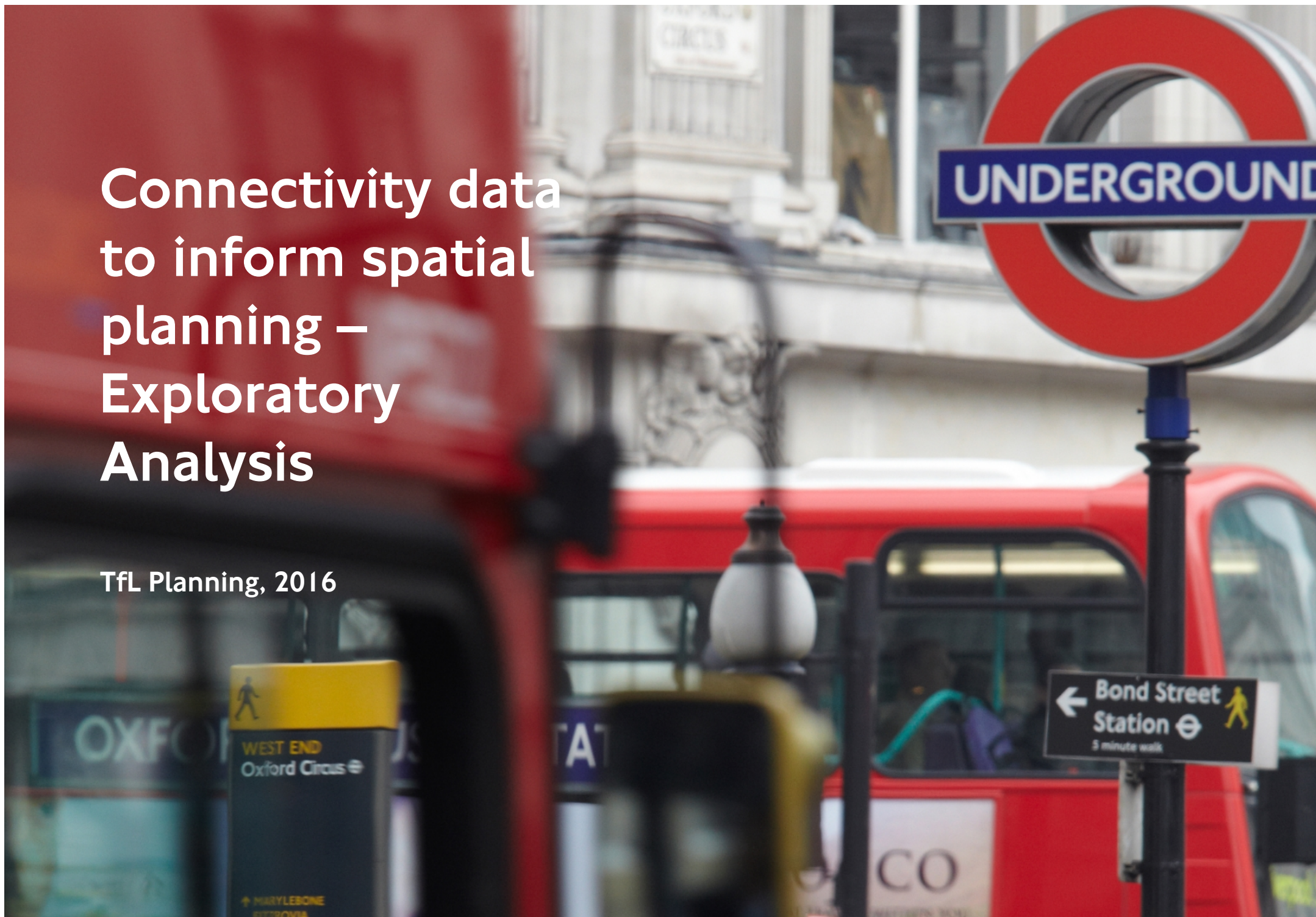


Connectivity data to inform spatial planning – Exploratory Analysis

TfL Planning, 2016



About this document

Background

The population of London currently stands at 8.6 million residents and is expected to grow to 10.4 million by 2041. To accommodate this growth and tackle the existing housing shortage, London is projected to need at least 50,000 new homes per year.

This population growth will put additional pressure on the transport system. London needs to provide housing and create places where people want to live and where they are not dependent on cars. TfL wants to enable 'good growth' so that people have sustainable travel options, with access to a wide range of places, services and opportunities. Good public transport and walk/cycle access can help make a more equal and healthy city.

The London Plan is London's strategic spatial plan. It includes policies on housing design, density and space standards amongst other things. As part of this, the Housing

Density Matrix (also known as the Sustainable Residential Quality matrix) sets the density range for new housing developments in London.

The housing densities recommended are based on the development's Public Transport Access Level (PTAL) and its Character Setting (of which there are three - Suburban, Urban, and Central).

As part of work on the London Plan the Greater London Authority (GLA) asked Transport for London (TfL) to be part of a workstream reviewing the Housing Density Matrix. Specifically, we were asked to:

- Review how PTAL is used to inform housing density
- Explore additional transport measures that could be used to inform planning decisions

Recommendations

Following the exploratory analysis outlined in this document it is recommended that:

1. PTAL should remain a key component of housing density policies.

2. TfL's WebCAT tool should be used in the process of determining appropriate housing density for developments.
3. Alongside PTAL, other factors are important in understanding how well-connected a place is e.g. access to jobs, proximity to rail stations and proximity to town centres.
4. TfL and the GLA should work together to develop appropriate guidance for planning practitioners on how to use and interpret connectivity data in WebCAT.
5. TfL and the GLA should continue to work together to explore the impacts of development and housing density, and check this is compatible with sustainable transport aspirations and the need for 'good growth'.

The Housing Density Matrix sets out recommended housing densities in the London Plan

The Housing Density Matrix (also known as the Sustainable Residential Quality Matrix) was developed by the GLA to present recommended housing densities for developments. It is used by developers, planners and local authorities.

The vertical axis presents the ‘Character Setting’. This describes the built form / environment of the location. There are three Character Settings defined in the London Plan:

Central - very dense development, mix of uses, large building

Setting	Public Transport Accessibility Level (PTAL)		
	0 to 1	2 to 3	4 to 6
Suburban	150-200 hr/ha	150-250 hr/ha	200-350 hr/ha
3.8-4.6 hr/unit	35-55 u/ha	35-65 u/ha	45-90 u/ha
3.1-3.7 hr/unit	40-65 u/ha	40-80 u/ha	55-115 u/ha
2.7-3.0 hr/unit	50-75 u/ha	50-95 u/ha	70-130 u/ha
Urban	150-250 hr/ha	200-450 hr/ha	200-700 hr/ha
3.8-4.6 hr/unit	35-65 u/ha	45-120 u/ha	45-185 u/ha
3.1-3.7 hr/unit	40-80 u/ha	55-145 u/ha	55-225 u/ha
2.7-3.0 hr/unit	50-95 u/ha	70-170 u/ha	70-260 u/ha
Central	150-300 hr/ha	300-650 hr/ha	650-1100 hr/ha
3.8-4.6 hr/unit	35-80 u/ha	65-170 u/ha	140-290 u/ha
3.1-3.7 hr/unit	40-100 u/ha	80-210 u/ha	175-355 u/ha
2.7-3.0 hr/unit	50-110 u/ha	100-240 u/ha	215-405 u/ha

Figure 2.1: Recommended housing densities in the London Plan

hr = habitable rooms
 u = a dwelling unit, i.e. a flat or a house
 ha = hectare

Table 1: Recommended housing densities in London Plan

footprints and typically 4-6 storeys. Located <800m walking distance of an International, Metropolitan or Major town centre.

Urban – dense terraced houses, mansion blocks, mix of uses, medium building footprints typically 2-4 storeys. Located < 800m walking distance of a District centre, or along arterial routes.

Suburban - mainly residential, low density detached and semi-detached houses, small building footprints and typically 2-3 storeys. Located > 800m walking distance from District, Major, Metropolitan or International town centres, although they can include local centres

The horizontal axis relates to transport – where PTAL reflects the level of transport connectivity in the area. The three columns reflect low, medium and high connectivity where PTAL 0 is lowest and 6 is highest.

