

# Public Transport Access Level (PTAL) in Slough

February 2018

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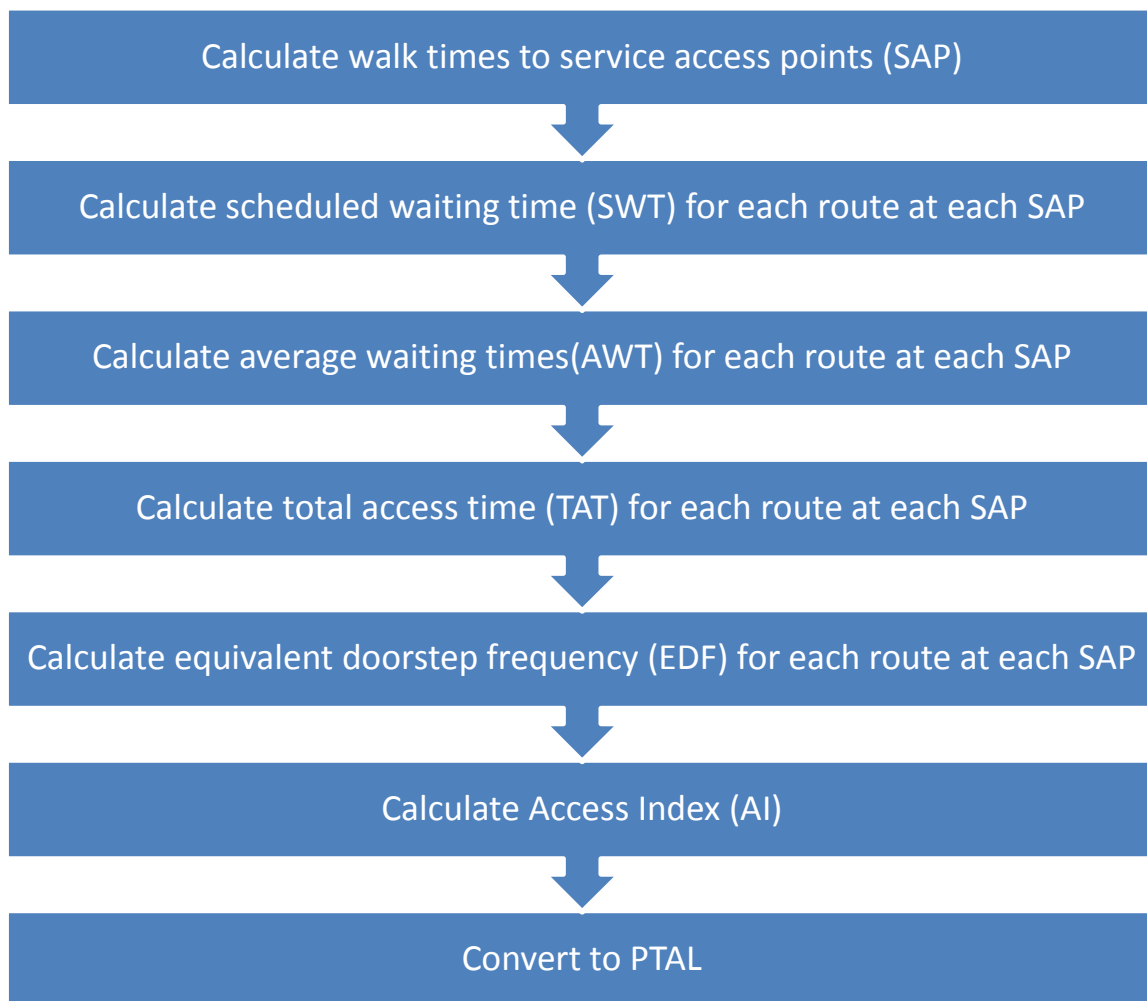
## 1 Introduction

- 1.1 Slough Borough Council (SBC) is in the process of writing a new Local Plan to shape the development in the town during the period 2016-2036. Slough has a high housing and employment demand which needs to be accommodated in a sustainable way that reduces the impact on the existing infrastructure.
- 1.2 The SBC planning department has decided to assess the Public Transport Access Level (PTAL) across the borough. PTAL is an indicator of accessibility to public transport; areas with better access to public transport can allow higher densities. The indicator goes from 0 to 6 where 0 represents the least accessible and 6 the most accessible. The levels 1 and 6 are also divided into two groups “a” and “b”.
- 1.3 PTAL is a well-known method used by Transport for London and Boroughs across London to plan housing densities and parking provision (TFL, 2015). SBC has selected PTAL as the method to assess connectivity in Slough to be able to compare results with the neighbouring London Boroughs.
- 1.4 The purpose is to look to the relative accessibility of areas within the borough and to compare Slough with London boroughs.

## 2 Methodology

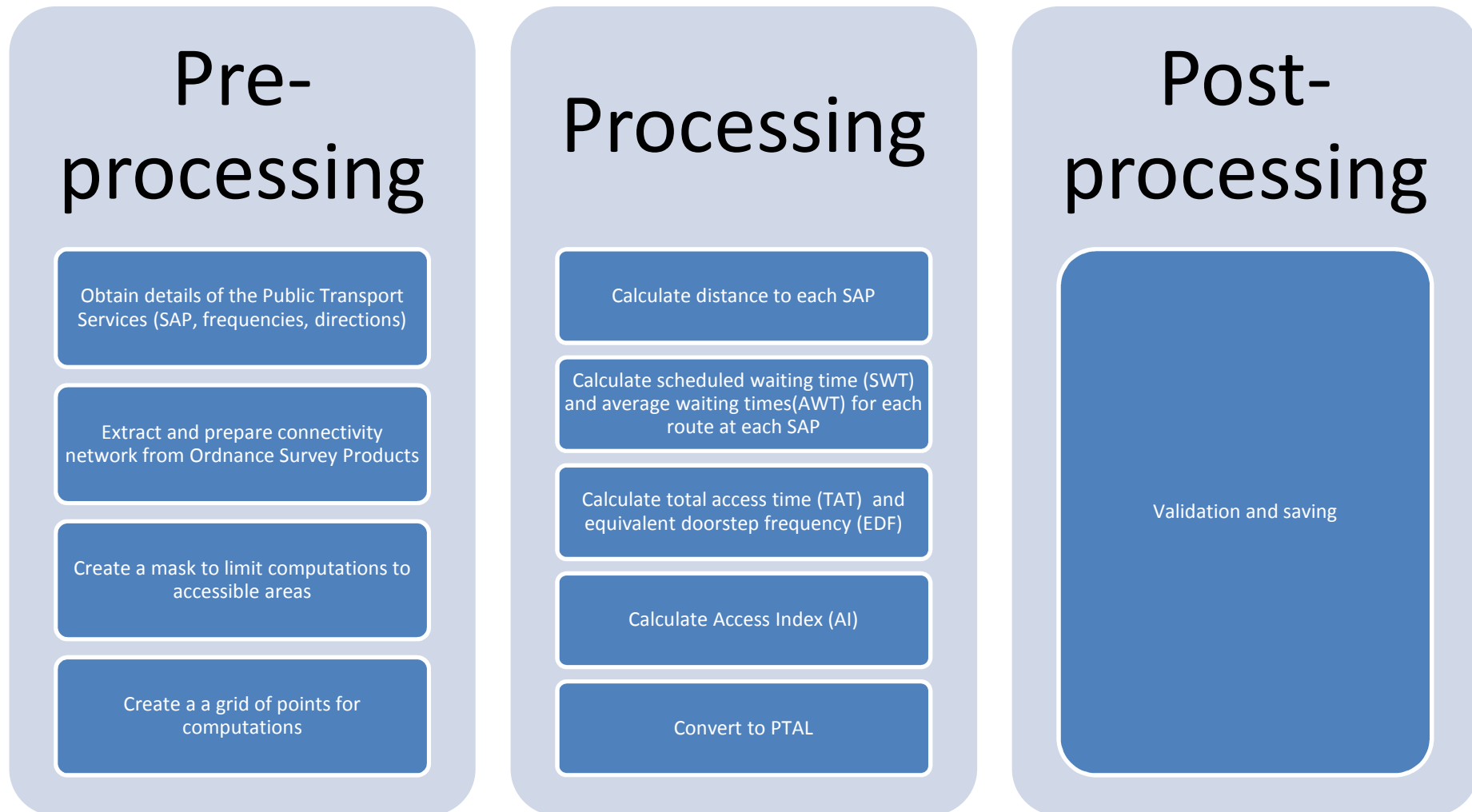
- 2.1 This assessment is based on the methodology produced by TFL and published in the guide titled “Assessing Transport Connectivity in London” (TFL, 2016). A summary of the steps required to calculate the PTAL can be found in Figure 1: Steps to calculate PTA.
- 2.2 The implementation of the PTAL was written by the SBC planning policy team in SQL using the PostgreSQL extensions PostGIS and pgRouting. The implementation is divided in three phases, post-processing, processing and post-processing as seen in Figure 2: Implementation of the PTAL methodology.

