scope, i.e. part of the catchment population. However, in reality not every person might have access to each mode of transport. One of the variations is to use Census data on car ownership, to exclude people without a car from the car catchment calculation. For each zone the population, the number of households and the number of households with no cars were given. It was assumed that the proportion of people without access to a car would be similar to the proportion of households with no car. These people were excluded from the car catchment population.

3.6.3 The base case compares catchment populations of bus and car modes. However buses might not be available for all trips and for a number of trips it might be more practical to walk or to cycle. Therefore a number of sensitivity tests included the modes walking and cycling. The public transport catchment then becomes:

Population living within X minutes by PT, or Walk, or Cycle.

3.6.4 A number of sensitivity tests looked at including bus fares, fuel costs and parking charges in the definition of access times. The monetary elements were all extracted using the TRIPS software.

3.7 *Eastbourne*

3.7.1 The accessibility tests for Eastbourne were divided into two sets. In the first set monetary elements were excluded, but they were included in the second. To convert monetary elements into time elements two Values of Time (VOT) were assumed: 6 pence per minute for car users and 2.5 pence per minute for users of public transport. These are typical values as used for travellers in the United Kingdom.

3.7.2 The base case (first test) is defined as bus catchment versus car catchment, a 20 minutes time threshold and no monetary elements included. Various sensitivity tests then examine the effect of change in the threshold time, the monetary elements, car availability and walk and cycle access. The following sensitivity tests were defined:

Time threshold	Population Catchments	Monetary Elements Included	Parking Charge Included	Correction for car availability
20 minutes	Bus vs. Car	N	N	N
20 minutes	Bus vs. Car	N	N	Y
20 minutes	Bus/Walk/Cycle vs. Car	N	N	N
10 minutes	Bus vs. Car	N	N	N
30 minutes	Bus vs. Car	N	N	N
20 minutes	Bus/Walk/Cycle vs. Car	N	N	Y
20 minutes	Bus vs. Car	Y	N	N
20 minutes	Bus vs. Car	Y	N	Y
20 minutes	Bus/Walk/Cycle vs. Car	Y	N	N
10 minutes	Bus vs. Car	Y	N	N
30 minutes	Bus vs. Car	Y	N	N
20 minutes	Bus/Walk/Cycle vs. Car	Y	N	Y
20 minutes	Bus vs. Car	Y	Y	N

3.8 *Leeds*

3.8.1 Four sensitivity tests were defined for the city of Leeds. In the Leeds transport model all access times included monetary terms and car access times included city centre parking charges as well. Because of the way the Leeds transport model was built, it was not possible to separate these elements out, without going through a lengthy process.

3.8.2 Because of this, the average generalised access time between zone pairs is higher than for Eastbourne. The base case was therefore defined as bus catchment versus car catchment, a 35 minutes time threshold and all monetary elements included. Various sensitivity tests then examine the effect of change in the threshold time and including walk and cycle access.

The following sensitivity tests were defined for Leeds:

Test	Time threshold	Catchment Ratio
1	35 minutes	Bus vs. Car
2	25 minutes	Bus vs. Car
3	45 minutes	Bus vs. Car
4	35 minutes	Bus/Walk/Cycle vs. Car

3.9 *Results*

3.9.1 Accessibility ratios for all sensitivity tests were plotted and are in Figures 1 to 19. For ease of comparison, Figure 1 reproduces all the Eastbourne plots on a single page and Figure 15 does so for Leeds.

3.10 *Eastbourne*

3.10.1 The Table below shows the results of the sensitivity tests for Eastbourne. A classification for the calculated ratios was defined, using ten different bands. For each test the number of zones in each ratio band are shown as well as the average ratio. Comparing the classification of sensitivity tests with the base case gives an indication of the effect of different definitions on the accessibility ratios.

Summary of Eastbourne sensitivity tests

	TEST												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Ratio													
0	*2*	*2*	*0*	*41*	*1*	*1*	*23*	*23*	*1*	*42*	*22*	*0*	*23*
0.0-0.1	*74*	*45*	*3*	*164*	*6*	*0*	*196*	*196*	*0*	*176*	*197*	*0*	*180*
0.1-0.2	*45*	*45*	*26*	*14*	*9*	*16*	*0*	*0*	*28*	*1*	*0*	*2*	*11*
0.2-0.3	*48*	*28*	*48*	*0*	*27*	*10*	*0*	*0*	*57*	*0*	*0*	*23*	*5*
0.3-0.4	*36*	*29*	*63*	*0*	*24*	*29*	*0*	*0*	*70*	*0*	*0*	*36*	*0*
0.4-0.5	*14*	*27*	*64*	*0*	*30*	*37*	*0*	*0*	*63*	*0*	*0*	*38*	*0*
0.5-0.6	*0*	*26*	*15*	*0*	*17*	*37*	*0*	*0*	*0*	*0*	*0*	*43*	*0*
0.6-0.7	*0*	*17*	*0*	*0*	*41*	*37*	*0*	*0*	*0*	*0*	*0*	*63*	*0*
0.7-0.8	*0*	*0*	*0*	*0*	*54*	*47*	*0*	*0*	*0*	*0*	*0*	*14*	*0*
0.8-0.9	*0*	*0*	*0*	*0*	*10*	*5*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Average	*0.18*	*0.29*	*0.34*	*0.03*	*0.53*	*0.53*	*0.01*	*0.02*	*0.32*	*0.02*	*0.02*	*0.51*	*0.13*

3.10.2 ***Test1: Base case***

The base case is based on the access times as set out in the previous section. The time threshold used is 20 minutes. As expected the relative accessibility is best along the main corridors in the bus network, with highest values achieved in the town centre of Eastbourne. Towards the edges of the study area the accessibility gets worse. For a number of zones the ratio is zero and this means that there are no people living within 20 minutes access time of public transport. This is because some zones with a long walk to a low frequency bus service have high access times to the bus network.