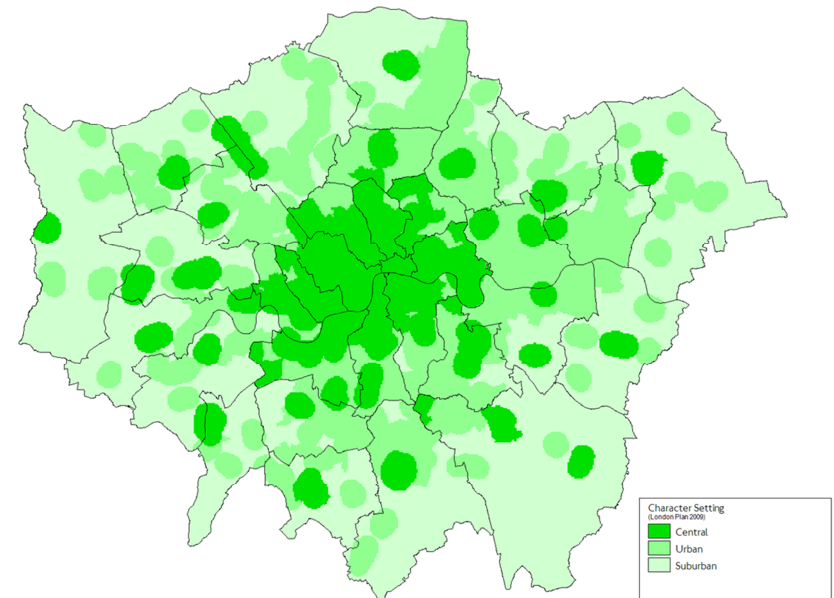


Figure 1: Existing London Plan Character Settings

PTAL tells us how well connected a place is to public transport

Connectivity refers to how well places are connected to each other using the transport network. Public Transport Accessibility Level (PTAL) is one of TfL's measures of connectivity.

For any location in London, the PTAL combines information about the proximity of public transport services and the frequency of these services during the morning weekday peak. PTAL does not consider the locations or services you can reach or proximity to a town centre.

PTALs are applicable to London because the capital has a dense integrated transport network. Provided an individual can access the network they will, in nearly all cases, be able to reach a variety of opportunities within a reasonable amount of time.

The measure is relatively simple which means it can be easily understood and is transparent. PTAL is calculated at a highly disaggregate level: using a regular grid of points at 100m intervals across London – giving over 150,000 values.

Figure 2 shows the Royal Borough of Greenwich and presents PTALs as a series of 'contours' highlighting transport corridors and hubs.

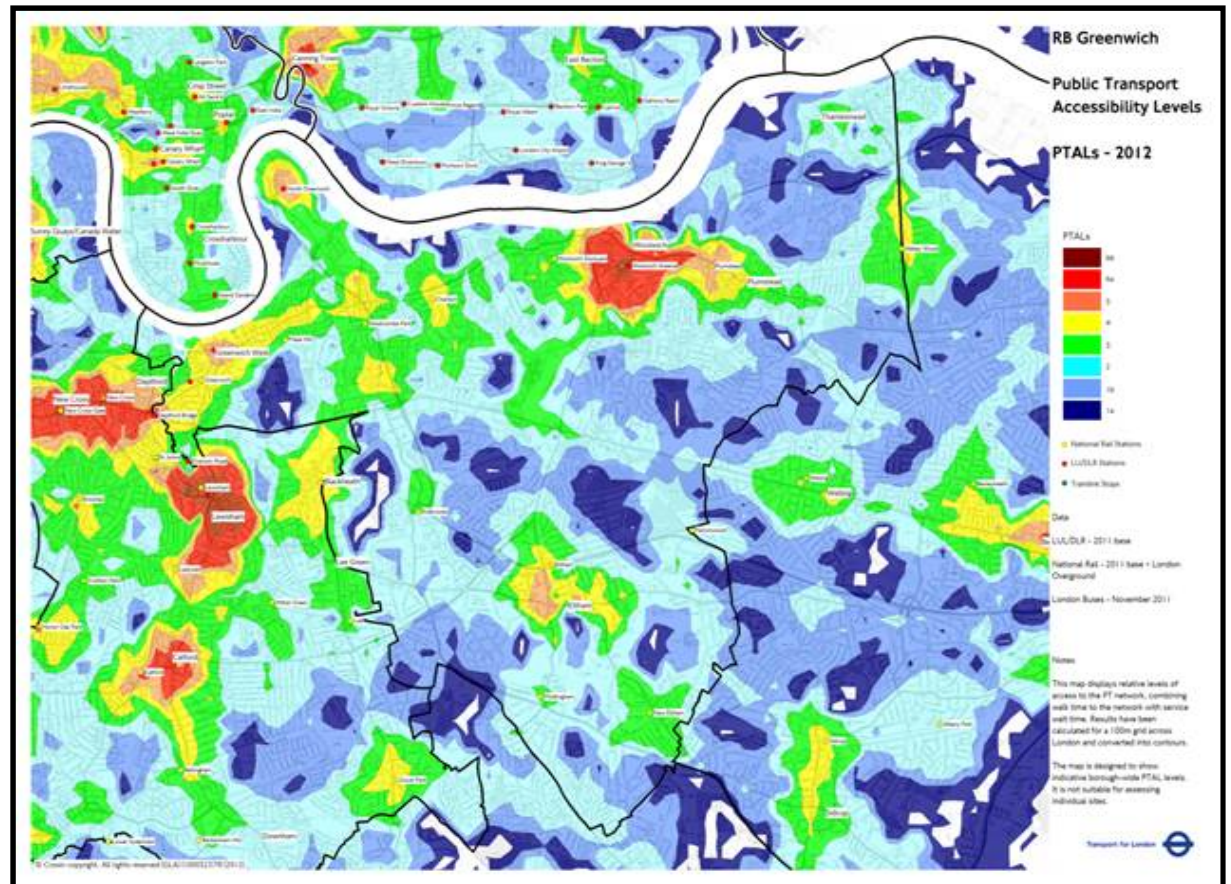


Figure 2: Example PTAL map of Greenwich. Highest PTAL in red; lowest in blue

PTALs range from zero to six: the highest value (6b) represents the best connectivity

It is difficult to give a precise definition for each level, as PTALs are a combination of walk distances to stations / stops and service frequencies. There is also substantial variation in the types of area and level of public transport access found within each PTAL score. However, the descriptions in Table 2 outline what each PTAL area is likely to include in terms of bus and rail provision, and where these areas tend to be found. Rail includes all non-bus modes i.e. rail, LU, Tram, DLR.

Further information on PTAL and their calculation is published in TfL's Connectivity Guide: <http://content.tfl.gov.uk/connectivity-assessment-guide.pdf>

PTAL	Characteristics	Where found?
0	More than the maximum walk distance to rail access points (960m) and bus access points (640m)	Almost exclusively outer London
1	Access to 1 or 2 bus routes, Of all PTAL 1 grid cells 95% include bus services, only 7% include rail.	Vast majority in outer London
2	Access to a variety of local bus routes often in the form of a local bus corridor. Low rail frequencies and limited bus provision could also result in PTAL 2. Of all PTAL 2 grid cells 98% include bus services, 44% include rail.	Majority in outer London
3	Access to both bus and rail services. Of all PTAL 3 grid cells 99% include bus services, 79% include rail.	Mostly in outer London, some in inner.
4	Major transport corridors and at the fringe of higher PTAL areas. Of all PTAL 4 grid cells 99% include bus services, 91% include rail.	Spread equally across inner and outer London.
5	High levels of public transport provision. Of all PTAL 5 grid cells 100% include bus services, 95% include rail.	Mostly in inner London, some in outer.
6	PTAL 6 is the highest range and linked to principal transport hubs. All metropolitan centres and 77% of major town centres have PTAL 6. All PTAL 6 grid cells include rail and bus services.	Mostly in central London, some in inner.

Table 2: Description of PTAL areas in terms of public transport provision and distribution across London

PTAL is a useful measure for planning purposes

PTAL is an established part of the planning process and is used by developers, planners and local authorities. PTAL information is available at a spatially detailed level and can be used for specific site assessments.