Figure 1: Steps to calculate PTA



Source: TFL (2016)

Figure 2: Implementation of the PTAL methodology



## 2.1 Pre-processing

This phase included the preparation of the data required to compute the PTAL. There was data about the public transport service and data about the connectivity network.

This phase also included the preparation of computational masks to limit computations and the preparation of a grid of points to compute the PTAL.

### 2.1.1 Public transport service

The details of every service access point and bus route were provided by ATKINS. These details included the location of all bus stops and train stations, and the frequency of the service for every bus route during the morning peak from 8:15 to 9:15. This period of time is based on the PTAL methodology (TFL, 2016).

The information regarding the train services was extracted from the website [www.nationalrail.co.uk](http://www.nationalrail.co.uk).

The locations of all service access points were amended to match their closest points on the connectivity network. This is required as pgRouting, the software used to calculate walking distances, can only calculate distances between points on the network. The average distance between the real position of the service access point and the position of their projections on the connectivity network is 6 meters.

An analysis of the public transport services features can be found in the chapter “Public transport”.

### 2.1.2 Connectivity network

The connectivity network was extracted from the Ordnance Survey Mastermap Highways-roads and from Ordnance Survey Mastermap Highways-path. This network includes all roads and paths where pedestrians can walk on. All roads and paths were extracted excluding motorways as pedestrians are not supposed to walk on motorways to get access to Public Transport Services. Similarly, any path leading only to motorways was excluded.

To improve the accuracy of the computations, the network was split in segments shorter or equal than 20 meters. This is recommended as pgRouting calculates distances based on the length of the segments. The value of 20 meters is arbitrary; smaller numbers will produce more accurate results but will require more computational time as well.

A short analysis of the mobility network features can be found in the chapter “Connectivity network and physical constraints”

### 2.1.3 Computational mask

A mask was created to increase speed and accuracy of computations. This mask extends only 1000 meter around Slough and excludes any large water bodies, motorways and rails.

Details of the physical constraints can be found in the chapter “Connectivity network and physical constraints”.

#### **2.1.4 Computational grid**

For this study the PTAL was calculated for every point in a grid spaced 20 meters in both east and north directions. The 20 meter value is also arbitrary; TFL (2016) uses a spacing of 100 meters.

An alternative to using a grid was to calculate the PTAL on every point over the connectivity network and then interpolate or extrapolate for areas not covered by the network. There are cases where the interpolation would provide a non-accurate result. Most interpolation methods don’t take into account physical constraints or walking distance thresholds. Both of these cases are taken into account for this study.

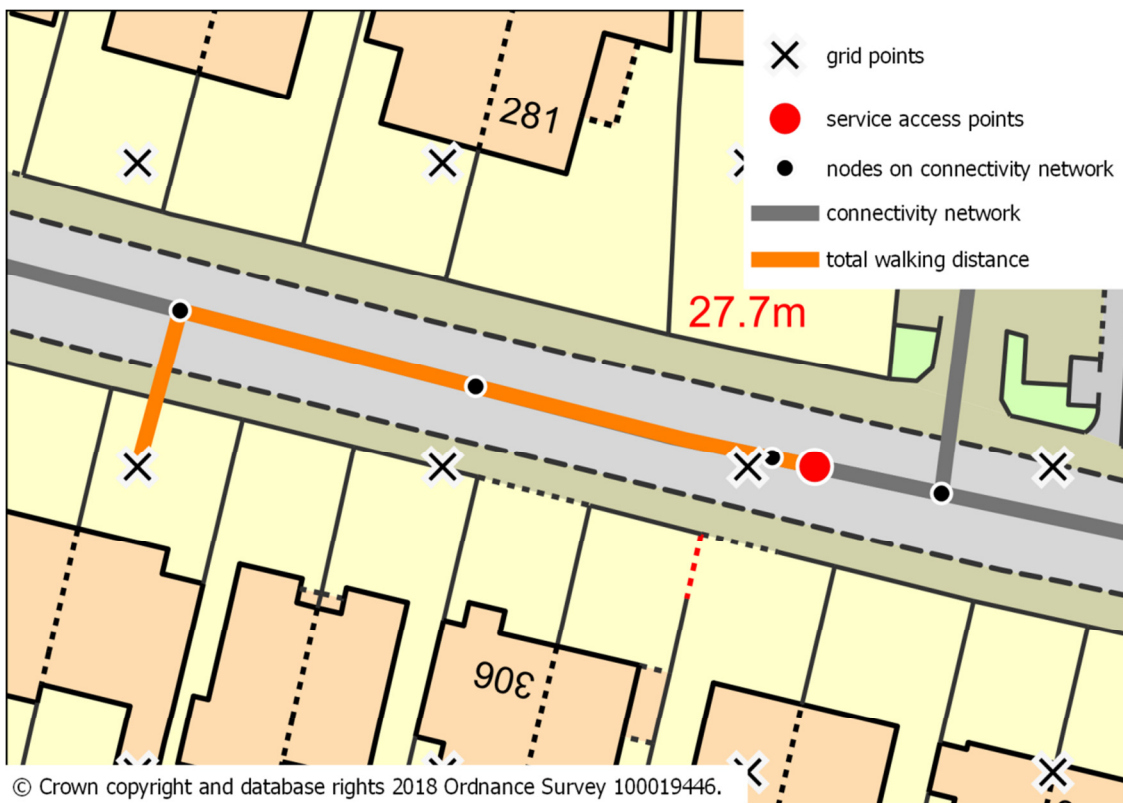
## **2.2 Processing**

The second phase focused on the actual computation of the PTAL and its elements: Computation of the distance to service access points (SAP), schedule waiting time (SWT), average waiting time (AWT), total access time (TAT), equivalent doorstep frequency (EDF) and public transport access level (PTAL).

### **2.2.1 Distances to service access points**

The distance from every service access point to every node on the connectivity network was calculated using the function `pgr_drivingDistance` of `pgRouting`. Afterwards the distance from every point in the computational grid to their closest node on the connectivity network was calculated using PostGIS. These two values were added to obtain the total distance from every point on computational grid to every service access point. See an example in Figure 3: Example of total walking distance..

Figure 3: Example of total walking distance.



