Measuring Accessibility as Experienced by Different Socially Disadvantaged Groups

End of Project Summary Report: July 2005

Background / Context

Concepts of 'accessibility' and 'social exclusion' are widely discussed in the international literature in disciplines such as geography, urban economics and social policy, but are variously defined and applied. In the UK, for example, the term 'accessibility' is used in two different contexts: (i) to describe the detailed design characteristics of transport systems that enable or inhibit their use by people with physical and mental impairments, and (ii) at a more general and strategic level, to describe the ease of reaching sets of opportunities from home, or the ease of being reached as a service provider.

At a national policy level, the importance of accessibility for promoting social inclusion was clearly recognised in the UK Social Exclusion Unit (SEU) 2003 report on 'Making the Connections: Transport and Social Exclusion'. The report identified transport as a significant barrier to social inclusion, and this has led to the emergence of a new framework for Accessibility Planning in England, in which transport professionals are required to base aspects of transport planning on access requirements rather than on traffic or mobility needs; comparisons with other G8 Countries indicate that the English work is world leading in this respect. However, relatively little is known about the accessibility needs of different socially disadvantaged groups.

While attempts were made by academics to apply accessibility concepts to rural and urban planning in several countries in the seventies and eighties, it is only with the fairly recent development of GIS systems and associated databases, that it has proved practical to develop workable accessibility planning tools, thereby facilitating the transformation from academia into practice.

Key Advances and Supporting Methodology

The project has sought to develop and incorporate more comprehensive measures of accessibility into operational planning tools, so that they become sensitive to the varying perceptions and needs of different socially disadvantaged groups, and to apply and test these ideas by modifying two current accessibility planning tools: CAPITAL in London, and PTAM in West Yorkshire. The research was divided into seven phases, starting with literature reviews of user needs and current accessibility planning concepts and tools, through data collection (both of public attitudes/behaviour and local bus stop/street conditions) to parameter specification and application, and validation of the two enhanced tools among user groups.

The research focused on seven socially disadvantaged groups: young people (16-24), older people (60+), Black and Minority Ethnic (BME) people, disabled people (physically disabled people and people with mental health illness), people travelling with young children (aged 11 or under), unemployed people and shift workers. Project partners included Bradford Metropolitan District Council and METRO, and the London Borough of Tower Hamlets and Transport for London.

Phase 1: Identification of User Needs

The accessibility needs of different socially disadvantaged groups were identified through a combination of a desk-based review, of both published and grey literatures, and an analysis of existing data sources (National Travel Survey and Family Expenditure Survey) – as reported in Working Paper 1 – plus a series of focus groups and depth interviews (Working Paper 2). Issues explored included: travel patterns, suppressed travel demand and preferred activity patterns, key journey and destination attributes, the relative importance of these attributes and threshold values for maximum walking distances and waiting times.

Rather unexpectedly, many barriers were found to be common to all these groups, including: limited travel choices (both spatially and temporally); excessive walk access distances to public transport services and various problems encountered on route; the time required to reach destinations (compared to going by car); poor service reliability (services cancelled and delayed); limited availability of public transport information in a suitable format; and the cost of using public transport. However, the impacts and intensity of these barriers did vary between population groups and times of day.

Phase 2: Review of Accessibility Concepts and Planning Tools

Working Paper 3 examined different concepts of accessibility and the various ways in which these have been translated into accessibility measures, particularly in relation to the measurement of public transport accessibility. Basic distinctions can be made between measures reflecting the density of public transport provision at a particular point (e.g. PTALS tool) and the measurement of accessibility between places. In the latter case, further differences arise according to whether the measure is origin or destination based, in the treatment of distance/time (i.e. whether or not to apply a deterrence function) and whether the emphasis is on space or on space-time.

The review identified three main approaches to the quantitative analysis of 'strategic' accessibility: land use/transport models (where accessibility measures are a by-product of demand modelling), aggregate accessibility planning tools – by far the most common type of planning aid – and trip planners, providing customised information at an individual trip level.

It was established that CAPITAL (TfL) and the PTAM GIS tool (METRO) are representative of two different types of commonly applied accessibility planning tools, and that – as with most such tools - they were currently largely insensitive to the varying accessibility concerns of different groups of people. In their representation of public transport walk access, the majority of tools use either Euclidean distance (as in the case of PTAM) or road centre line data; CAPITAL builds on the latter, in that it includes pedestrian-only routes in its access networks, in addition to road centres lines.