People want to live in well-connected places and areas with PTAL 4+ tend to have a higher population and / or workplace density. Good public transport makes places more attractive with people paying more to live closer to a station¹. Therefore PTAL is a key component when making decisions about appropriate housing densities.

There is a strong link between the PTAL of a location and how the people who live there travel. For example this is reflected in the mode share of trips local residents make.

¹

http://www.nationwide.co.uk/-/media/MainSite/documents/about/house-price-index/London_Transport_Special_2014.pdf

The chart shows that people living in higher PTAL areas make more trips by public transport and walking or cycling. The red bars in Figure 3 show the proportion of London's population that live in each PTAL Band (broken down by central, inner and outer London).

Car mode share is much higher in lower PTAL areas; more than 50 per cent of trips to and from the home in PTALs 1a and 1b are made by car.

In order to provide better access to jobs and services and enable a more sustainable travel, TfL recommends that locations with higher PTALs have the transport capability to support higher levels of housing densities.

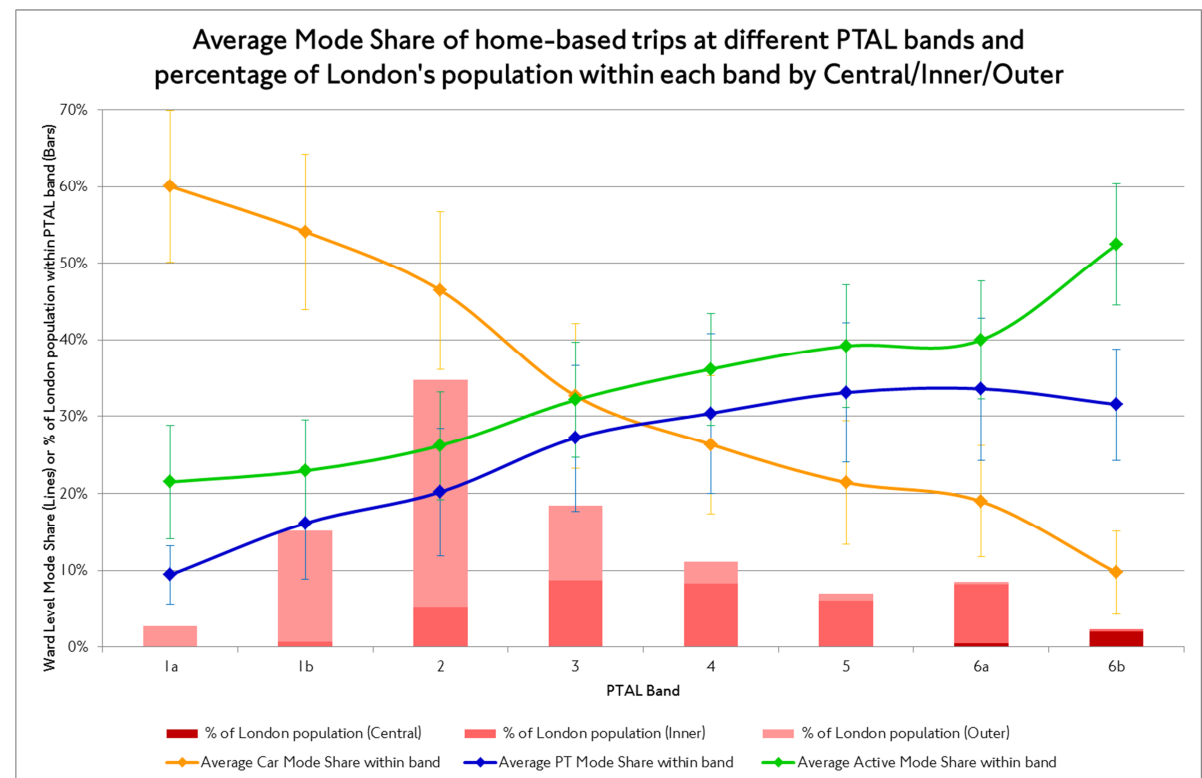


Figure 3: Average mode share of home-based trips by PTAL i.e. trips by London residents with 'Home' as purpose for trip origin or destination. Source: LTDS data (2005/6 to 2014/15)

WebCAT is TfL's online connectivity assessment toolkit

PTALs are publically presented on WebCAT; TfL's online connectivity resource. The website presents PTALs and other connectivity information via an interactive map interface.

WebCAT: www.tfl.gov.uk/WebCAT

WebCAT is designed to help the work of planners in London and currently offers two main tools:

1. **PTALs** (access to the network) – Users can click on specific locations to create their own PTAL maps and reports.
2. **Time Mapping** (access through the network) – Users can view maps showing how long it takes to travel to or from a specified location

PTALs are displayed using a grid of 100m squares across London, overlaid on a Google base map of London. The actual calculation point is the centre of the cell.

Displaying PTALs as a series of grid cells means that users can view PTALs in context. For example, due to the nature of the calculation, a site may have a low PTAL but is on the edge of an area of higher PTAL values.

PTALs can also be viewed across an area of interest such as an opportunity area, highlighting those areas with good or bad connectivity within the site.

WebCAT's travel time options allow planners to generate location specific plots using a range of variables including:

- Year: 2015, 2021 or 2031
- Mode: All public transport, bus only, step-free
- Direction: To the location, From the location. Average of To and From.
- Time of day: AM peak, inter-peak, PM peak.

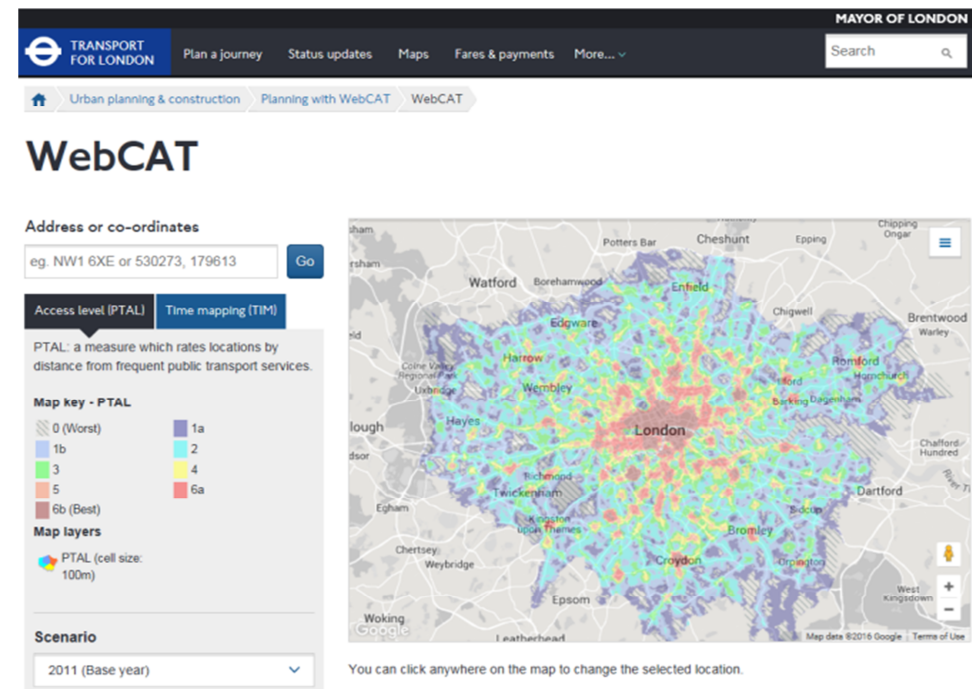


Figure 4: Example screenshot from WebCAT website

WebCAT can generate a range of maps and statistics, and Phase 2 will offer more

WebCAT presents PTALs for the base year (2015) and also forecasts PTAL values for future scenarios based on committed improvements to the transport network. Outputs can be created for any location in London at a local or strategic level. It is also possible to download the calculations behind the PTAL scores.

