Technical Note

Project: **Staffordshire LCWIP**

Subject: **GIS Methodology**

Client:	Staffordshire County Council	**Version:**	2
Project No:	03277	**Author:**	AK/APL
Date:	Oct 19	**Approved:**	APL

1 Summary

1.1.1 This technical note summarises the GIS analysis undertaken by PJA to support the Staffordshire LCWIP for Staffordshire County Council.

1.1.2 Staffordshire's LCWIP spans six towns across Staffordshire; Stafford, Lichfield, Tamworth, Burton-on-Trent, Cannock and Newcastle-under-Lyme. For each town, output maps for the GIS analysis described below are in Appendix A.

2 Origin – Destination Analysis to Identify Journey Patterns

2.1.1 **Trip Distance Filter:** Origin–destination analysis is undertaken to determine where people make journeys short enough to be cycled. For the cycling analysis this distance is assumed to be 5 km or 20 minutes (2km is used for walking trips). The study area is therefore defined by the six town boundaries plus a 5km buffer, to consider short trips into or out of the area.

2.1.2 **Walking and Cycling Network:** A network of roads and paths available to cyclists was built for the study area using OpenStreetMap data. The road and path network enable the origin and destination analysis to take account of "real world" distances on the highway network. The Network Analyst extension of ArcPro is used to undertake the origin-destination analysis, using data from the latest Census (Journey to Work, all modes).

2.1.3 **Determination of Origin-Destination:** After the study area is defined, the Lower Super Output Area (LSOA) population-weighted centroids within 5km of the study area are selected.

2.1.4 For the selected centroids, we download the Location of Usual Residence and Place of Work, with the selects LSOAs as both origins and destinations.

2.1.5 **Predicting Existing Demand:** The Method of Travel to Work at LSOA level was downloaded for the whole of Staffordshire. For each origin-destination pair, the average mode share for pedestrians and cyclists was applied to the number of commuters.

2.2 Matching the Trips to Available Routes

2.2.1 In Network Analyst, a closest facility matrix was produced. The selected OA centroids were both origins and destinations. The matrix produced a route between each possible origin-destination along the shortest path, with a cut-off of 5km.

2.2.2 The census data is brought into the GIS system as a table, which is joined to the route geometry from the matrix.

2.2.3 To understand the demand on each section of the network, the route geometry from the closest facility tool was joined to the line dataset associated with the road network. This spatial join summed the total potential number of commuters on each link, which can then be symbolised to show demand as in Figure 1.

Figure 1: Journeys to 5km - Tamworth

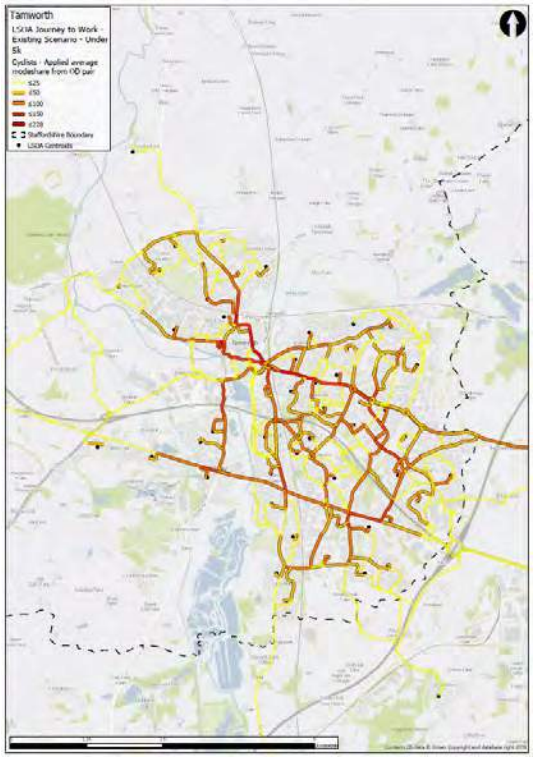
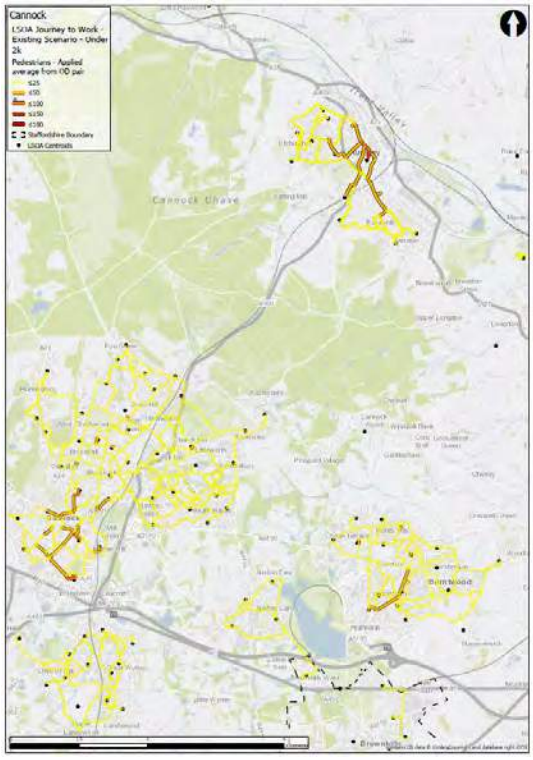