### 2.2.2 Schedule waiting time (SWT) and average waiting time (AWT)

TFL (2016) defines the schedule waiting time (SWT) as “half the time interval between arrivals of the service at the SAP” and the average waiting time (AWT) as the SWT plus a reliability factor. Mathematically the SWT and AWT are defined as:

$$SWT = 0.5 * (60 / \text{frequency})$$

$$AWT = SWT + \text{reliability factor (Table 1: Reliability factor)}$$

Table 1: Reliability factor

Service type	Reliability factor
Train	0.75 minutes
Bus	2 minutes

Source: TFL (2016)

Both values were calculated for every service access point, route and direction if the service is provided in two directions for the same service access point. Train services with same origin and destination but different stops were considered different routes. For example a stopping service from Maidenhead to Paddington is considered a different route than a semi fast service from Maidenhead to Paddington.



### 2.2.3 Total access time (TAT) and equivalent doorstep frequency (EDF)

TFL (2016) defines the total access time (TAT) as walking time to service access points plus the average waiting time (AWT). The distance to service access points was divided by 80 to obtain the walking time to service access points assuming a walking speed of 4.8 kph or 80 meters per minute as suggested by TFL (2016).

The equivalent doorstep frequency (EDF) is defined by TFL (2016) as the frequency of the service if there were no walking time. Mathematically the TAT and the EDF are defined as:

$$\text{TAT} = \text{walking time to SAP} + \text{AWT}$$

$$\text{TAT} = (\text{distance to SAP})/80 + \text{AWT}$$

$$\text{EDF} = 0.5 * (60/\text{TAT})$$

The EDF was calculated for every transport mode, route and direction for every SAP and for every point in the computational grid.

### 2.3 Access index (AI)

The access index is the step previous to obtaining the PTAL. TFL (2016) calculates the AI for every transport mode at a given point by taking the largest EDF plus half of the remaining EDF. The total AI for the point in the grid is the sum of all AI for every transport mode. The AI is mathematically defined as:

$$AI = \text{largest EDF} + 0.5 * \sum(\text{all other EDF})$$

$$AI \text{ total} = \sum(AI \text{ bus} + AI \text{ rail} + AI \text{ tube} + AI \text{ tram})$$

The AI calculation ignores any SAP further than 640 meters for bus service and 960 for train service. The AI was calculated for every point in the computational grid.

#### 2.3.1 Public transport access level (PTAL)

The AI got transformed into the PTAL using the values in Table 2: Conversion from AI to PTAL.

**Table 2: Conversion from AI to PTAL**

PTAL	AI	Colour
<b>0 (worst)</b>	0	
<b>1a</b>	0.01 - 2.50	
<b>1b</b>	2.51 - 5.00	
<b>2</b>	5.01 - 10.00	
<b>3</b>	10.01 - 15.00	
<b>4</b>	15.01 - 20.00	
<b>5</b>	20.01 - 25.00	
<b>6a</b>	25.01 - 40.00	
<b>6b (best)</b>	40.01+	

Source: TFL (2016)

## **2.4 Post-processing: Validation and saving**

The post-processing phase only included the validation of PTAL values by auditing the calculations of 10 random locations. Any error found in the process was corrected and all computations repeated.

Final AI and PTAL values were saved as TAB files and maps were produced.

### 3 Public transport

- 3.1 Slough is served by three train stations and 342 bus stops. For the AM peak time from 8:15 to 9:15, Slough is served by 20 train different services (Table 3: Train routes) and by 20 bus routes (Table 4: Bus routes and frequencies). Frequencies for bus and trains were correct for the date 30/04/2017.
- 3.2 Bus stops are well distributed around the town and very few areas are not within 640 meters from a bus stop which is the threshold required for PTAL calculations. These areas out of range are mainly at the south of the borough (Figure 3: Example of total walking distance.).
- 3.3 Train stations are also well distributed around Slough; however there are only three stations and many areas around Slough do not fall within the threshold of 960 meters from any station (Figure 4: Distance to closest bus stop).
- 3.4 The train service has between 1 and 2 trains in the AM peak with an average of 1.2 trains. The bus service has between 1 to 6 buses in the AM peak with an average 2.35 buses. There are buses services that do not cover this time period and thus were excluded from this analysis (routes 63, 68, 305, 335, 350, 582, H55, H57 and H57X).

**Table 3: Train routes**

Train station	Direction	Route	Freq	Type
Slough Rail Station	eastbound	mhd-pad	1	semifast
Slough Rail Station	eastbound	mhd-pad	1	stopping service
Slough Rail Station	eastbound	oxf-pad	1	semifast
Slough Rail Station	eastbound	rdg-pad	2	stopping service
Slough Rail Station	eastbound	slo-pad	1	stopping service
Slough Rail Station	westbound	pad-hfd	1	fast
Slough Rail Station	westbound	pad-mhd	1	stopping service
Slough Rail Station	westbound	pad-oxf	1	fast
Slough Rail Station	westbound	pad-oxf	2	stopping service
Slough Rail Station	westbound	pad-rdg	1	fast
Langley (Berks) Rail Station	eastbound	mhd-pad	1	stopping service
Langley (Berks) Rail Station	eastbound	rdg-pad	1	stopping service
Langley (Berks) Rail Station	eastbound	slo-pad	1	stopping service
Langley (Berks) Rail Station	westbound	pad-mhd	1	stopping service
Langley (Berks) Rail Station	westbound	pad-oxf	2	stopping service
Burnham (Berks) Rail Station	eastbound	mhd-pad	1	stopping service
Burnham (Berks) Rail Station	eastbound	oxf-pad	1	semifast
Burnham (Berks) Rail Station	eastbound	rdg-pad	2	stopping service
Burnham (Berks) Rail Station	westbound	pad-mhd	1	stopping service
Burnham (Berks) Rail Station	westbound	pad-rdg	1	stopping service

**Table 4: Bus routes and frequencies on 30/04/17.**

<b>Route</b>	<b>Frequency AM peak (8:15 - 9:15)</b>
<b>7</b>	6
<b>81</b>	6
<b>1</b>	4
<b>6</b>	4
<b>3</b>	3
<b>WP1</b>	3
<b>2</b>	2
<b>4</b>	2
<b>5</b>	2
<b>8</b>	2
<b>12</b>	2
<b>13</b>	2
<b>X74</b>	2
<b>10</b>	1
<b>15</b>	1
<b>53</b>	1
<b>74</b>	1
<b>353</b>	1
<b>583</b>	1
<b>702</b>	1

Source: Atkins, 2017.

3.5 The bus stops with higher total frequency of buses are located at the centre of Slough, along the Stoke road, along the A4 from the centre to the east and in some areas of Langley and Farnham road (Figure 6: Total AM peak bus frequency per bus stop). This total values takes into account all routes stopping in each stop. The low frequency in the west of the borough is result of the concentration of services between Slough centre and Heathrow.