WebCAT has a number of applications:

- Identifying places that could benefit from transport improvements
- Informing planning decisions using PTAL or catchment analysis
- Assessing connectivity impacts of new stations / routes.
- Assessing future year connectivity

WebCAT Phase 2 will go live in December 2016. In addition to a site's PTAL and travel time catchment planners will be able use new functionality and datasets including:

- Catchment bar charts (bottom right-hand image) showing how many people / jobs / town centres / schools etc. are reachable; within the travel time bands displayed on the map for the selected location.
- User defined travel time bands – the default is 15 minutes but users will be able to change this to 5, 10, 20, 30, or 45 minute intervals. These intervals will also be applied in the catchment bar charts.
- Comparison travel time plots – users can compare one travel time variable to another for the chosen location and display the differences on the map and the associated bar charts.
- Cycling will be included as an additional transport mode. Allowing users, for example, to compare cycle times to public transport times.

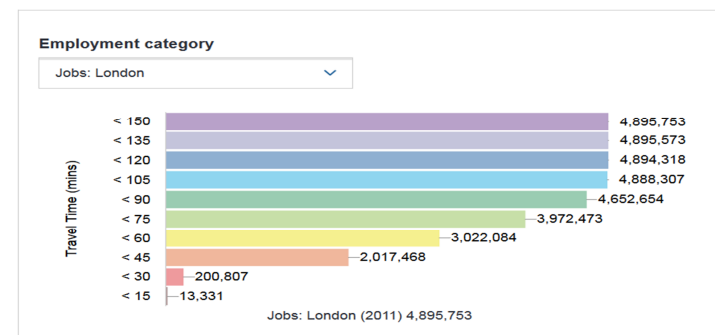
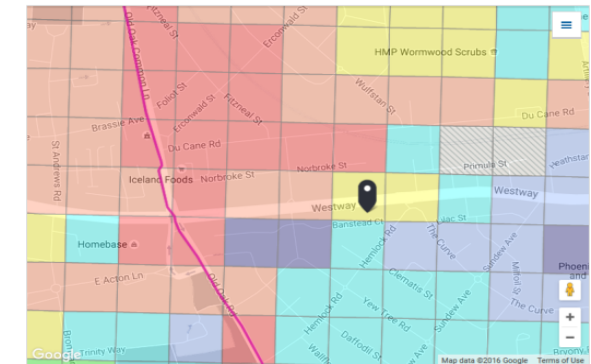


Figure 5: Different views from the WebCAT website (first two = existing; third image = Phase 2)

Additional connectivity factors could complement PTAL

TfL has worked with the GLA to identify additional measures that could help establish whether a location is suitable for higher density housing.

We identified a list of connectivity measures that could be used to complement PTAL – these are shown in the table opposite.

From this we identified three key connectivity factors that could sit alongside PTAL to inform housing density. They reflect people's primary needs;

- Access to jobs within 45 min by public transport,
- Access to a rail station by walking,
- Access to services (represented by walk distance to a town centre).

CATEGORY	MEASURE
PTAL	PTAL
Jobs accessibility	Jobs reachable within 45mins by PT
	Jobs reachable within 45mins by Highway
Population	Population Density per Hectare
	Population reachable within 45mins by PT
Employment	Jobs Density per Hectare
Existing Setting	Setting (Suburban/ Urban/ Central)
Rail Access	Distance to nearest Rail/LU station
Town Centre Access	Distance to nearest Town Centre
Crowding	Ease of boarding service at nearest Rail/LU station
Local Services	Distance to nearest Primary School
	Distance to nearest Grocery Store
	Distance to nearest GP
	Distance to nearest Open Space
	Distance to nearest Secondary School
	Primary Schools within 1500m
Cycling connectivity	E.g. Cycle network, cycle travel times to jobs, services

Table 3: List of additional connectivity measures that could complement PTAL

Analysis shows that the connectivity of your home location influences how you travel

Looking at survey data from the London Travel Demand Survey (LTDS) it is possible to analyse the trips that people make to and from their homes.

From this, TfL have shown there is a link between people's choice of transport mode and the connectivity factors of the area in which their home is located. The analysis presented uses 10 years' worth of data from the LTDS (2005/6 to 2014/15).

The analysis is carried out at ward level. Analysis is based on average values for the ward – it is **not** correct to extend these conclusions to specific locations, for example, using the distance from a particular site or development to a particular rail station or town centre to infer the likely mode share at the site or development.

The analysis includes trips of all journey purposes. The main conclusions are that people are more likely to drive, and less likely to use public transport, cycle or walk if they live in areas:

- of low public transport provision than in areas of high public transport provision
- of low population density than in areas of high population density
- which are further from central London than areas which are closer to the centre
- which are further from rail stations than in areas which are closer to rail stations
- which are further from town centres than in areas which are closer to town centres
- from which more jobs can be accessed within 45 minutes by public transport than in areas from which fewer jobs can be accessed within 45 minutes by public transport.

There is no discussion about the relative importance of the variables. However it can be seen that for home-based trips the strongest relationships are between mode shares and public transport provision, and access to jobs.

The red bars in the following charts (Figures 7 to 9) show the proportion of London's population that live in each PTAL Band (broken down by central, inner and outer London). They aim to provide context about how many people live in wards with different characteristics.



Areas with good access to jobs by public transport have higher public transport and active travel mode shares

There is a strong link between the number of jobs that can be accessed by public transport within 45 minutes, and Public Transport trip mode share. Car use decreases as more jobs become accessible by Public Transport. This relationship holds for home-based trips of all purposes e.g. leisure, shopping, personal business, not just commuting trips.

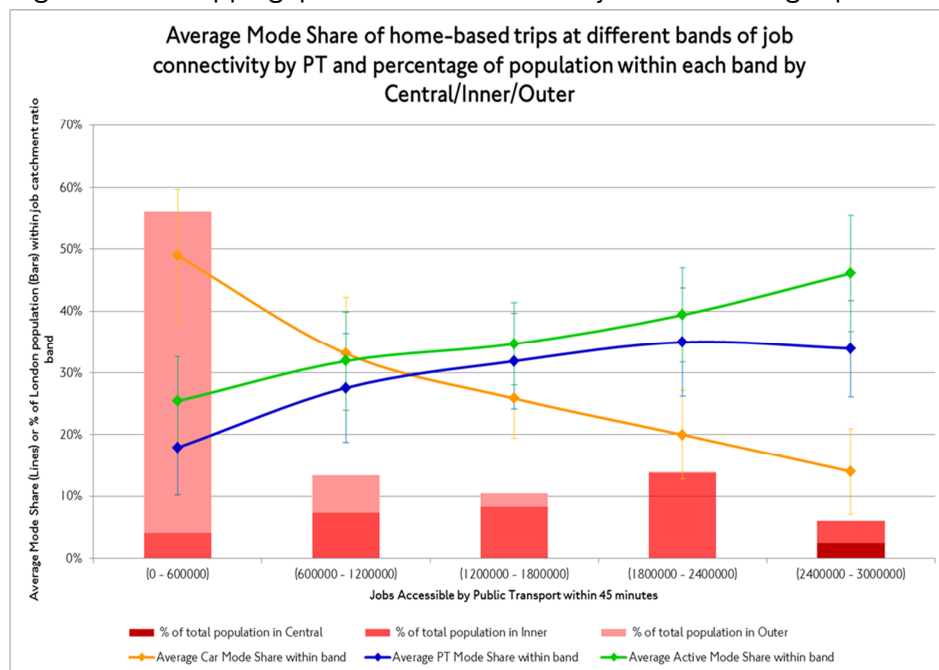


Figure 6: Average Mode share of home based trips by access to jobs and the population in central, inner and outer London

People who live in wards near rail / LU stations have a higher public transport mode share

Proximity to a rail / LU station is associated with higher public transport mode share for residents. Car use increases as the average ward-based distance from a rail station increases.