3.10.3 ***Test 2***

In test two an adjustment was made for car ownership. In the base case the entire population of a zone was included in the car catchment population if the time to reach the destination zone was within the specified time threshold. In reality not everyone has access to a car. Therefore we used the Census data to extract information on car ownership for each ED in Eastbourne.

Using this revised number in the catchment definition the relative accessibility for public transport would be expected to improve. The average ratio goes up from 0.18 to 0.29. The overall picture remains the same, with zones clustered around the main bus corridors and the zones in the city centre retaining the highest relative accessibility.

3.10.4 *Test 3*

In the third test in Eastbourne an allowance was made for walk and cycle access. Car catchment was defined similarly to that in the base case. The population of a zone is included in the public transport catchment when either PT, cycle or walk access is within the specified time threshold.

It was assumed that people walking and cycling would use the same roads as the cars would use. We extracted the shortest distance between two zones and applied a uniform walking and cycling speed to determine walk and cycle access times. For public transport movements the access costs are often high, in comparison to walk and cycle access. Therefore by including walk and cycle access a better relative accessibility for non-car modes would be expected.

The average ratio is almost double the ratio from the base case. We can see an increase in virtually every zone. Zones in the town centre and along the main bus corridors retain the highest accessibility.

3.10.5 *Test 4*

In the previous tests time thresholds of 20 minutes access time were considered. Test 4 uses the same accessibility definition as in the base case but uses a time threshold of 10 minutes.

Irrespective of the journey length there are access costs (i.e. walk and wait time) for public transport movements. In testing low time thresholds they dominate in the total access times and as a consequence the relative accessibility gets worse. The average ratio is very low. In practice there are only few zone pairs that have a public transport access time of less than ten minutes.

3.10.6 *Test 5*

Test 5 is similar to test 4, although a time threshold of 30 minutes was used. Compared to the base case there is an increase in the average ratio, which almost triples from 0.18 to 0.53.

It should be noted that Eastbourne is a small study area. Car access times are made up of access time to the network, the drivetime over the network and the time to reach the destination. As Eastbourne is small and not very congested almost all destinations are within a short access time of each other. Increasing the time threshold from 20 to 30 minutes hardly makes a difference to the car catchment populations, as most people were already included. Much of the increase in car catchment would come from people living outside the study area, so that the ratio in this case probably overstates the relative performance of public transport.

3.10.7 *Test 6*

Test 6 is a combination of test two and three. An allowance was made for walk and cycle access and the car catchment was adjusted for car ownership. Both these changes in definition lead to an increase of the average ratio. In combining the two the average ratio increases to 0.53. This is higher than the average ratio for both test two and three. An increase in relative accessibility is visible for all zones, with the town centre zones still achieving the highest accessibility.

3.10.8 *Test 7*

Test 7 is the first in a range in which allowance is made to include monetary elements in the definition of access times. Test 7 is similar to the base case, but has included bus fares in the public transport access times and the operating costs in the car access times.

Generally the bus fare works out to be a higher penalty in minutes than the car operational cost element. The extra 'cost' for a public transport journey is at least a fixed 22 minutes, because the minimum fare is 55p, irrespective of the distance travelled. Therefore the average ratio has dropped.

3.10.9 *Test 8*

Test 8 is the same as Test 7 with an adjustment for people without access to a car. The relative accessibility improves slightly. Because of the high public transport access costs there are still few people within this catchment and car catchments are dominant in the ratio.

3.10.10 *Test 9*

Test 9 allows for walk and cycle access and can be compared to Test 3. In the definition of walk and cycle access times no monetary terms have been included and they therefore remain unaltered. Car access times are slightly worse than in test case 3. Compared to Test 3 the average ratio is slightly down from 0.34 to 0.32.

3.10.11 *Test 10 and 11*

Test 10 and 11 are similar to test 7, although time thresholds of 10 and 30 minutes were used. The average ratios remain low. Because of the high public transport access costs and the relatively higher penalty in minutes caused by the bus fare compared to the car operational cost, car catchments are dominant in the ratio.

3.10.12 *Test 12*

Test 12 combines test 9 and test 8 and can be compared to Test 6. It includes walk and cycle access and adjusts for people with access to a car. The average ratio is lower than in test 6, for the same reasons as set out under Test 9.

3.10.13 *Test 13*

In the previous tests parking charges are not included in the monetary terms. In Eastbourne there is a mix of parking facilities available. A substantial number of parking spaces are free of charge for short term parking, although there is paid parking as well. In the previous tests it was assumed that there is free parking available everywhere. In Test 13 a parking charge of £1 is introduced for zones in the Eastbourne town centre. This test can be compared to test 7.

Additional monetary elements are now included in the definition of car access times. It is expected that the car catchment within the specified time threshold will be smaller and that there will be an increase in relative accessibility, notably for the zones where the parking charges were introduced. It can be seen that for zones in Eastbourne town centre there is an increase in relative accessibility.

3.11 *Leeds*

3.11.1 The following section summarises the results of the sensitivity tests in Leeds. The cases where the ratio is zero, are due to zones with high parking charges for which the time equivalent exceeds the threshold tested. In these zones the number of people within the catchment is zero and the ratio cannot be calculated. The results are summarised below.