Figure 4: Distance to closest bus stop

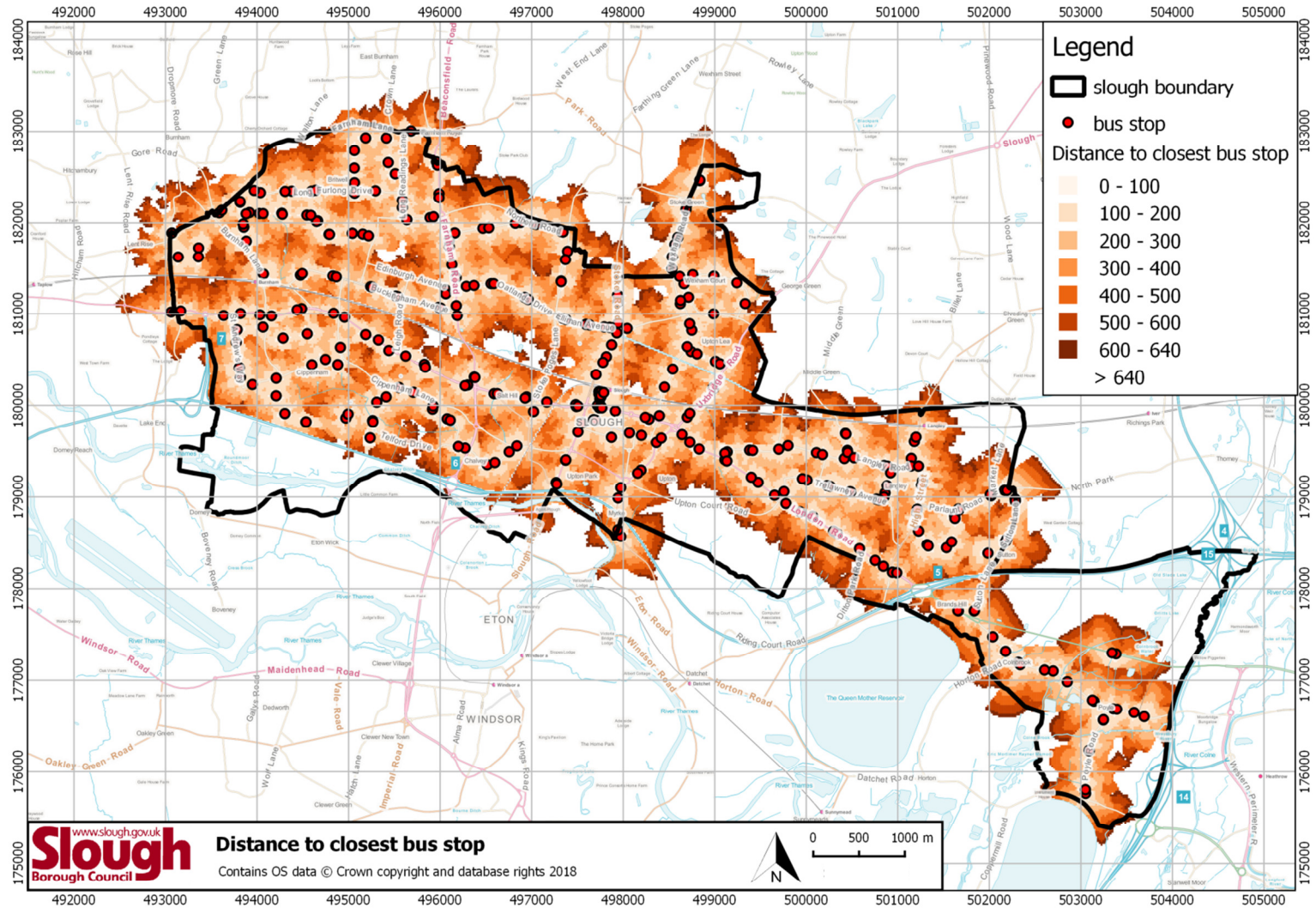


Figure 5: Distance to closest train station

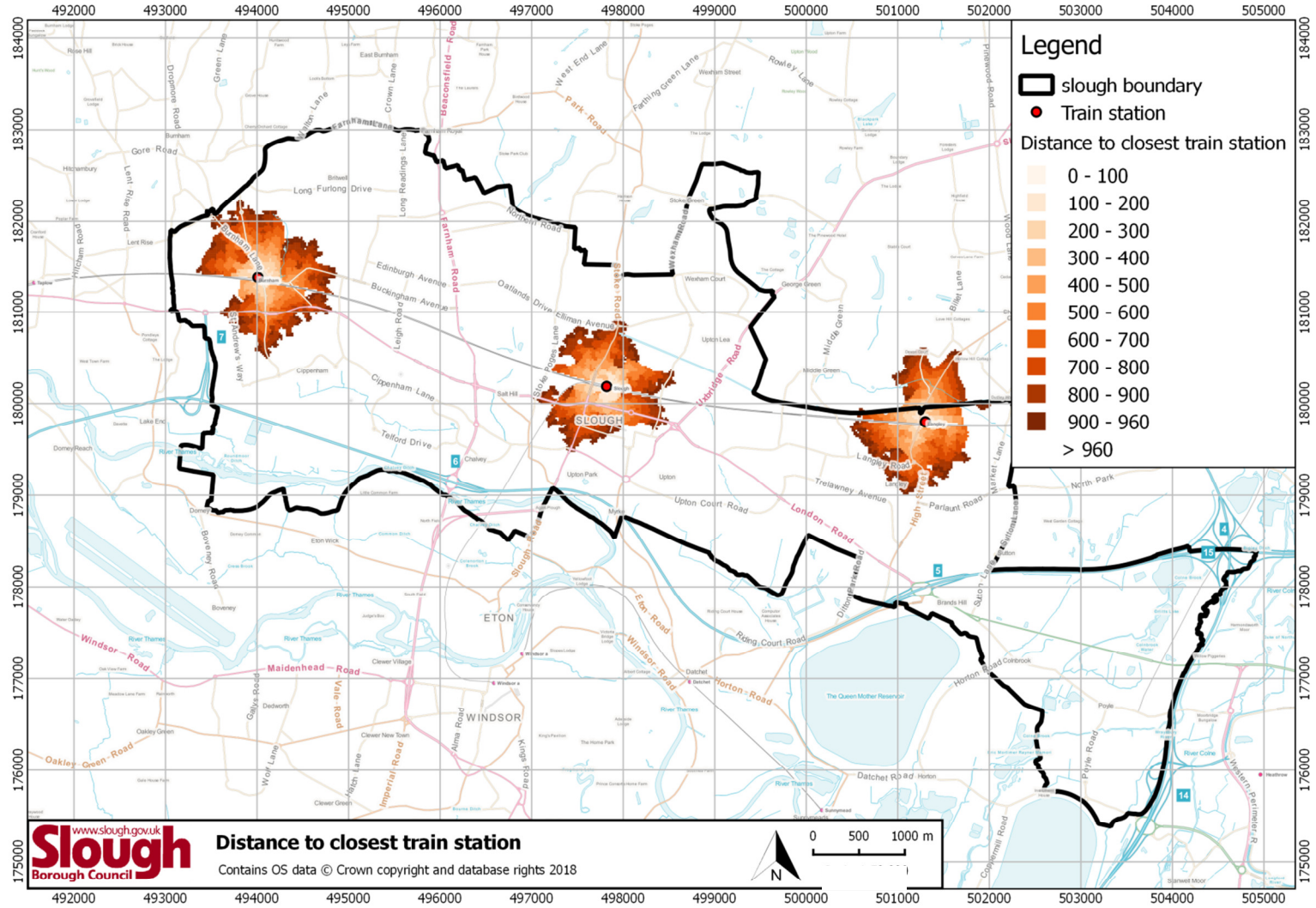
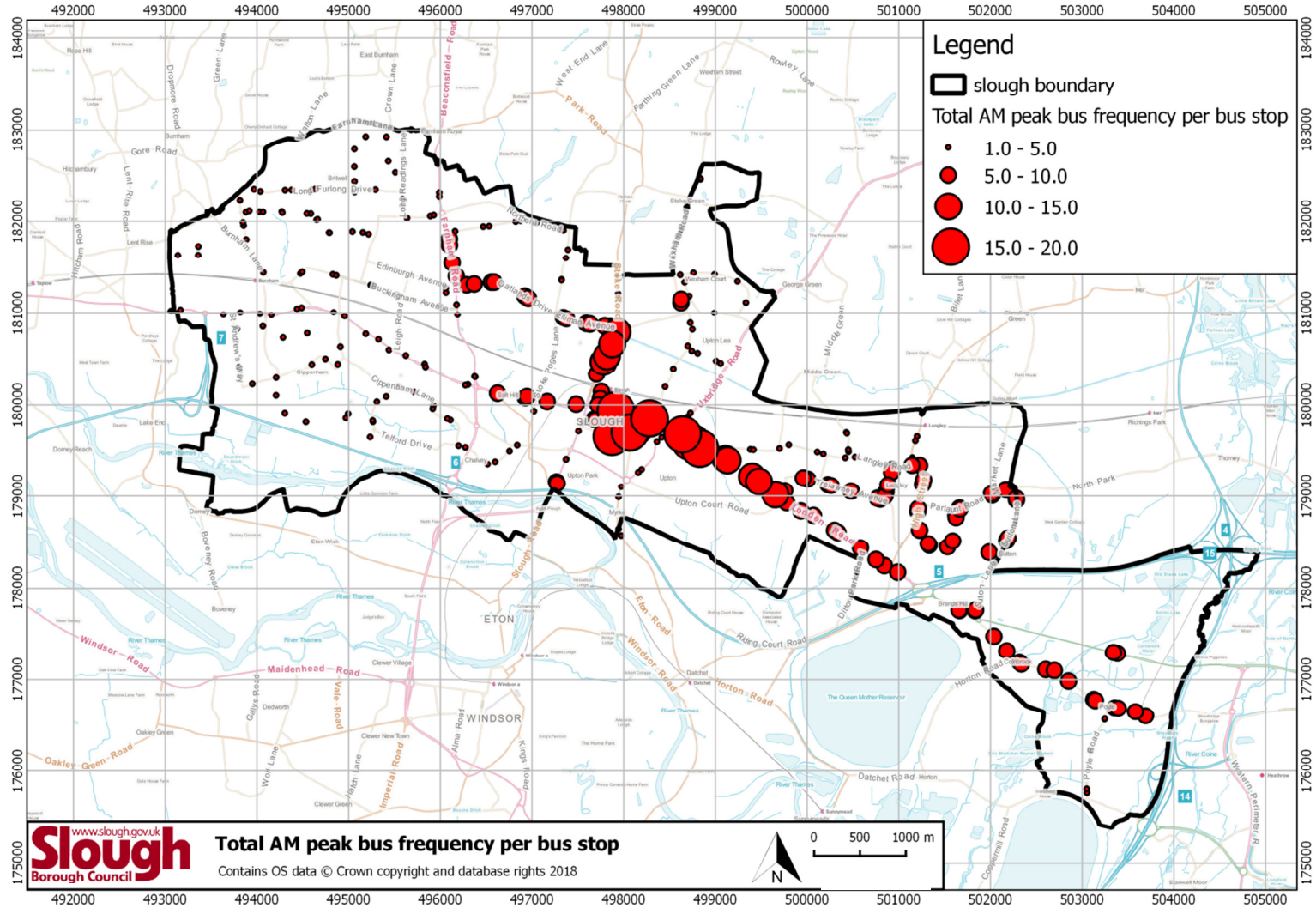