Phase 3: Conversion of identified needs into accessibility components and parameters

The original aim of the project was to identify ways in which existing accessibility tools could be enhanced to sensitively reflect the needs and concerns of different user groups, using CAPITAL and PTAM as examples. Several enhancements were made to both tools, by METRO and TfL, including:

- CAPITAL: re-programming to enable separate values to be input for different social groups (e.g. average walk speeds, maximum walk distances); treatment of cost constraints and interchanges, using proxy measures.
- PTAM: addition of rail network and explicit treatment of interchange; more detailed examination of timing constraints.

In addition, the initial survey work with disadvantaged groups (in Phase 1) highlighted the need to look in much greater detail at conditions associated with walk access to bus stops and railway stations than had been done in any of the existing accessibility planning tools. For various reasons it proved impractical to directly enhance this aspect of the two tools within the timescale of the project, due to other developments in the two organisations, and so a new, free-standing tool was developed by TSG researchers to reflect perceived walk access conditions, called 'WALC' (Weighted Access for Local Catchments).

Barriers associated with walk access were found to include: (i) the local terrain (e.g. steep hills); (ii) the lack of provision of seating and a shelters at bus stops; (iii) difficulties in crossing busy roads, due to speeding traffic, heavy traffic volumes, lack of safe crossing points, and barriers (e.g. guard railing) preventing crossing at convenient points; and (iv) low levels of street lighting. Further user surveys were carried out to identify the weights different groups attach to each of these features, and to collect complementary data on physical conditions through street audits in the case study areas (see Phase 4).

Phase 4: Collection and collation of new data for the two local areas

Through on-street and on-vehicle surveys in parts of Keighley and Tower Hamlets, bus, underground and DLR passengers (Tower Hamlets only) were asked a series of trade-off questions, to establish how much further they would be prepared to walk to avoid encountering the four types of barrier noted above (see Working Papers 4 and 5). Using median values, weights were calculated for each of the different factors for each social group; in some cases these were represented in the form of fixed time penalty values (i.e. for different bus stop types and for crossing a busy main road)), while in the other cases they were applied as a scaling factor proportionate to the distance/time involved (i.e. for steep gradients and poor lighting).

Simultaneously, the local authority partners undertook a comprehensive street audit in the same areas to collect data on:

- Location/condition of bus stops (e.g. seat, shelter, timetable, light, type of base);
- Location/type of pedestrian crossings (e.g. zebra, pelican, junction tables);
- Location and length of guard railing;
- Lighting data (e.g. location and type of lamp post, height, wattage);
- Luminosity readings (in a small area of Keighley only to verify the validity of using lighting provision as a proxy).

In addition to the street audits, the local authority partners were also able to supply other relevant data (e.g. height data, traffic accident and traffic flow data from Keighley, and traffic flow/accident data and a station audit of DLR and underground stations in Tower Hamlets).

Phase 5: Incorporation into the two project accessibility tools

The literature review and fieldwork findings identified a number of possible enhancements to each of the accessibility tools, both in terms of how accessibility is measured and how it is displayed. Some related to the strategic, 'line-haul' components of accessibility and others to the local treatment of walk access (see Working Paper 6).

Strategic accessibility enhancements

After lengthy discussions with the project partners it was agreed that the following enhancements would be made to the existing accessibility tools by the authorities or their consultants:

- CAPITAL: reprogramming of core tool to enable input of population group specific input values (e.g. maximum walk times, walk speeds), separate estimation of accessibility by different combinations of public transport modes (all modes, all buses, one bus), to reflect different cost constraints, and the inability of some groups of people to make certain types of interchange (due to physical or mental limitations); improvements to the presentation of accessibility plots.
- PTAM: addition of rail services to the existing bus network data; finer examination of public transport accessibility at specific times of day; addition of bus/bus and bus/rail interchange analysis; cap on waiting times; improved presentation of accessibility plots.

Development of a local access tool

The WALC (Weighted Access for Local Catchments) tool was developed by TSG research staff using ArcGIS software. The purpose of the tool is to show how standard walk catchment areas change shape and shrink once the impedance effects of different types of barriers on various population groups are taken into account.