Summary of Leeds sensitivity tests

	Test 1	**Test 2**	**Test 3**	**Test 4**
Ratio band				
0	1	5	1	1
0.1-0.2	39	31	44	0
0.2-0.4	4	3	1	0
0.4-0.6	1	3	0	6
0.6-0.8	0	1	0	21
0.8 and more	1	3	0	18
Average	0.09	0.59	0.06	2.22

3.11.2 *Test 1: Base Case*

The time threshold used in the Leeds base case is 35 minutes. There is not much variation in relative accessibility between the zones in the city centre. A number of zones achieve higher ratios than neighbouring zones. These are mainly the zones in the shopping centre and around the railway station. These zones have a good public transport provision and limited car access. The zone representing the station has a zero car catchment for the defined threshold. This is due to the high parking charge included in the access time for this zone.

3.11.3 *Test 2*

In test 2 a 25 minutes time threshold was used. Compared to test 1 the ratios of relative accessibility are higher. For a number of zones there is no car catchment within the specified access time threshold. It appears that in the morning peak hour it is more advantageous to use public transport to reach the city centre zones. Car access times for city centre zones are generally high.

3.11.4 *Test 3*

Test 3 is similar to test one and two, although a 45 minutes time threshold was used. The relative accessibility ratio decreases. Because of an increase in the access time threshold proportionally more people are included in the car catchment than there are in the bus catchment.

3.11.5 *Test 4*

In Test 4 walk and cycle access is included. Access times are based on distances between zone pairs. A uniform walk speed of 5 kph and a uniform cycle speed of 10 kph were assumed. As in Eastbourne it can be seen that by including these other non-car modes there is an area wide increase in relative accessibility.

3.12 *Conclusions*

3.12.1 It is clear that the impression given by a ratio-based accessibility measure depends on how that measure is defined, and that the use of a single plot or measure in any case may be unwise. The variations reflect the characteristics of each mode:

- Very short time thresholds tend to make public transport look particularly bad, because of relatively high fixed access and wait time associated with it;
- Larger time thresholds improve the relative performance of public transport, but this is partly because the true car catchment is likely to be extended beyond the study area, under representing the car catchment;

- Including walk and cycle increases the non-car catchment (and demonstrates how effective these modes could be for improving accessibility over short distances);
- Including monetary costs tends to reduce the relative performance of public transport because it tends to have a higher marginal cost of travel than car.

4 *Analysis of parking accumulation at TRICS sites*

4.1 *Introduction*

4.1.1 The research reported here forms part of the DETR project "Methodologies for Devising Parking Standards". In December 1998, a report submitted to the Department[4] contained a preliminary analysis of parking accumulation data at a sample of TRICS sites. A further report in February 1999 gave fuller analysis of the TRICS sample, including individual parking accumulation plots for each of the sites.[5] Here we provide a summary of the work.

4.1.2 Assistance and support in the preparation and interpretation of the TRICS data used in this research is gratefully acknowledged from Essex County Council, JMP Consultants, and W S Atkins consultants. The authors take full responsibility, however, for any errors.

4.2 *Overall purpose of the analysis*

4.2.1 Analysis of the TRICS sample sites is focussed specifically on the issue of parking accumulation. As far as we are aware, there have hitherto been few attempts to analyse TRICS data for parking accumulation on an hourly basis, at least on the scale attempted here. The TRICS database is used by local authorities mainly as a source of information on likely peak car trip generation rates at sites comparable to the one being considered for planning permission. It is not generally seen as a resource for establishing patterns of peak parking accumulation. Indeed it is rarely seen as a normative planning tool as used here. Also TRICS is most often used to examine peak car trips at one or two "comparable" developments, rather than for examination of overall patterns for a particular land use type or other aggregated analysis.

4.2.2 The car parks surveyed are in every case Private Non Residential (PNR) car parks. The purpose is to gain a better understanding of the take-up of parking space at different types of development, and in particular to compare parking demand with parking supply. The

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[4] Llewelyn-Davies for Department of the Environment, Transport and the Regions, Methodologies for Devising Parking Standards project, "Report of further studies: response to DETR letter of 19th November 1998.

[5] Llewelyn-Davies for Department of the Environment, Transport and the Regions, Methodologies for Devising Parking Standards project, "Peak parking accumulation: report of further analysis of sample of TRICS sites", February 1999.

pattern of demand and supply is considered in relation to the impact of a theoretical reduction of supply by one third at each site.

4.2.3 The analysis focuses on the following questions:

- To what extent are car parks at Private Non Residential development utilised, and what is the pattern of peak demand?
- What is the variation between land uses in the pattern of parking accumulation?
- What is the variation between different sites of the same land use?
- What relationship is there (if any) between the rate of parking provision (spaces per 1,000 square metres of Gross Floor Area) and peak parking demand?
- What relationship is there (if any) between peak parking demand and the level of public transport provision at the site?

Analysis of parking demand in relation to the location of the site (e.g. town centre, inner ring, suburban, out of town) would potentially be useful, but location information in the TRICS database provides insufficient detail or accuracy to make such analysis meaningful.

4.3 *Method*

4.3.1 *The sample of sites*

4.3.2 From the national TRICS database of development sites, a sample of 126 sites was selected where parking accumulation had been surveyed within the last five years (1994 or later), and to give as wide a spread of land use types and regional location as possible. A few were rejected where there were inconsistencies I the data, leaving a sample of 121 cases.

4.3.3 The land use categories best represented in the TRICS database are A1 retail (food, non-food, and general or mixed retail) and B1 Business. Together these therefore account for 80% of the sample. Some categories of land use are not represented in the TRICS database, or are represented by only a few sites. Available cases were included where the survey date criterion was met.