Figure 6: Total AM peak bus frequency per bus stop



## 4 Connectivity network and physical constraints

- 4.1 Slough has access to two motorways (M4 and M25), three A roads (A4, A355, A412) and five B roads (B376, B416, B470, B3022, B3027). Roads are well distributed and density is only lower at the south of the Borough and to the east of the borough (Figure 7: Connectivity network and constraints).
- 4.2 For this study water bodies, railways and motorways are constraints as people can't walk on these surfaces or cross them without taking diversions. Most of these constraints are aligned west-east affecting movement north-south (Figure 7: Connectivity network and constraints).

## 5 Access index

- 5.1 The access index (AI) was calculated for busses and trains. For busses the highest AI values in Slough, those from 10.01 to 20.00, form a cluster around Slough Bus Station with an area of 60 hectares, 2% of Slough (Figure 8: Bus access index; Table 5: Bus AI values). These AI values, from 10.01 to 20.00 are in the middle of the Access Index Scale.
- 5.2 Next in rank for busses in Slough are the AI values from 5.01 to 10.00, found along segments of Farnham Road, segments of Stoke Road and London Road from centre to east with an area of 274 hectares, 8% of Slough. The rest of the borough show really low AI values from 0.01 to 5.00. Slough bus services does not reach AI values higher than 20.00.

**Table 5: Bus AI values in Slough**

Bus AI	Total area (ha)	%
0	676	21
0.01 - 2.50	1062	33
2.51 - 5.00	1182	36
5.01 - 10.00	274	8
10.01 - 15.00	29	1
15.01 - 20.00	31	1
20.01 - 25.00	0	0
25.01 - 40.00	0	0
40.01+	0	0
<b>TOTAL</b>	<b>3254*</b>	<b>100</b>

\*Total Slough area



5.3 Trains show a different distribution. There are three clusters, each one around the train stations in Slough: Slough, Burnham and Langley (Figure 9: Train access index). These clusters are limited by the maximum walking distance of 960 meters.

5.4 The highest train AI value in Slough is from 5.01 to 10.00, only found around Slough station with a cover of 21 hectares, 1% of Slough (Table 6: Train AI values). Next in rank for trains is the AI value from 2.51 to 5.00, found in around the three clusters, mainly around Slough Station covering of 92 hectares followed by Langley station covering 29 hectares and Burnham station covering of 5 hectares. The total coverage is 126 ha, 4% of Slough. The lowest AI value for trains in Slough is from 0.01 to 2.50 found around Burnham covering 130 hectares and Langley covering 50 hectares.

5.5 All AI values for trains found in Slough are considered low within the AI scale.

**Table 6: Train AI values in Slough**

Train AI	Total		Burnham station		Langley station		Slough station	
	Area (ha)	%*	Area (ha)	%*	Area (ha)	%*	Area (ha)	%*
<b>0</b>	2927	90	0	0	0	0	0	0
<b>0.01 - 2.50</b>	180	5	130	96	50	63	0	0
<b>2.51 - 5.00</b>	126	4	5	4	29	37	92	81
<b>5.01 - 10.00</b>	21	1	0	0	0	0	21	19
<b>10.01 - 15.00</b>	0	0	0	0	0	0	0	0
<b>15.00 - 20.00</b>	0	0	0	0	0	0	0	0
<b>20.01 - 25.00</b>	0	0	0	0	0	0	0	0
<b>25.01 - 40.00</b>	0	0	0	0	0	0	0	0
<b>40.01+</b>	0	0	0	0	0	0	0	0
<b>TOTAL</b>	3254*	100	135	100	79	100	113	100