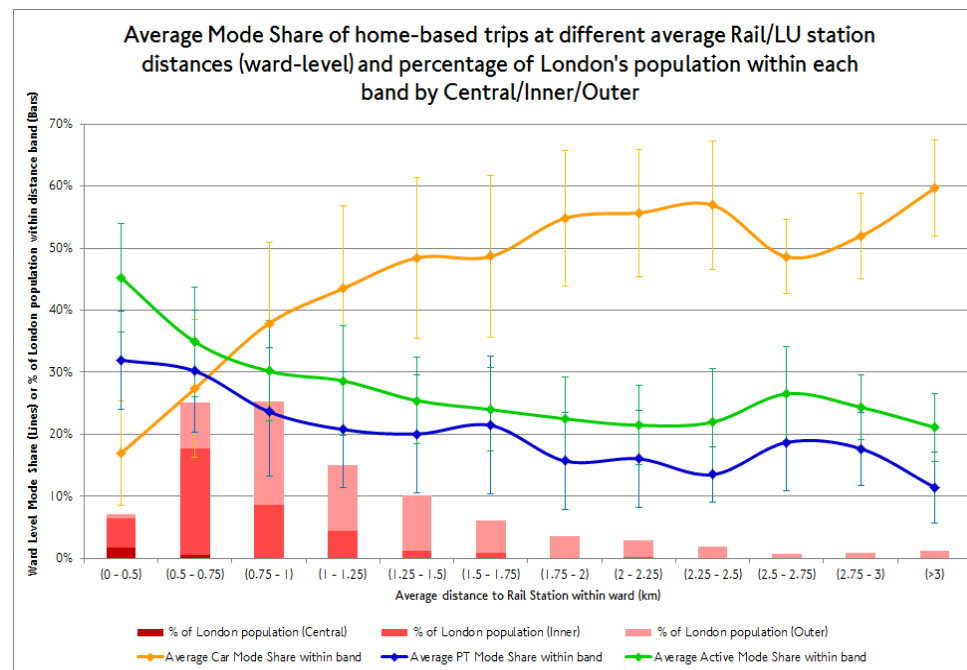


Figure 7: Average Mode share of home based trips by distance to rail and the population in central, inner and outer London

Proximity to town centres is linked to more public transport use by local residents

Analysis of travel behaviour shows that people living in wards that are further from town centres tend to travel more by car, and have lower public transport and active mode shares. The falling average public transport mode share seems to flatten off once average distance to town centre is above 1.5km.

Proximity to a town centre can help describe an area's level of connectivity. Access to town centres can be used as a proxy for access to services as town centres typically provide shops and services such as a GP, library, etc.

PTALs do not fully reflect proximity to town centres. Whilst PTALs are often higher in large town centres, this is because they are often hubs for rail and / or bus services, rather than reflecting any element of the town centres themselves. Not all centres offer adequate public transport, and similarly not all high PTAL areas are town centres.

TfL would therefore recommend that proximity to town centres is included when considering appropriate housing densities, for example, as they are currently, as part of the character settings.

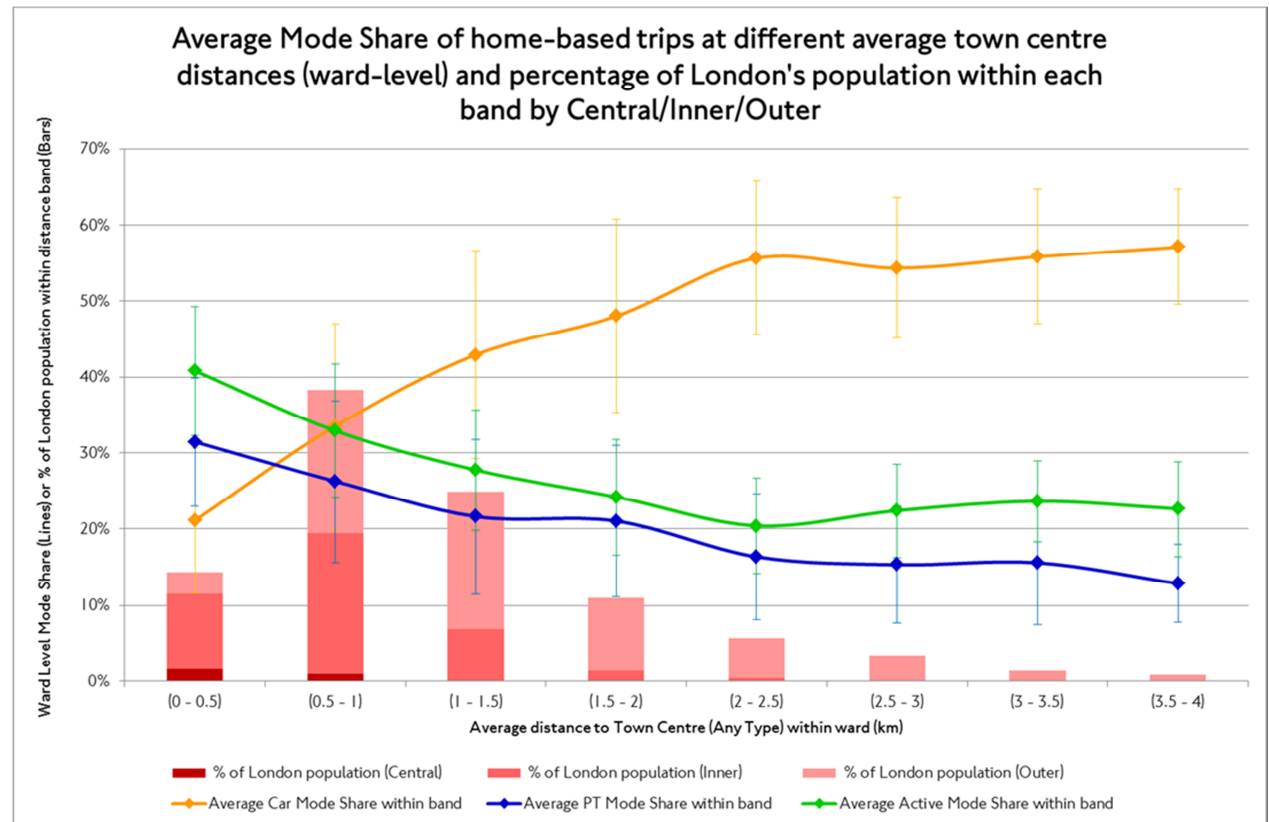


Figure 8: Average Mode share of home based trips by distance to town centres and the population in central, inner and outer London

TfL mapped these three additional connectivity factors in a piece of exploratory analysis

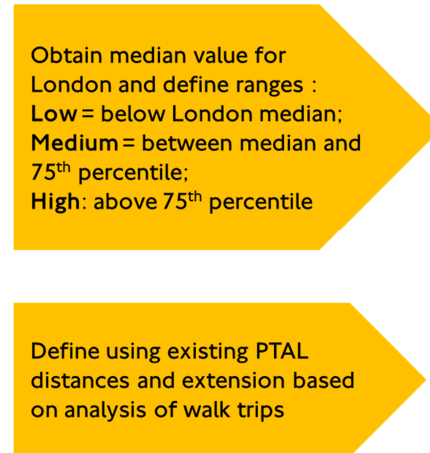
In order to map the three connectivity factors London was divided into 100• • grid squares and relevant values were obtained for each square.

Jobs within 45 minutes by PT - the data was provided from TfL’s public transport model (RailPlan) at a zone level (there are 3,200 zones). Values are applied to each grid square based on the zone they are located in but can be weighted by the PTAL rail Accessibility Index values or the distance to the nearest rail station which is provided at the grid level.

Distance to nearest London Underground (LU)/rail/DLR/tram – the distance from the centre of each grid square to the nearest LU, rail, DLR or tram station. This was calculated using the shortest path along the latest Integrated Transport Network (ITN) from the Ordnance Survey.

Distance to nearest town centre - calculated using the shortest path along the latest ITN network and available at 100m grid cell level.

For each measure we defined Low /Medium /High ranges: High = “good”, Low = “bad”. Using ranges based on the median and 75th percentile for jobs, and data on current walk patterns. These ranges are flexible and could be altered to reflect or test different outcomes.