4.3.4 The land uses with only a few sites available in the sample are:

- B2 General Industry (7 sites)
- B8 Storage or distribution (6 sites)
- C1 Hotel (one site)
- C2 Residential Institutions (two sites, both hospitals)
- D1 Non-residential institutions (one site, a college)
- D2 Assembly and leisure (11 sites, 3 of which excluded from some analyses)

4.3.5 The land uses not represented at all, either in the TRICS database or in the sample are:

- B3, B4, B5, B6, B7 (special industrial groups)
- C3 Dwelling houses

4.3.6 *Comment on the TRICS sample*

4.3.7 The major categories represented in the TRICS database, and also in our sample are A1 (divided in this report between "General", "Food" and "Non-food" retail), and B1 (office/business and residential-compatible industry).

4.3.8 The range of surveys undertaken by TRICS tends to reflect the primary interests of the members of the TRICS group, and thus has not been geared to gaining a comprehensive picture of traffic or parking generation across the entire spectrum of land uses. It is probably fair to say that the TRICS database has to date primarily served the retail planning process.

4.3.9 It should be noted that the TRICS database sites are not considered (or intended) to be representative of development activity across the country. Some land use types are more heavily represented than others, and the geographical spread also is uneven. However, the sample derived for the analysis in this paper is considered to be reasonably representative of the range of sites in the database as a whole.

4.4 *Summary of Results*

4.4.1 *Peak parking demand*

4.4.2 Table 1 provides a summary of peak parking demand for 121 sites. This shows the following results.

- Of the car parks at 121 sites, 97, or 80%, were never recorded as being full. ("Never" in this context relates to the information recorded in the database).
- Almost two thirds of the sites (62%) were never more than two thirds full.

4.4.3 The pattern for all sites in the sample is shown in Figure 1 which shows that:

- The extent of car park utilisation varied somewhat between land uses.

4.4.4 The pattern for main land use categories is shown in Figure 2, which shows that:

- Land uses with excess parking supply most evident are
  - A1 Both Food and Non-Food
  - C1 Hotel (only 2 sites)
  - D1 College (only 1 site)
  - D2 Leisure
- Land uses where parking supply was more often fully taken up, though still with significant over-supply in some cases were:
  - B1 Business
  - B2 Industrial

4.5 *Relating parking demand to supply*

4.5.1 **Figure 3** relates the peak parking demand to the size of the car park at the site. It should be noted that in the TRICS database, parking accumulation sometimes exceeds 100% of supply. In this analysis we have given 100% as the maximum possible accumulation, since it is not known what happens in practice to the excess demand (e.g. whether it is a data error, or whether cars are double parked, or whether the size of the car park has been under-estimated).

4.5.2 There is no apparent relationship between the size of car park provided and the proportion of it taken up at peak times. There is a slight clustering of results around the two-thirds level of peak demand.

4.5.3 **Figure 4** provides the same information for each land use type (excluding those with only a few sites in the sample). Again, there is no apparent relationship for any land use type between parking supply and percentage of take up at the peak.

4.5.4 **Figure 5** shows the relationship for the whole sample between peak demand and the parking supply ***rate*** in terms of number of car parking spaces per 1,000 square metres of Gross Floor Area (GFA). As with size of car park, there is no obvious relationship between the parking provision ratio and peak parking demand.

4.5.5 **Figure 6** gives the same information disaggregated by main land use type. Again the picture for each category is a more or less random scatter of results.

4.6 *Public transport supply*

4.6.1 For most of the sites in the sample, TRICS provides an estimate of the quantity of public transport access to the site. This is classified according to five broad headings (very low, low, medium, high and very high). **Figure 7** shows the mean peak parking level within each category of public transport accessibility.

4.6.2 It may at first seem surprising that peak parking demand (as a percentage of supply) is somewhat higher at sites with higher levels of public transport access. However, factors that may explain this result include:

- Larger car parks being provided in locations with poor public transport;
- Areas with higher public transport access having higher levels of parking pressure, and hence multiple use of the car parks in private developments.

4.6.3 However, the assessment of public transport accessibility in the database is known to be variable, and the information is not recorded at all sites.

4.7 *Site by site analysis*

4.7.1 Parking accumulation was analyses for each of the 121 sites, and the conclusions in this paper are drawn for an aggregation of these analyses. It should be noted that the survey data are in most cases only for a single week or even in some cases a single day. There is likely to be variation in peak demand from week to week, for example due to Christmas shopping in December, and the data do not allow analysis of such variation.

4.7.2 Furthermore, the data in the TRICS database is for the majority of sites more than two years old. It is possible that parking accumulation will have increased since the survey date. **Figure 8** shows the peak parking demand by the year of survey of the individual sites. This does indicate fewer sites with low levels of utilisation in the 1997 surveys compared to those in the 1994 surveys. The reason for better utilisation rates in sites more recently surveyed may be due to a number of factors, not just increasing car access. For example more recent development sites may have somewhat lower levels of parking provision, or they may be subject to planning conditions for the car park to be available for public use.

4.7.3 For some sites, mostly non-food retail, the parking accumulation is known for 5 or 7 days of the week. These show considerable day to day variation of parking accumulation at retail sites. At two B1 sites where multiple-day data are available, the pattern of parking accumulation is much more consistent between the five weekdays but, as expected, markedly lower at the weekends. As might be expected at employment locations, there is little weekday variation at business and industrial sites.