\*Total Slough area

Figure 7: Connectivity network and constraints

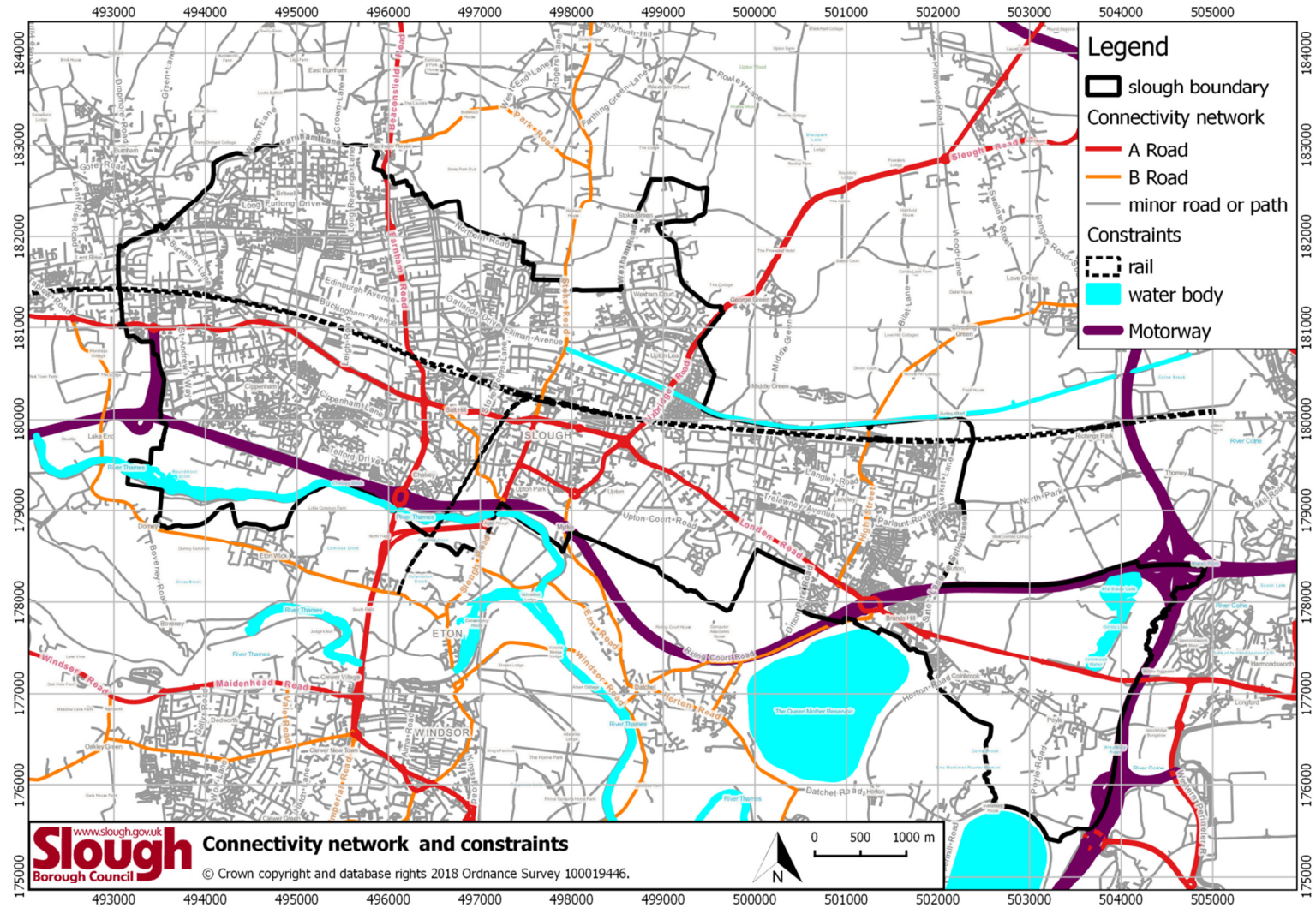


Figure 8: Bus access index

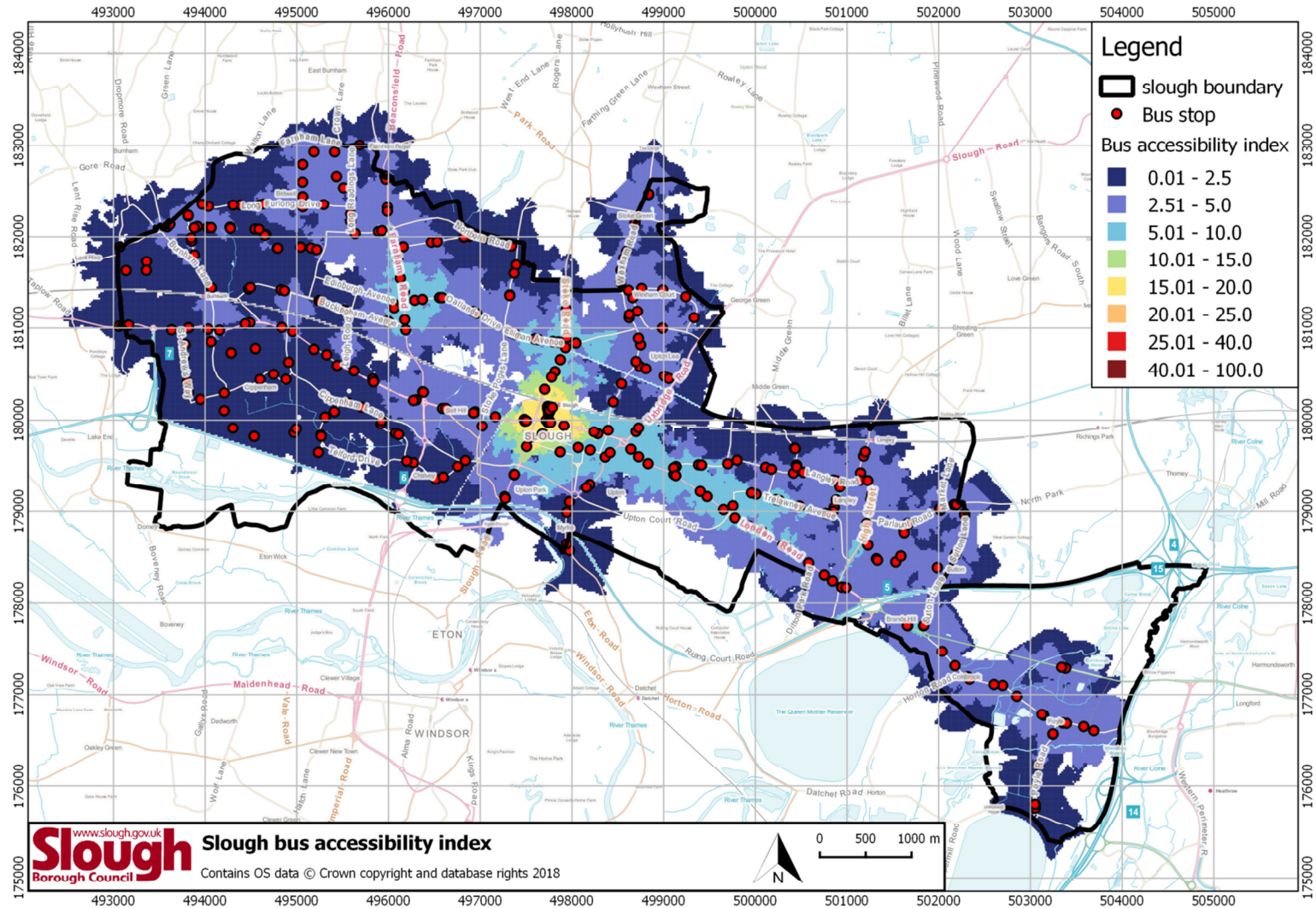
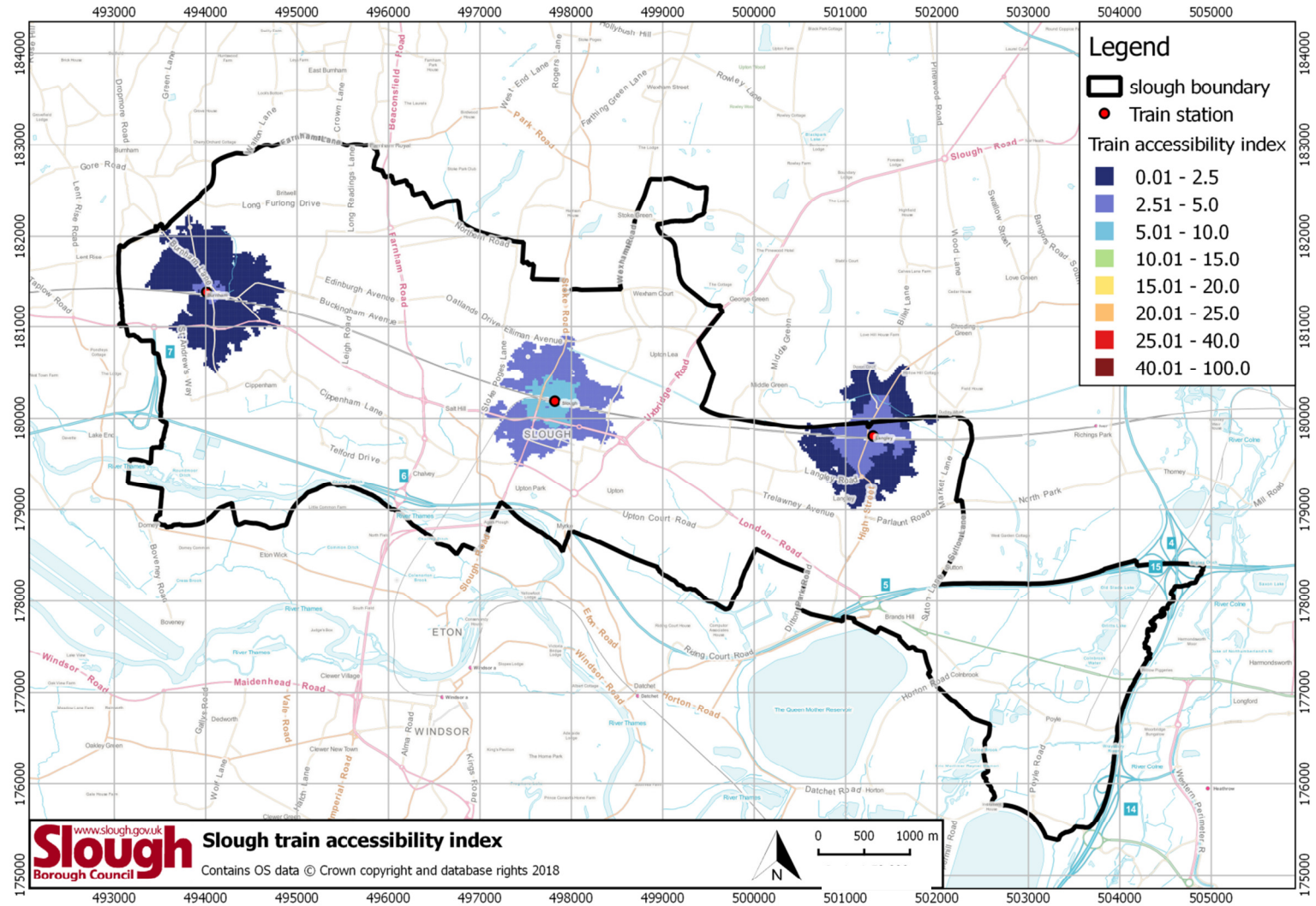