Measure	Band name	Lower Value	Upper Value
Jobs reachable within 45 minutes by PT (jobs)	Low	0	175,000
	Medium	175,000	600,000
	High	600,000	3,500,000
Distance to nearest Rail/UG station (metres)	Low	1,500	>1,500
	Medium	960	1,500
	High	0	960
Proximity to Town Centres (metres)	Low	1,500	>1,500
	Medium	960	1,500
	High	0	960

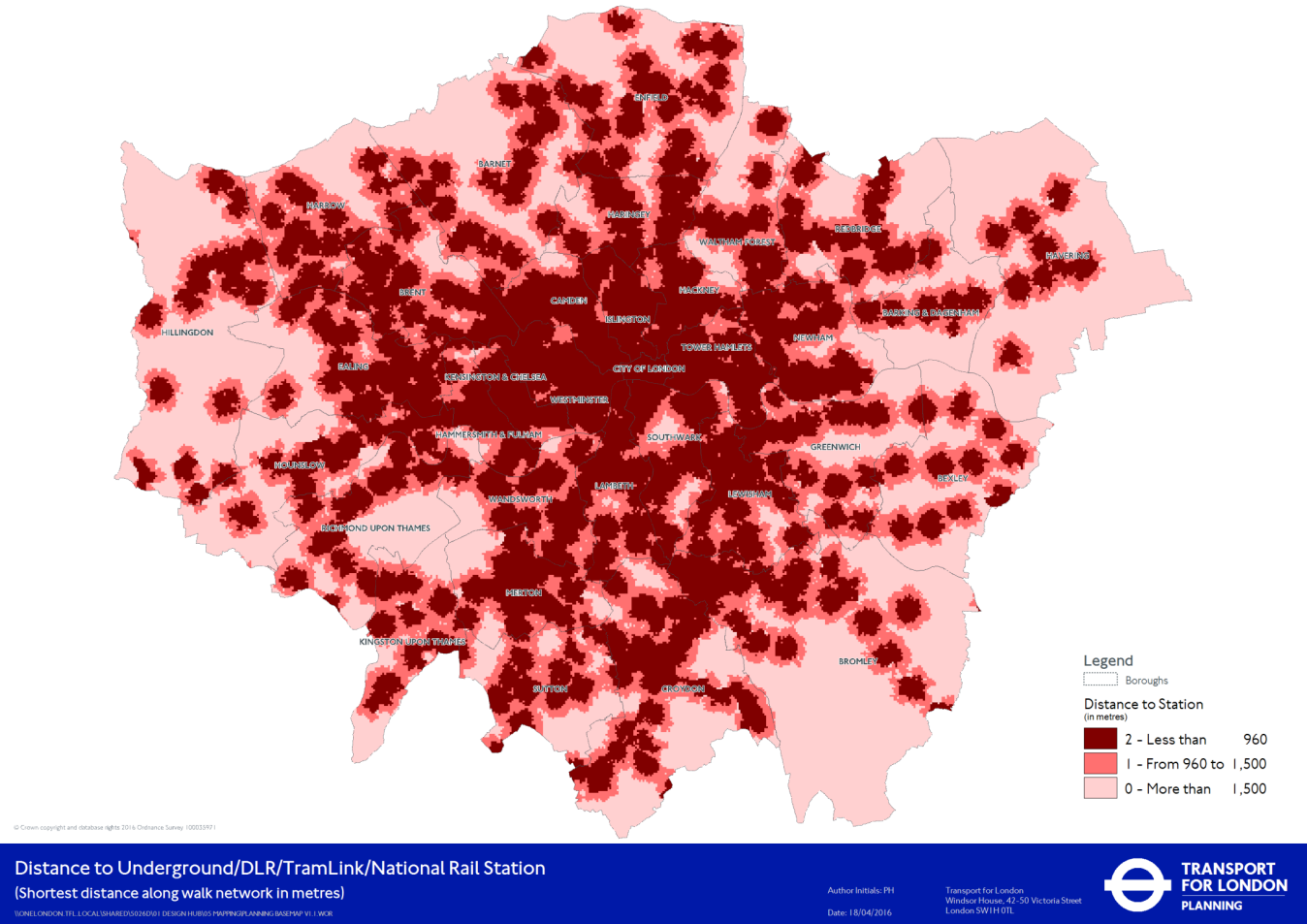
Figure 9: Table of values used to map the three factors

Distance to nearest Underground, rail, DLR or tram station

The map illustrates distance to the nearest underground, rail, DLR or tram station (all these modes are collectively referred to as rail).

The dark red shows locations with the shortest walk distance to rail (less than 960m); the pink shows a medium distance to rail (between 960m and 1,500m); and the pale pink shows the longest distance to rail (more than 1,500m).

These distances were selected because the PTAL calculation has 960m as the maximum walking distance for accessing public transport. TfL surveys suggest 1.5km is the maximum likely walk distance that most people would be willing to walk.

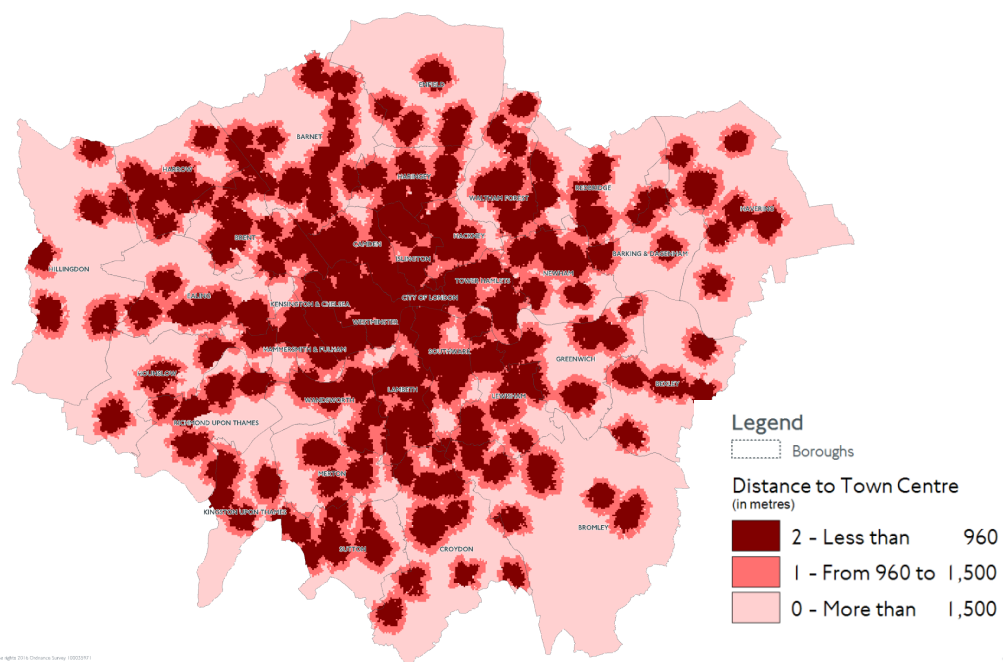


Map 2: Map of walk distance to rail stations

Walk distance to nearest town centre

The darker shaded areas have shorter walk distances to town centres, calculated using the walking network provided by streets (instead of crow-fly distance).

Map 3 shows all town centres (no matter their size) and their spread across London.



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Distance to Town Centre (District, Major, Metropolitan or International)
(Shortest distance along walk network in metres)

Author Initials: PH
Date: 18/04/2016

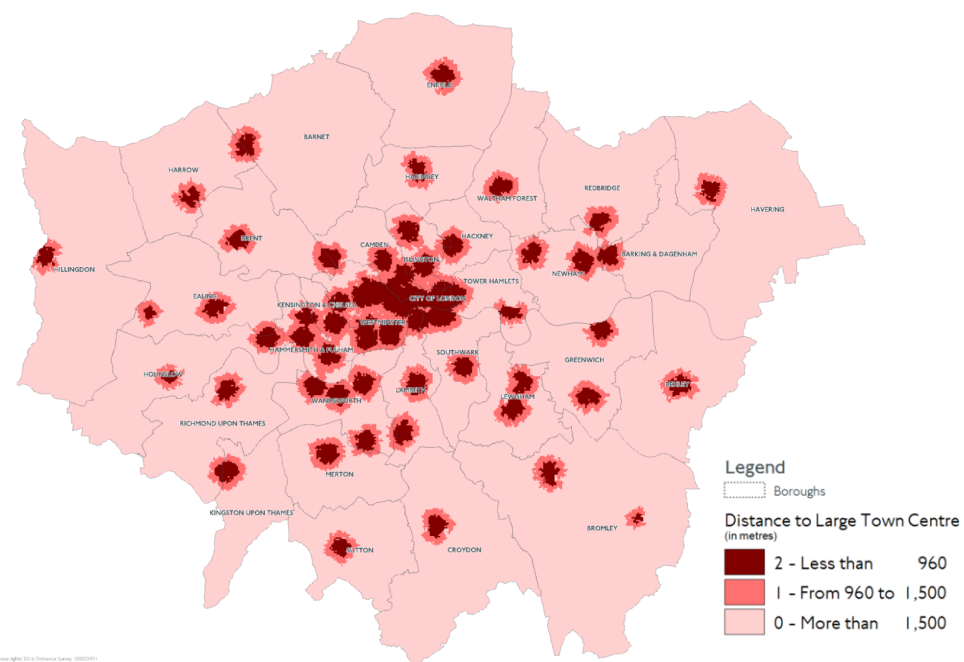
Transport for London
Walkfor House, 47-50 Victoria Street,
London W1H 0TL



Map 3: Map of walk distance to District, Major and Metropolitan town centres

Map 4 shows large town centres (major and metropolitan) only and illustrates that they are fewer in number and not as spread out across London.