4.8 *Conclusion*

4.8.1 Responses to the basic questions posed at the start of this paper are:

4.8.2 *To what extent are car parks at Private Non Residential development utilised, and what is the pattern of peak demand?*

Overall there is a high degree of under-use of PNR car parks, with roughly two thirds of the sample sites being rarely if ever more than two thirds full. Parking demand (in the survey period) at about one quarter of the sample sites reaches or exceeds car park capacity.

4.8.3 *What is the variation between land uses in the pattern of parking accumulation?*

Retail and leisure sites tend to have greater variation through the day and through the week than employment-related sites such as B1 and B2. The employment related sites also tend to have higher levels of peak demand compared to parking capacity. Car parks at industrial estates in particular tend to be full during weekday working hours.

4.8.4 *What is the variation between different sites of the same land use?*

There is wide variation between different sites. This may be due to differences in parking standards applied at the time, variation in the quality of access by other modes and, related to this, the site location. These explanations are, however, largely speculative. What is clear is that the conventional use of the TRICS database, which in the planning of new schemes gives a parking-supply rate for "comparable" developments, may in practice be multiplying problems of over-provision.

4.8.5 *What relationship is there (if any) between the rate of parking provision (spaces per 1,000 square metres of Gross Floor Area) and parking demand?*

Taking the sample as a whole, or by land use category, there is no general relationship, and over-supply (or under-supply) of parking in terms of peak demand has to be explained in terms other than simply the rate per GFA. This supports the view that account should be taken of wider accessibility and location issues at each site.

4.8.6 *What relationship is there (if any) between parking demand and the level of public transport provision at the site?*

There is a tendency for peak parking accumulation to be higher at sites with good public transport access.

4.8.7 *Overall conclusion*

4.8.8 Had rates of parking supply at the sample sites been applied at one third below the rate prevailing at the time of permission, peak parking (and hence car access generally) would have been unaffected at two thirds of the sites.

4.8.9 Of the one third of sites with higher peak demand (i.e. where it is in excess of two thirds of capacity), sites with customer parking (A1 retail and D2 leisure in particular) would be affected on only certain days of the week, and at certain times of the day. Such peaks of demand within the week could, in theory at least, be levelled out using charging or other management devices, or by variation of opening or service hours.

4.8.10 This overall finding suggests both a positive and negative aspect of a theoretical proposal to reduce PNR parking one third below current norms.

4.8.11 The positive side is that such a proposal would be unlikely to cause any major upheaval in the development industry or planning process. The one third reduction on current norms may therefore offer a reasonable basis for a national limit on PNR supply.

4.8.12 The negative side is that a third reduction will have virtually no impact on traffic generation or mode split, and greater reductions would need to be implemented locally to achieve such an impact.

5 *Parking Ratio and development size*

5.1 *Parking provision and development size*

5.1.1 This annex provides formulae for varying the upper parking level in according to development size. This tool could be used in support of a policy to encourage smaller developments and to discourage larger scale developments. The logic of this is that the larger the development, the greater will be its car catchment relative to its catchment by non-car modes. In terms of transport sustainability (reducing travel distances and the proportion of travel by car) it is beneficial to have a larger number of facilities serving local catchments than a smaller number of large facilities serving very large catchments.

5.2 *Formulae for Determining Parking Maxima*

5.2.1 The formulae can be adjusted to provide the desired outcome, but the basic algorithms are shown on the accompanying spreadsheets.

5.2.2 These formulae determine both the rates and number of parking spaces for different development sizes in different accessibility zones. The formulae have been designed so as to yield the kind of results as shown by the accompanying tables. As such they can be manipulated to yield different kinds of results.

5.2.3 If we look at the formulae which determine the maximum number of parking spaces in each zone (where x = GFA in thousands of m^2):

$1 + 10x - 1/200x$; $3 + 10x - 1/10x$; $7 + 10x - 1/3x$; & $12 + 10x - 1/2x$

We can see that each formula is in the form : $a + bx - \frac{c}{dx}$,

For the zone 1 maximum parking spaces formula: a=1, b=10, c=1 & d=200.

5.2.4 Manipulating these values will give different values for the maximum number of parking spaces in zone 1:

- An increase or decrease in the value of 'a' will increase or decrease all the results by that amount.
- An increase or decrease in the value of 'b' will affect the results for higher GFA's much more drastically than for the lower GFA's. Thus an increase of 10 (so that in zone 1 b=20) will raise the maximum number of spaces for a GFA of 100m² from 2 to 3. But it will raise the maximum number of spaces for a GFA of 10000m² from 101 to 201.
- Changing c & d will only really affect the maximum number of parking spaces in relation to GFA's of under 500m². Changing c & d will not affect the results for GFA's over this number. This is a useful tool to have but the manipulation of c & d is more complicated than the manipulation of a & b:

  Although c & d DO NOT behave as a fraction in the formula they can be treated as a fraction for the purposes of manipulation. Thus in the formula for zone 1 c & d express the fraction 1/200th. Raising this fraction will lower the results for the maximum number of parking spaces for GFA's under 500m^2. Lowering this fraction will raise these results. Thus for c & d the relationship with the GFA is inversely proportional.

- Any of these manipulations can be combined. For example, if you wanted to raise the maximum number of parking spaces for *large* GFA's in zone 1 and simultaneously lower the maximum number of parking spaces for *small* GFA's, you can manipulate the values of b and c&d and they will act somewhat independently.

5.2.5 The formulae for the maximum number of parking spaces were designed before the formulae for the rate of parking spaces per thousand were calculated. The rate formulae were calculated by dividing the formulae for maximum number of parking spaces by x. Thus the corresponding numbers in the rate formulae can also be manipulated. However this process will yield more unwieldy results (since a small change will make a large difference). It is perhaps better to concentrate on the formulae for the maximum number of parking spaces. If any changes are made then simply divide your new formula by x to obtain the corresponding new formula for rate.