Figure 9: Train access index



## 6 Public Transport Access Level (PTAL)

- 6.1 AI values for buses and trains in Slough were added up and converted into PTAL values. More details of this process can be found in the methodology section “Public transport access level (PTAL)”. As the PTAL values are product of the AI values, they show a similar pattern: Three clusters with the highest values, one centred in Slough train and bus stations, one centred in Burnham train station, one along Farnham Road, one along Stoke road and one along London road from the town centre to the east (Figure 10: Public transport access index).
- 6.2 The highest PTAL value in Slough are 3, 4 and 5, found only around the town centre with a coverage of 89 hectares which represent only the 2.5 % of Slough (Table 7: PTAL values in Slough). These values are medium to high in the PTAL scale.
- 6.3 The next PTAL value in rank for Slough is 2, a low value, found only around the other clusters (Langley station, Burnham station, Farnham road, Stoke road and London road from centre to east) and covering 331 ha, 10.2 % of Slough.
- 6.4 The rest of the borough show lower values. Areas with values equal to 0 are or inaccessible, or beyond the 640 or 960 meters threshold or any close bus or train stations have 0 frequency. These areas with 0 PTAL value are common to the south and East of Slough.

**Table 7: PTAL values in Slough**

PTAL	Total area (ha)	%*
<b>0</b>	667	20.5
<b>1a</b>	941	28.9
<b>1b</b>	1236	37.9
<b>2</b>	331	10.2
<b>3</b>	21	0.7
<b>4</b>	28	0.9
<b>5</b>	30	0.9
<b>6a</b>	0	0
<b>6b (best)</b>	0	0
<b>TOTAL</b>	3254*	100

\*Total Slough area

- 6.5 Two things are important to remember when reading these results. First, these results are sensitive to changes in routes and frequencies of the public transport service. The PTAL should be revaluated if there is a significant change to the services.
- 6.6 Second, this PTAL implementation ignores local access constraints such as small water streams, land property, walls, etc only when there is no path or road available. But

nearly all areas in Slough this is not the case. For specific sites it is necessary to perform a more detailed access and transport analysis. However, with the right care, these results still provide a good contextual analysis for sites.

## 7 Comparison with London boroughs

7.1 One of the goals of this study was to compare Slough PTAL values with London values. Slough PTAL average is comparable to those of Havering and Hillingdon (Table 8: Slough PTAL (current) vs London PTAL (2015)). Table 8 also shows that Slough PTAL is in the rank 33 of 34 compared to all London boroughs. If we take this analysis to a ward level, the five Sloughs wards with the highest PTAL values are comparable to wards in Ealing, Bromley, Redbrige and Bexley.

7.2 It is important to note that the average for the borough of Slough, 1b, is really low in the PTAL scale. For Slough wards, the average goes from 1a to 2, also low values.

**Table 8: Slough PTAL (current) vs London PTAL (2015)**

Borough Name	Average AI	Average PTAL
Havering	2.747859	1b
Slough	2.94	1b
Hillingdon	3.561241	1b
Bromley	3.592084	1b
Bexley	4.552927	1b
Enfield	4.627966	1b
Richmond upon Thames	4.896334	1b
Sutton	5.396992	2
Kingston upon Thames	5.425275	2
Barnet	5.54233	2
Barking and Dagenham	5.58373	2
Redbridge	5.73344	2
Harrow	5.822306	2
Hounslow	5.842208	2

<b>Croydon</b>	6.757744	2
<b>Waltham Forest</b>	7.831742	2
<b>Greenwich</b>	8.37817	2
<b>Ealing</b>	8.50351	2
<b>Merton</b>	8.561352	2
<b>Brent</b>	9.223249	2
<b>Newham</b>	11.079336	3
<b>Lewisham</b>	12.590368	3
<b>Haringey</b>	12.614837	3
<b>Wandsworth</b>	13.973088	3
<b>Hammersmith and Fulham</b>	16.325973	4
<b>Hackney</b>	17.478762	4
<b>Tower Hamlets</b>	18.53287	4
<b>Southwark</b>	20.513884	5
<b>Lambeth</b>	22.239912	5
<b>Kensington and Chelsea</b>	23.262691	5
<b>Camden</b>	24.316782	5
<b>Islington</b>	26.667566	6a
<b>Westminster</b>	39.750796	6a
<b>City of London</b>	90.802508	6b

London values: TFL, 2017a.