A number of stages were involved in its development and application:

- Development of the pedestrian walk network
- Addition of barriers to the network
- Calculation of weighted walk times for different population groups
- Output maps, displaying different types of catchment area

Due to the lack of a national dataset[1], there was a need to create a detailed pedestrian network for each study area. The Ordnance Survey's OSCAR centre line data was used as a starting point. This only provides one link per road section, and so does not separately represent the footway on each side of the carriageway. On quieter roads it was decided that this was adequate, as people would be able to cross at will, virtually anywhere along the section; but on 'busy' roads inhibiting crossing (defined as having two-way peak period flows in excess of 1,000 vehicles/hour) – and where there were sections of guard railing - it was decided to model each footway separately. In this latter case, it was also necessary to add explicit links across the dual link roads. These were added at all main and side road junctions, adjacent to bus stops, and at recognised pedestrian crossings; where there were gaps of more than 40 metres between these notional crossing points, a new link was inserted between the parallel footway links. In addition, local off-road paths were added, using street maps and local knowledge.

The different types of barrier were next linked to the basic pedestrian network. Bus stops were identified as destination nodes (as well as underground and DLR stations in London), and details added to reflect the provision of seating and a shelter. In part of Keighley only, sections of road incorporating gradients of 1 in 5 or steeper were identified as being 'steep hills'[2], and in both areas lighting provision along each road section was recorded; in one area of Keighley, detailed luminosity data was also collected, and found to correlate highly with lamp wattage, so the latter could be used as a readily available proxy for lighting levels in both study areas. Sections of 'busy roads' had already been identified, as part of the process of defining dual links.

Values specific to each population group were then added, including time penalties for bus stop and road crossing conditions (i.e. crossing where there is no protected crossing along dual link roads), and ratio values applied to link lengths for gradients (one area of Keighley only) and lighting levels. Intermediate weights were applied where provision was partial (e.g. seat but no shelter, or intermediate lighting levels). Different average walk speeds were assumed for different population groups: i.e. 4mph for young people, 3mph for 'all' and 2mph for older people.

Maps were next created to show how catchment sizes vary by type of social group, for both daytime and evening conditions. The bus stop catchment maps, for example, are based on unweighted 5-minute catchment areas. They show what happens to the size of this catchment area, once different weightings and walk speeds are applied (see Figures 1 to 4). In these figures, three measures of the walk access catchment area are layered on top of one another, namely:

- The green layer is the simple, unweighted catchment area superimposed on the pedestrian network, without any weights attached to it (though using footway rather than crow fly distances);
- The amber layer shows the size of the daytime catchment area (reflecting weights associated with road crossing conditions, bus stop conditions and - in the case of Riddlesden in Keighley - gradients of more than or equal to 1 in 5).
- The red layer shows the size of the night time catchment area, when daytime weightings plus appropriate lighting impedance values are included in the routing calculations.

In addition, for comparison, Figure 1 shows the standard 400 metre bus stop catchment boundary currently used in PTAM.

Figure 1: WALC: All Population in Keighley

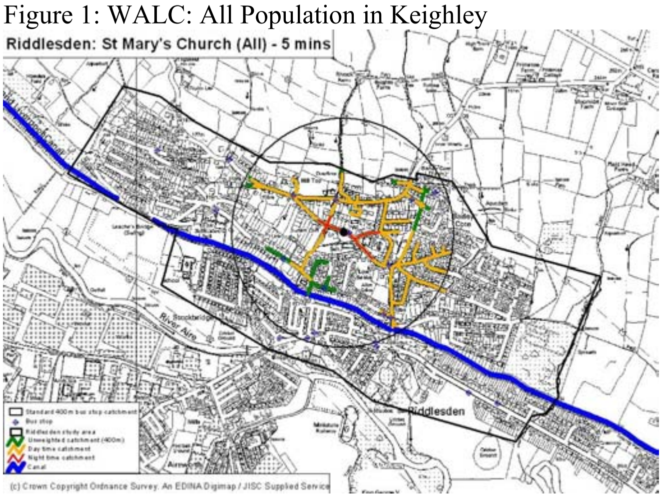
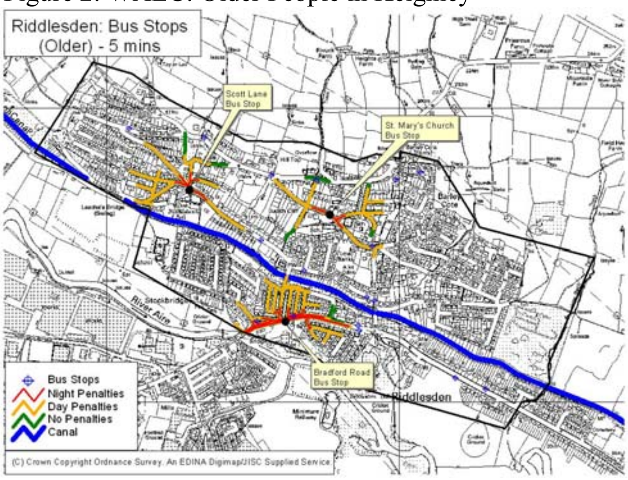