**add excel tables

6 *Bibliography*

The basic bibliography for the parking study is set out here.

Auchincloss (1996), Housing Corporation Good Practice Guide

Avon County Council (Oct 1995) 1995 Commuted Payment Survey, Trasnportation Studies / Forward Panning Division Department of Highways and Transport Engineering.

Survey of local authorities involved in commuted payments for park and ride schemes. It looks at what the sums are used for, how they are calculated, and methods of securing payment and challenges to policy.

Balcombe R J, York I O (1993) The Future of Residential Parking – Project Report 22, Transport Research Laboratory, Crowthorne, Berkshire.

Considers how the forecast growth in car ownership and traffic levels affects the demand for parking. The research is intended to identify and clarify concerns. Looks at perceptions of car parking adequacy, the value of a parking space. The research suggests that increased residential parking problems will prompt very little response from owners. Where action would be taken private sector housing occupants would most commonly move house and in public sector areas, residents would convert gardens. Controlling demand by restricting parking is briefly discussed as a means of easing the problem.

Banister D, The Bartlett School of Planning, University College London (July 1997) A Review of the Relationship Between Planning and Transport, for the Department of the Environment and Department of Transport, unpublished.

The research seeks to assess the influence of planning on transport, in particular travel demand and modal choice. It concludes that both quantitative and qualitative analysis methods are appropriate an that a closer co-operation and interaction between planning and transport will permit greater integration at all levels of decision making, which in turn will allow sustainability and environmental objectives to be met. It identifies density, size and location and the main factors influencing the amount of travel undertaken. It specifically examines parking, location decisions on new development and complementary policies.

Bedfordshire County Council Land Use and Transport Strategy Group, Department of Environment and Economic Development

(Nov 1997) Travel Assessment Guidelines, Consultation Draft, unpublished.

Consultation document seeking views on proposals for a revised Traffic Impact Assessment, which takes account of changing policy and increasing non car modes of travel. In favour of commuted payments for transport infrastructure. Seeks comments on the role of commuted payments and other mechanisms to influence parking.

Bull, D (1997) Measuring Public Transport Accessibility *in* LPAC 1997 Parking Advice: Background Paper No. 3, LPAC, London.

Discusses the PTAL method and the related plot ratio approach to car parking provision.

CPRE (1998)London's Great Parking Plague CPRE London Branch, London

Outlines the thrust of policy in PPG 13 Transport and work by GOL into parking provision. Lists development proposals with large amounts of parking space in London

Dasgupta M Oldfield R, Sharman K and Webster V (1994) Impact of Transport Polices in Five Cities published by and for Transport Research Laboratory – Department of Transport.

Research which estimates the impacts of a range of transport policies on road traffic and emissions.

Department of the Environment and Foreign Office (1994) Sustainable Development: the UK Strategy, CM 2426, presented to Parliament by the Secretary of State for the Environment and the Foreign Office, HMSO, London.

Used in setting the scene on the current sustainability agenda in the UK.

Department of the Environment, and Department of Transport (1994) Planning Policy Guidance Note 13: Transport, Department of the Environment, and Department of Transport, London

Guidance aims to ensure that local authorities carry out and integrate their land use policies and transport programmes in ways which help to reduce growth in length and number of motorised journeys, encourage alternative *means of travel which have less environmental impact and reduce reliance on the private car. It considers managing demand, preparing for less travel, locating development where there is a choice of travel modes and higher levels of accessibility, promotes maximum parking standards and reduced parking in locations which have good access to other means of travel than the private car. Suggests payments to improve access to replace commuted payments, which fund off site parking facilities and production of accessibility profiles for public transport provision at sites.*

Department of the Environment, Department of Transport (1995) PPG13 A Guide To Better Practice, HMSO London

The report offers basic planning principles and methodologies for developing and applying land use and transport policies to help local authority planners and councillors in plan preparation and planning application determination. It covers planning principles, putting these into practice, the planning framework, location of development and transport measures. The principles and methods are backed up by examples. These include case studies of authorities trying to reduce car use in town centres, measuring accessibly to different developments by means other than the private car, promoting a choice of means to travel and a framework for complementary transport measures according to location and development types.

DETR (1998) A New Deal for Transport: Better for Everyone, Cm 3950, The Stationery Office, London

Relevance to the report to be added for final report

Department of the Environment, Transport and the Regions (1998) Sustainable Development: Opportunities for Change, HMSO, London

Consultation paper on a revised UK strategy for sustainable development. This includes development of an integrated transport strategy, establishment of a Social Exclusion Unit, and setting up of Regional Development Agencies. Offers a definition and key objectives of sustainable development. One the four objectives is building sustainable communities, which seeks to limit demands on land, the environment and reduce the need to travel especially by car.

Department of the Environment, Transport and the Regions (1998)The Future of Regional Planning Guidance Consultation Paper Department of the Environment, Transport and the Regions London

Focuses on questions related to the broad scope and content of strategic plans at the regional level, and the procedures that might be adopted for their preparation. It is proposed that Regional Planning Guidance prepared by the Regional Development Agencies in conjunction with relevant planning authorities, should incorporate a regional integrated transport strategy based upon the promotion of environmentally friendly modes. This could include broad objectives for the use and future development of major transport corridors, public transport accessibility criteria that would guide the location of new regionally or sub- regionally significant volumes of development. Such criteria could be supported by complimentary traffic management measures, including a strategic approach to off-street parking standards. Views are invited on these suggestions.