Town centres vary in terms of size and the services they offer. Major and Metropolitan town centres tend to have high PTALs, reflecting the rail and bus hubs they offer. District town centres are far less likely to have a high PTAL as they tend not to have rail and bus stations found in larger town centres. In the composite measure on the following page we used all town centres (as in Map 3).



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Distance to Large Town Centre (Major, Metropolitan or International - excluding District)
(Shortest distance along walk network in metres)

Author Initials: PH
Date: 18/04/2016

Transport for London
Walkfor House, 47-50 Victoria Street,
London W1H 0TL



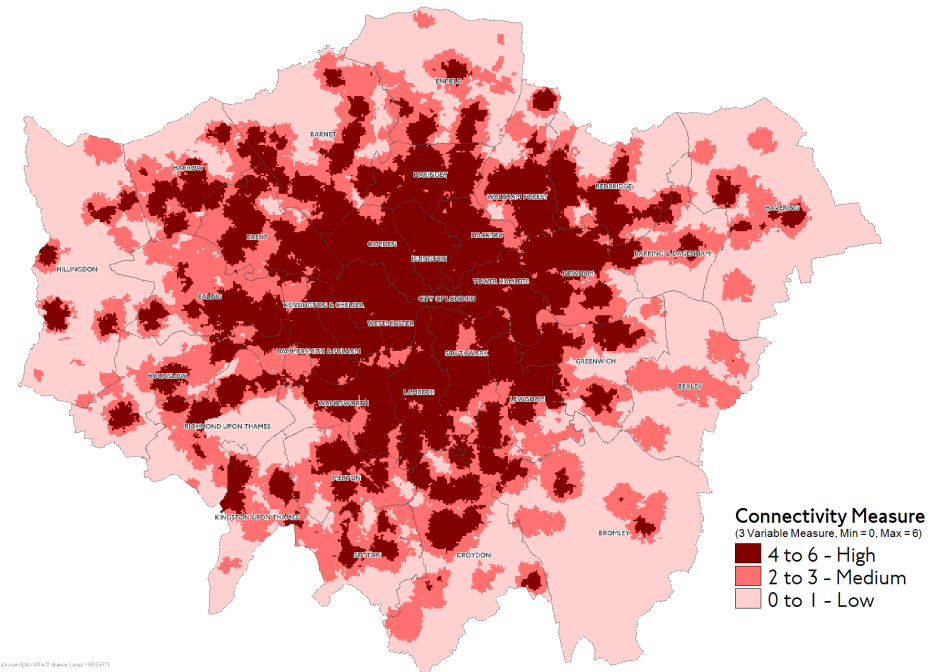
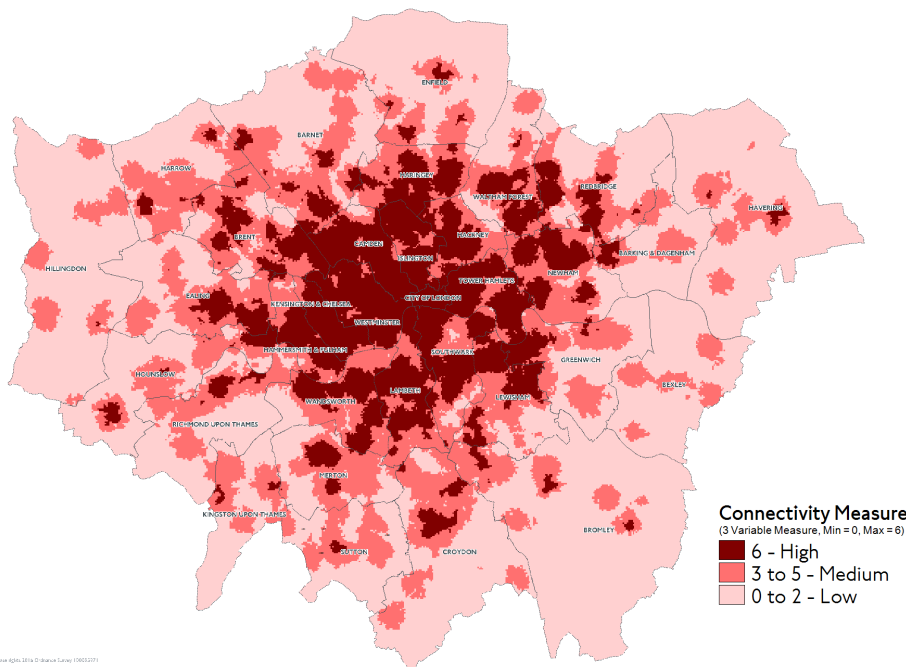
Map 4: Map of walk distance to Major and Metropolitan town centres only


A composite map shows areas of high and low connectivity


We combined the three factors using a scoring system. In the first example (Map 5) 'high' connectivity areas were defined as having all three factors in the 'high' category (i.e. dark red in Maps 1, 2 and 3).

Map 6 shows a slightly looser definition of High connectivity. Here, 'high' connectivity was defined as having at least two factors in the 'high' category and one in 'medium' Category.

This is one way to summarise how well connected different areas are. It could inform decisions on suitable levels of housing density / development, complementing PTAL which is presented in the Housing Density Matrix.



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 Connectivity Measure combining Jobs within 45 mins, Distance to Station, Distance to Town Centre
 (High range defined as all variables in their respective "High" category)
 Author: Inhabis, PH
 Transport for London
 Windsor House, 42-50 Victoria Street
 London SW1W 0DL
 Date: 18/04/2016
 **TRANSPORT FOR LONDON PLANNING**

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 Connectivity Measure combining Jobs within 45 mins, Distance to Station, Distance to Town Centre
 (High range defined as at least 1 variable in its respective "High" category)
 Author: Inhabis, PH
 Transport for London
 Windsor House, 42-50 Victoria Street
 London SW1W 0DL
 Date: 18/04/2016
 **TRANSPORT FOR LONDON PLANNING**

Map 5: Composite map showing 'high' connectivity areas

Map 6: Composite map with looser definition of 'high' and 'medium' connectivity

People travel more sustainably in areas with higher connectivity

Analysing the travel patterns of people living in areas with different 'connectivity scores' (based on the trialled mapping analysis on the previous page) found that the car mode share is much higher in poorly connected areas.

This suggests people who don't have access to good public transport or local walk / cycle options are more reliant on their car.

In locations which scored 'high' in two or three of the connectivity variables (i.e. a score of 5 or 6 in total), the mode share for active travel and public transport exceeded the car mode share, showing that more trips in these well-connected areas are made by sustainable modes.