Figure 2: WALC: Older People in Keighley



[1] OS have produced a road centre line data set as part of their new MasterMap product – ITN (Integrated Transport Network). The second phase of ITN, which was not available at the time of creating WALC, includes pedestrian-only tracks and paths – but does not differentiate footways on each side of the carriageway.

[2] This involved creating a 3D surface from OS spot height data, then checking from map contours any areas with steep hills, and finally sampling points along the relevant footway sections to check differences in heights between adjacent points.

The example outputs in Figures 3 and 4 show bus stop catchments calculated for the total sample and for the older people group, for part of the Tower Hamlets study area. They are calculated using different walk speeds and impedance values for the following conditions:

- A time penalty attached to Devons Road bus stop (it lacks both seating and a shelter);
- A time penalty attached to unauthorised crossing points along Bow Road and Devons Road (these are 'busy roads'); and
- A half ratio multiplier attached to those streets in the local area where the lamp wattage is 10-20lux and a full multiplier to those streets where the wattage is less than 10lux.

Figure 3: WALC: All population in Tower Hamlets

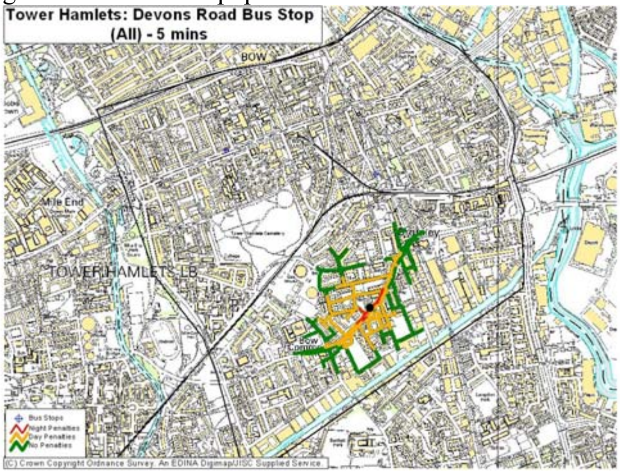
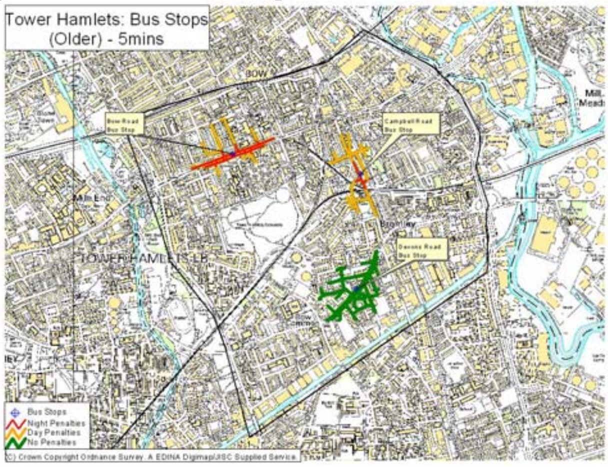


Figure 4: WALC: Older People in Tower Hamlets



Phase 6: Running the Modified Strategic Accessibility Tools

As well as the various changes agreed in Phase 5, TfL and METRO also incorporated a number of suggested improvements to the presentation of the accessibility maps, based on the feedback received from the initial focus groups.

Figures 5 and 6 illustrate the types of outputs of the PTAM tool, showing total access times along public transport corridors (shaded according to time band), with standard 400m circles around individual bus stops. Figure 5 shows accessibility (bus only) to Keighley bus station during the morning peak period for two time bands – 0-15 minutes and 16-30 minutes - and Figure 6 shows accessibility (by bus and rail modes, including an interchange function) from Riddlesden during the morning peak period, for two time bands – 0-20 minutes and 21-40 minutes.