Department of the Environment, Transport and the Regions, Property Advisory Group (Dec. 1997) Sustainable Development and the Commercial Property Sector, unpublished.

This report addresses specific issues, relevant to commercial property development, which generate sustainable development. Offers a definition of sustainable development for the commercial property industry and recommends which actions are required from local authorities DETR and developers to achieve this: e.g. provide indicators, encourage denser development along transport axis.

Department of the Environment, Transport and the Regions, Department of the Environment for Northern Ireland, The Scottish Office, The Welsh Office (1997) Developing an Integrated Transport Policy Department of the Environment, Transport and the Regions, Department of the Environment for Northern Ireland, The Scottish Office, The Welsh Office, London, Edinburgh, Cardiff and Belfast.

Document, which sets out the Government's objectives for an integrated transport strategy and seeks a response to them from consultees. The objectives include: reduce car dependence, provide realistic alternatives to the private car, change our personal travel patterns and behaviour, and generate more strategic thinking about provision.

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Donelly, Andrew (1998) Parking Standards Based on Reference Standards, Employment Densities and Modal Split Targets, GOEM parking standards seminar, 19th June 1998.

Considers the use of reference standards to determine the degree of traffic reduction compared to unrestrained demand, and in determining commuted payments in the context of maximum parking standards

Government Office for London (1996) RPG3: Strategic Guidance for London Planning Authorities, London

Sets out a new direction for parking policy in the South East, which seeks to progressively restrain car use where alternatives are or can be made available. It advocates the use of maximum parking standards and suggests off street parking standards foe employment generating uses.

Fairview New Homes plc (1997) A Study of Car Parking Use, Section 4. Fairview New Homes.

See for example Llewelyn-Davies et al for LPAC (1994) "The Quality of London's Residential Environment".

JMP Consultants Ltd (1996) Surrey Parking Standards Review – Explanatory Note: Application of Proposed Technical Approach.

This document sets out the procedure for applying the proposed technical approach and gives case studies to illustrate its application. The approach introduces an element of selective restraint of car use through the adoption of maximum (rather than demand based) standards for on-site parking at new developments in specified circumstances, assuming demand management policies already or will apply to public parking provision.

JMP Consultants Ltd (March 1995) Traffic and Parking at Food Retailing report for Trip Rate Information Computer System [TRICS] and Safeway

Data and analysis of a survey aimed at providing an up to date independent database relating to the traffic implications of a range of current stores. It considers trip generation by day and by mode of transport, volume of linked *trips, and parking characteristics (maximum parking demand by floor area, and number of customer visits). Looking at the impact of the new stores the survey shows that following their opening the average journey length of local residents was reduced.*

JMP Consultants Ltd (1993) Parking and Public Transport, The Effect on Mode Choice – A study of B1 Developments, for Trip Rate Information Computer System [TRICS], The London and South East Regional Planning Conference [SERPLAN], JMP Consultants Ltd, London.

This reports the survey and analysis of parking demand and modal choice at a range of office located throughout the SERPLAN area. The objective of the study was to seek a relationship between the modal choice for the journey to work and public transport and parking availability. The study concluded that public transport accessibility corresponds to pubic transport use, private car is used significantly more for out of town developments, but the car remains the primary mode of transport in all locations. Also considers the scale of parking restraint and its effectiveness in reducing car use.

Kent County Council -Strategic Planning (Feb 1998) Vehicle Parking Standards – Consultation Draft, Kent County Council, Maidstone

Supplementary planning guidance on parking standards in the county. Looks at demand management, parking standards and vehicle parking requirements by land use. Using a zonal approach and maximum standards, the guidance aims to reduce car use and provide mechanisms (e.g. commuted payment options) to offer flexibility and raise money for alternative modes to the car. Also defines operational parking and promotes conditions to tackle increased parking pressures arising from a non-material change of use.

Llewelyn-Davies with JMP for Department of the Environment, Transport and the Regions (1998) Parking Standards in the South East as yet unpublished report

This report gives advice on the actions necessary at regional level to secure more rapid implementation of revised parking standards in the region in line with PPG13 and other Guidance.

Llewelyn-Davies for LPAC (1998) Sustainable Residential Quality , LPAC, London

Llewelyn-Davies was appointed to explore how London might accommodate additional housing in ways which enhance the quality of the urban environment and encourage more sustainable urban living. The study shows how higher density, well designed housing with reduced car parking provision could be accommodated on vacant and under-used land within walking distance of London's town centres.

Llewelyn-Davies *et al* for LPAC (1994) The Quality of London's Residential Environment, LPAC, London

London Planning Advisory Committee (Feb 1998) Revised Advice On A Parking Strategy for London, London Planning Advisory Committee, London.

A supplementary document to LPAC's 1994 Advice on Strategic Planning Guidance for London looking at parking provision in London in the context of achieving broader planning objectives. The approach requires complementary policies from Government, a regional approach and public transport improvements if it is not to be undermined. Recommends parking plans, a matrix for determining A2/B1 parking standards, test of requests for additional town centre parking, Transport Impact Assessments, Green Transport and Commuter Plans.

London Planning Advisory Committee (Feb 1998) 1997 Parking Advice: Background Papers, London Planning Advisory Committee, London

Background papers to the revised Supplementary Advice on Parking Standards which explain, elaborate and justify policy advice on parking matters (on-street, off street and private non-residential). The preferred policy is for maximum parking standards determined in accordance with a matrix of accessibility levels and levels of sustainable transport. Background papers include: issues raised during consultation; issues pertaining to development control; what should be included in parking plans and transport impact statements; examples of policy application, conversion of PNR to other uses, and limited consideration of parking standards for leisure and retail developments.