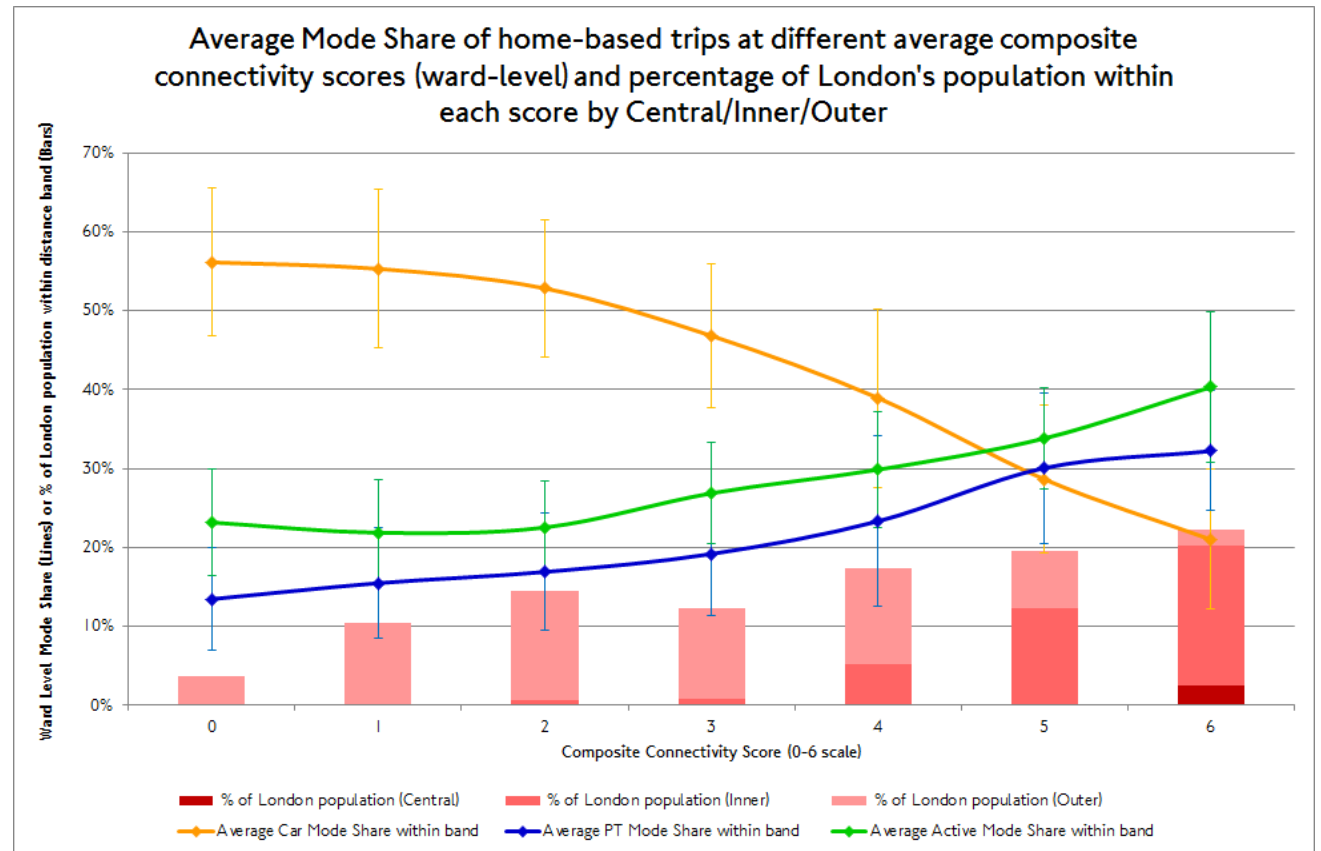


Figure 10: Average Mode share of home based trips by the composite connectivity score and the population in central, inner and outer London

WebCAT could include additional information and guidance to assist with planning

Whilst PTAL should remain the key transport measure in housing density policy, additional connectivity information could be used to provide more context. This would help give a fuller understanding of the connectivity of an area.

In this paper we have presented three factors that influence how people travel and trialled a way to map these characteristics in a consistent way across London:

- access to jobs within 45 minutes by public transport,
- walk distance to rail stations,
- access to services (represented by walk distance to town centres).

PTALs complement travel time based measures (which are at a larger zonal level) by

providing analysis at the local/sub-zonal level.

We could complement the use of PTAL in WebCAT by incorporating additional information to support the definition of appropriate housing density or other planning decisions.

Supporting information could be made available to download and/or incorporated into the PTAL calculation report. We present two examples of what this could look like on the right.

TfL and the GLA should work together to develop appropriate guidance for practitioners on how to use connectivity data and WebCAT to inform planning.

The content and presentation of this guidance has not yet been discussed or resourced. However, some ideas of what it could include are: site-specific connectivity measures alongside average London figures to provide context; information to help interpret connectivity data (for example to link outputs to appropriate density levels presented in the Matrix ranges); how to interpret jobs access data given its limited spatial resolution; and how to interpret variations in PTAL across large sites.

Guidance could draw on technical background in the connectivity guide and add practical user information <http://content.tfl.gov.uk/connectivity-assessment-guide.pdf>

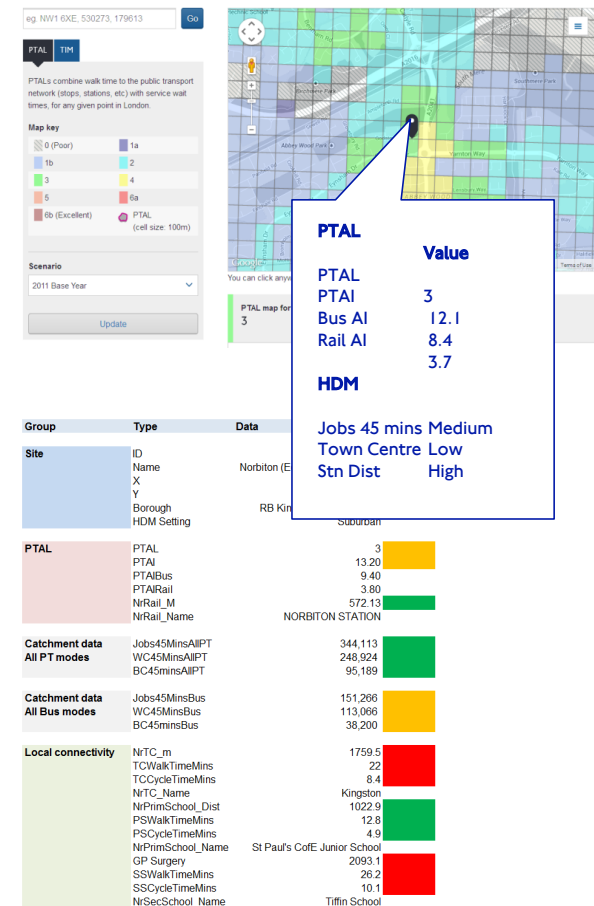


Figure 11: Ideas for possible outputs that could be provided in WebCAT

Summary and Recommendations

Connectivity affects where people live and how they travel. We want people to live in well-connected areas so they can access jobs and services, and travel sustainably.

Areas with higher PTALs are linked to areas with a higher public transport and active mode share. PTAL is available at a spatially detailed level and can be used directly for specific site assessments. PTAL is an established method and should continue to be a main consideration in housing density.

WebCAT makes PTAL publically available and easy to produce site or area-specific maps. It also presents a range of supplementary information about travel time statistics. The upcoming Phase 2 will present information on access to population, employment and various services across the whole of London, as well as cycling connectivity. This can add information about how well-connected a place is and people's ability to access jobs and services from homes there. This additional information can

be used to supplement planning assessments.

We explored one way to present additional connectivity information (access to jobs, rail station, town centres). Like PTAL, the explored connectivity measures are linked to higher levels of public transport and active mode shares.

The analysis in this paper has identified sources of information which would be useful to incorporate when identifying appropriate housing densities and has suggested WebCAT as a platform for doing so.

This analysis links with the GLA's wider programme of density work. Further work is required to understand how the different pieces of research will be brought together and conclusions drawn to inform the revised London Plan. TfL will continue to work with the GLA to do this and understand the links between housing policy and transport. This is important to ensure London delivers 'good growth' by providing housing in well-connected places, where people have sustainable travel options and good access to opportunities and services.

Our recommendations are that:

1. PTAL should remain a key component of housing density policies.
2. TfL's WebCAT tool should be used in the process of determining appropriate housing density for developments.
3. Alongside PTAL, other factors can provide context on how well-connected a place is e.g. access to jobs, proximity to rail stations and proximity to town centres.
4. TfL and the GLA should work together to develop appropriate guidance for planning practitioners on how to use and interpret connectivity data in WebCAT.
5. TfL and the GLA should continue to work together to explore the impacts of development and housing density, and check this is compatible with sustainable transport aspirations.