Figure 5: PTAM: Access to Keighley Bus Station

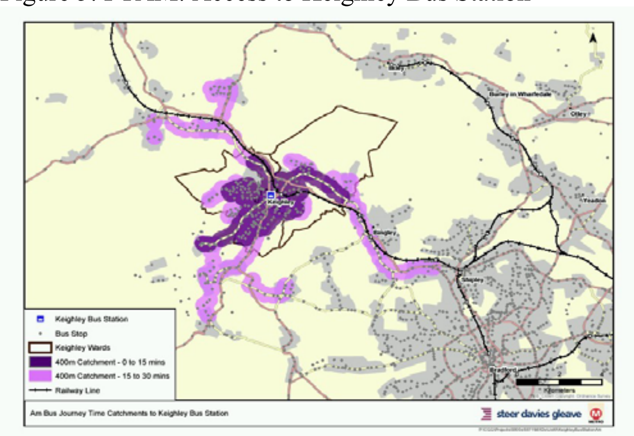
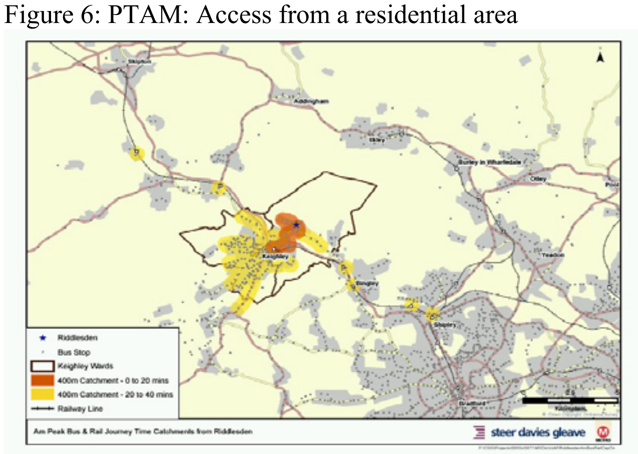


Figure 6: PTAM: Access from a residential area



Figures 7 to 10 illustrate some of the outputs from CAPITAL, showing accessibility from a pre-defined bus stop in the Tower Hamlets study area. All the figures relate to the morning peak period. The maps show how accessibility varies according to the set of pubic transport modes used, reflecting differences in travel costs and interchange requirements.

Figure 7 shows the level of accessibility from the bus stop if travelling by one bus without interchange (also indicating how far people can travel for a single fare of £1.20). Figures 8 & 9 illustrate the level of accessibility experienced – both locally and London-wide - when a bus interchange function is introduced (showing the distance people can travel for £3 within a given time period), and Figure 10 shows how accessibility improves when all modes of public transport are included within the calculation (cost of travel ranges from £6.00 peak/£4.70 off peak (Zones 1-2) to £8.00/£5.20 (Zones 1-4)). Successive time bands are represented as shaded areas of colour, over the appropriate part of the Greater London area.