**Table 9: Slough wards PTAL (current) vs London wards PTAL (2015)**

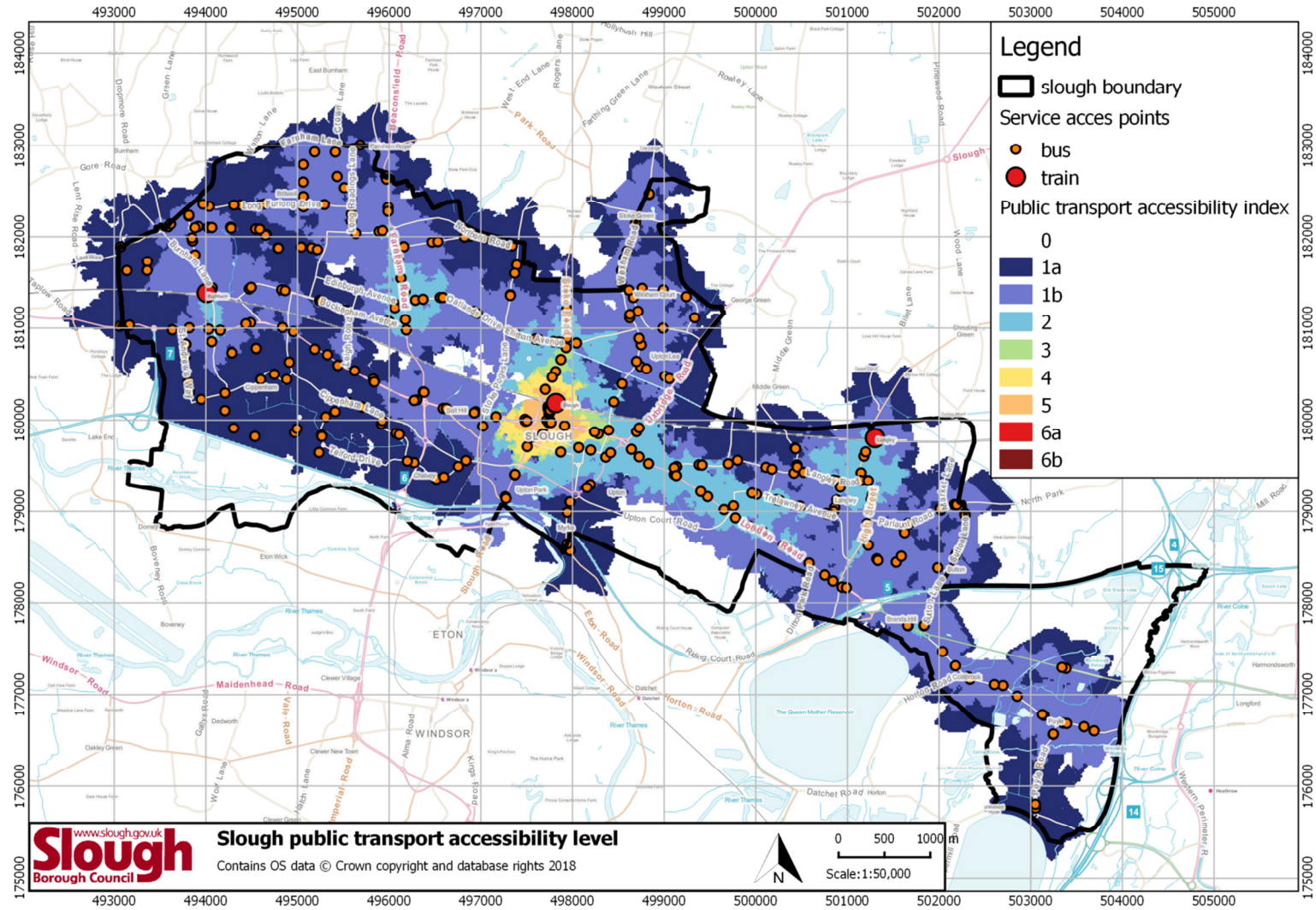
<b>Ward Name</b>	<b>Average AI</b>	<b>Average PTAL</b>	<b>Closest London ward</b>	<b>London Borough</b>	<b>Average AI</b>	<b>Average PTAL</b>
<b>Central</b>	7.975098	2	Northolt Mandeville	Ealing	7.97482	2
<b>Elliman</b>	5.168756	2	Plaistow and	Bromley	5.167082	2

Sundridge						
<b>Langley Kedermister</b>	4.513716	1b	Fullwell	Redbridge	4.509174	1b
<b>Farnham</b>	3.697914	1b	Norwood Green	Ealing	3.688654	1b
<b>Foxborough</b>	3.465498	1b	Crayford	Bexley	3.471033	1b
<b>Langley St. Mary's</b>	2.994053	1b	Heaton	Havering	2.997093	1b
<b>Chalvey</b>	2.970275	1b	Heaton	Havering	2.997093	1b
<b>Haymill &amp; Lynch Hill</b>	2.884586	1b	Chislehurst	Bromley	2.901341	1b
<b>Upton</b>	2.881795	1b	Chislehurst	Bromley	2.901341	1b
<b>Britwell &amp; Northborough</b>	2.632254	1b	Feltham West	Hounslow	2.637224	1b
<b>Wexham Lea</b>	2.625479	1b	Feltham West	Hounslow	2.637224	1b
<b>Baylis &amp; Stoke</b>	2.493513	1a	North End	Hammersmith and Fulham	2.499109	1a
<b>Cippenham Green</b>	2.111515	1a	Harold Wood	Havering	2.211921	1a
<b>Colnbrook with Poyle</b>	1.531545	1a	Ham, Petersham and Richmond Riverside	Richmond Upon Thames	1.488865	1a
<b>Cippenham Meadows</b>	1.039359	1a	Upminster	Havering	1.001332	1a

London values: TFL, 2017b.



Figure 10: Public transport access index



## 8 Conclusion

- 8.1 The study shows that the Public Transport Access Level in Slough is in general low mainly due to the low frequency of buses and trains in the AM peak.
- 8.2 Bus services are well distributed across Slough and cover most of the borough with certain exceptions, especially at the south and east of the borough. Train stations are also well distributed across the borough.
- 8.3 The bus service shows a higher frequency on the centre and the east of the borough, impacting negatively the PTAL values of the west.
- 8.4 PTAL values are in general low with an average of 1b of a scale that goes from 1a to 6b. Some areas have higher PTAL values, the Town Centre, Farnham Road, Stoke Road, Langley and Burnham. Of these, only the Town Centre reaches PTAL values of 3, 4 and 5.
- 8.5 Comparing PTAL averages with London, Slough scores worse than any of the boroughs apart from Havering. Taking the comparison to a ward level, only the wards of Central and Elliman reach an average of 2, similar to London wards of Northolt Mandeville in Ealing and Plaistow and Sundridge in Bromley.
- 8.6 The study shows that any high density development should be focused on the Centre of Slough which has the highest PTAL values.

## 9 Appendix A: References

ATKINS, 2017. *Slough Borough Council, Public Transport Support, PTAL Frequencies, Version 0.3*. Unpublished document

Transport for London (TFL), 2015. *Assessing transport connectivity in London*. Available from : <https://tfl.gov.uk/cdn/static/cms/documents/connectivity-assessment-guide.pdf>

Transport for London (TFL), 2017a. *Public Transport Accessibility Levels, 2015 PTAL borough*. Available from : <https://files.datapress.com/london/dataset/public-transport-accessibility-levels/2017-01-26T18:50:00/Borough%20AvPTAI2015.xlsx>

Transport for London (TFL), 2017b. *Public Transport Accessibility Levels, 2015 PTAL ward 2014*. Available from: <https://files.datapress.com/london/dataset/public-transport-accessibility-levels/2017-01-26T18:50:00/Ward2014%20AvPTAI2015.xlsx>