Marshall P J L (1989) Development Valuation Techniques, South Bank Polytechnic, London.

Marshall P J L (1993) Development Valuation Techniques, RICS, London.

These two reports by Marshall investigate the methods and techniques by which development companies and their advisors value land and projects for development and redevelopment.

MTRU (March 1988) An Access Strategy for Cambridge, unpublished.

MVA with WS Atkins for DETR (Dec 1997) Options for Influencing PNR Usage – Report on Qualitative Research unpublished

Research which among other things looks at the reactions of landlords/property agents to the introduction of PNR controls.

Nathaniel Lichfield and Partners, Symonds Travers Morgan (February 1998) Better Appraisal of Development Proposals – Draft Report prepared for the Department of the Environment, Transport and the Regions, unpublished.

Studies ways of improving appraisals of the transport impact of development schemes to better support the Government's Integrated transport strategy and considers complementary changes to the planning system to achieve this. Concludes that a packages of measures offers the biggest impact on reducing car use and promoting non car modes. It recommends complimentary policies including accessibility zoning, promotion of high density development where public transport accessibility is greatest, refinement of the Use Class Order to take account of changes within the same use class which significantly increase traffic generation, and reviews the role of planning obligations and conditions.

Nathaniel Lichfield and Partners Ltd (March 1990) Commuted Car Parking Policy and Practice, Nathaniel Lichfield and Partners Ltd, London

Research into local authority practice with regard to commuted parking charges.

Noble J, Jenks M (1996) Parking – Demand and Provision in Private Sector Housing Developments, School of Architecture, Oxford Brookes University, Oxford.

Investigates problems associated with parking in recently built private sector housing development and suggests ways in which *problems can be overcome through design and different parking standards .*

Ove Arup and Partners, University of Reading (1997) Planning Policy Guidance on Transport (PPG13) – Implementation 1994-1996, Department of the Environment Transport and the Regions.

This report looks at the implementation of PPG13 by examining its influence on local authority policies and decisions and the difficulties encountered both by local authorities and private developers; and then by making recommendations on how difficulties might be addressed. The research suggests that policies for public transport provision, revision of car parking standards and development at public transport nodes and corridors are less well developed than perceived importance would suggest. Recommendations include co-ordinated policy development to prevent development poaching, consistent policy implementation and the need for complimentary measures to the land use planning system to assist in the implementation of PPG13.

Royal Borough of Windsor and Maidenhead (October 1997) Update to Appendix 9: Parking Standards – Local Plan, Director of Housing and Planning Policy, Maidenhead.

Information about parking standards.

Royal Borough of Windsor and Maidenhead (1994) Royal Borough of Windsor and Maidenhead Local Plan Appendix 9 -Parking Standards Director of Housing and Planning Policy, Maidenhead.

Information about parking standards which have changed from minimum to maximum.

SERPLAN (1998) Implementing Sustainable Development, SERLAN, London

Looks at the real and perceived difficulties of implementing restrictive parking standards.

SERPLAN [The London and South East Regional Planning Conference] (1998) A Sustainable Development Strategy for the South East – Public Consultation, SERPLAN.

Information about the draft regional strategy was used in the analysis of local authorities.

SERPLAN [The London and South East Regional Planning Conference] (1993) Parking Policies for the South East, SERPLAN, London.

The report explores how far parking policy can be used to implement a demand management approach to transport policy. The recommendations provide advice to local authorities on how to balance supply and demand for parking. It reports that most counties are beginning to see control of parking as a legitimate area of traffic management but few are acting on it. SERPLAN recommends a shift towards less parking provision, a development control system which favours locations with access from modes other than the car and a range of other transport policies geared towards managing demand. It also calls upon the Departments of Transport and the Environment to provide a climate for national and regional policy which offers encouragement for this demand management approach.

Transport 2000 (Feb 1998) A Taxing Question: How a Parking Tax Might Work. Transport 2000, London.

Proposes use of a parking tax on all private-non-residential off street parking spaces at a flat rate across the country. Such a tax would be ratcheted up each year. It could reduce car use, and raise significant revenue, which could be spent wither on improving non-car modes of travel or be spent in reducing rates or national insurance contributions. Aims to reduce car travel by modal substitution.

Transport 2000 (1998) Streets Ahead: Just the Ticket, Traffic Reduction Through Parking Restraint, London.

UK Round Table on Sustainable Development (1997) Getting Around Town and Housing and Urban Capacity (1997).

Northampton case study

University of Westminster, School of the Built Environment (Feb 1998) Development Plan Transport Assessment (DPTA) Scoping Report prepared for the Royal Town Planning Institute, unpublished.

This report recommends principles and structure for detailed guidelines and suggests the best way forward for DPTA application in England, Scotland, and Wales. It includes a review of the techniques for DPTA and the need for and requirements of assessment measures and establishes data/ technology availability. One of the most important factors affecting the DPTA methodology is development size.

West Midlands Regional Forum of Local Authorities (March 1998) An Integrated Transport Action Plan, West Midlands Regional Forum of Local Authorities.

Wooton Jeffreys Consultants for LPAC (1991) Parking Policies and Standards Main Report Vol. 1, LPAC.

Report looking at parking policies and standards in London, with recommendations for future policy application with the objective of securing more effective control over traffic levels.

Wycombe District Council (November 1995) Car Parking Standards Wycombe District Council.

Information about local parking standards