Figure 7: CAPITAL: only 1 bus map

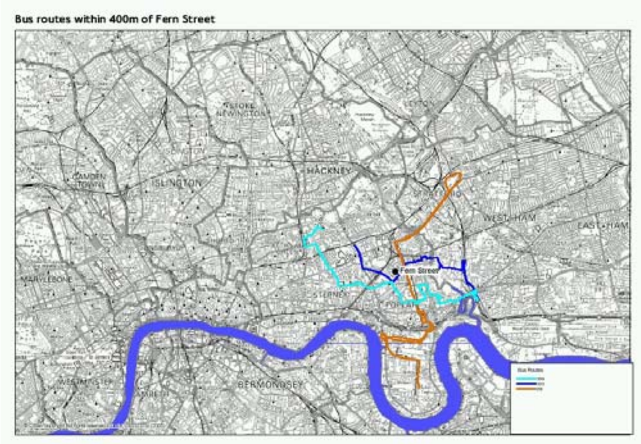


Figure 8: CAPITAL: bus interchange map – local area

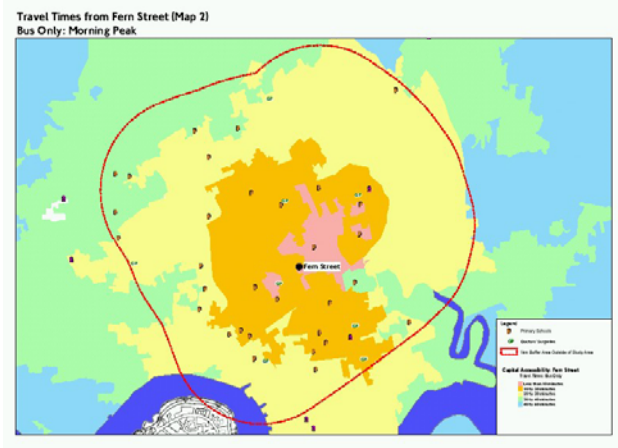


Figure 9: CAPITAL: bus interchange map – larger area

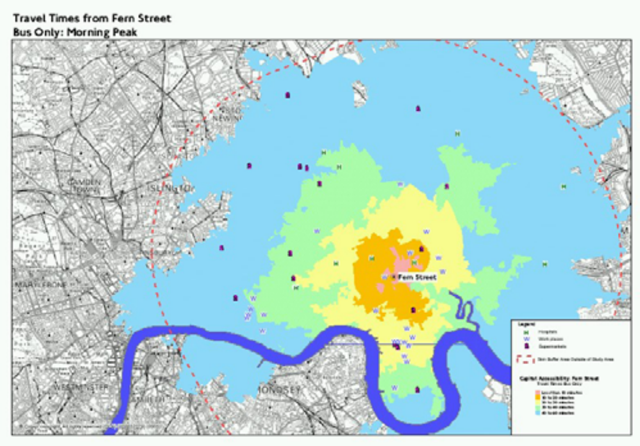
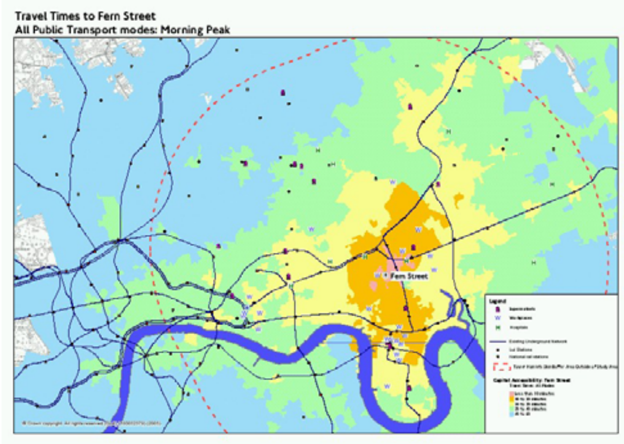


Figure 10: CAPITAL: all modes of public transport



Phase 7: Validation of findings against perceptions of user groups

The new and modified tools were then presented to respondents in the two case study areas, in focus groups comprising representatives of selected social groups, using examples of outputs relevant to their particular activity and travel needs. To validate the results of the tools, groups were asked about their comprehension of the maps, and to compare the strategic and WALC tool outputs with their own perceptions of accessibility to/from and within their local area (see Working Paper 7).

Participants across all groups showed a clear understanding of the purpose and content of all the accessibility maps, and found them to be comprehendible, relevant and useful. The groups supported the WALC tool's assumption of an unweighted 5 minutes walk time to a bus stop, 8 minutes to a DLR station, or 10 minutes to an underground station, and the approach that had been used for calculating weighted accessibility by type of barrier. Questions were raised about walk speeds (i.e. young people regarded the assumption that they would walk at 4mph as being too high), and about the failure to take full account of the impacts of service reliability (including the ability to board the first vehicle) and some bus connecting times at interchanges, on the realism of some of the outputs - suggesting the need to adjust some parameter values. The validation process has also provided the local authorities with a rich source of data about the concerns of local people living in the area.

Further Reports

WP1: User needs literature review
WP2: Social groups user needs - survey findings
WP3: Accessibility analysis literature review
WP4: Bus user walk access barriers (Keighley)
WP5: Bus, DLR/underground walk access barriers (Tower Hamlets)
WP6: Developing accessibility planning tools
WP7: Feedback on new/enhanced tools from social groups
WP8: Final report

Contact Details

For further information about this project please contact:

Prof. Peter Jones, Transport Studies Group, University of Westminster (e-mail: jonesp2@wmin.ac.uk; tel: 020 7911 5021).
Dr Sarah Wixey, Transport Studies Group, University of Westminster (e-mail: wixeys@wmin.ac.uk; tel: 020 7911 5073).