Figure 2: Journeys to 2km - Cannock



2.2.4 To understand the patterns of walking demand, this analysis was repeated for journeys under 2km (approximately a 25-minute walk) as in Figure 2.

2.3 School Data

2.3.1 Staffordshire County Council provided PJA with journey to school data. The data consisted of a spreadsheet containing the origin Output Area (OA) and the destination primary or secondary school with the associated number of pupils. The schools were also provided in GIS format. An average mode share for walking, cycling and scooting was provided by Staffordshire and applied to the data, 49% for primary school and 51% for secondary school.

2.3.2 Within ArcPro, the closest facility tool was used to route from the OA population weighted centroid to the school. The excel file was joined with the routes in GIS.

2.3.3 The pupil demand on each section of the road network was then calculated using a spatial join, this was then symbolised accordingly.

Figure 3: Journey to Primary - Lichfield

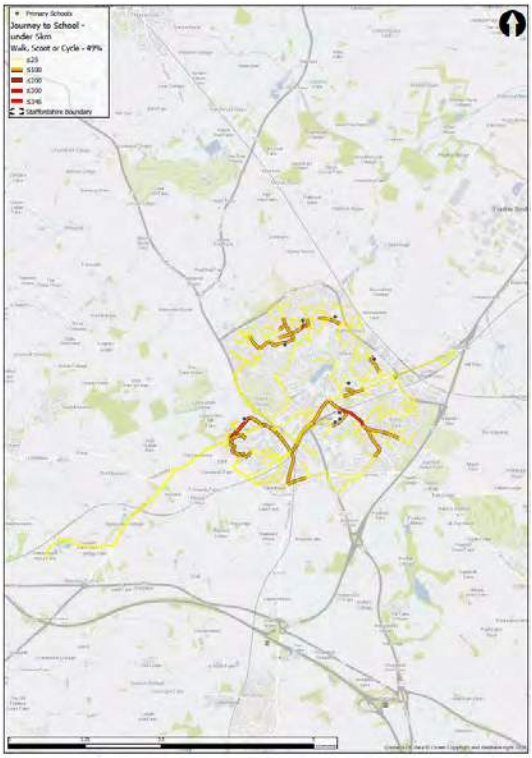
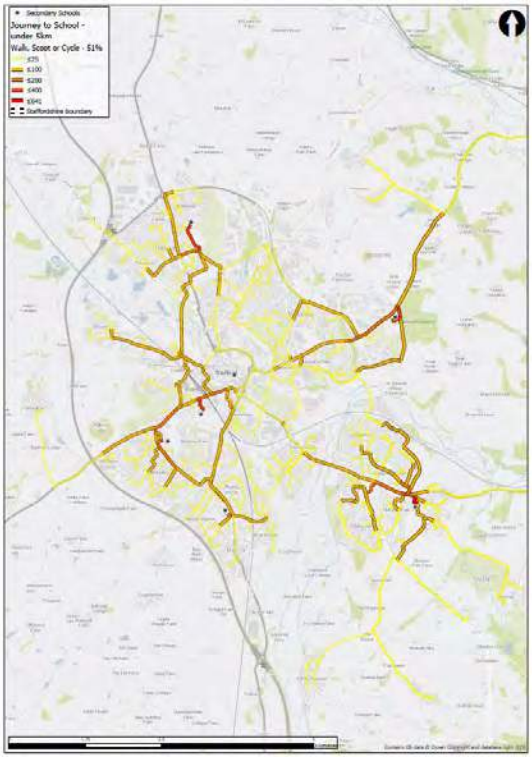


Figure 4: Journey to Secondary - Stafford



2.4 Forecasting Future Demand

2.4.1 Residential developments from the Local Plan were brought into GIS, with the associated forecast housing numbers. Using TRICS, a trip rate was obtained to forecast trips from these developments. For the AM Peak departures (0700-1000), a total persons trip rate of 1.184 was used.

2.4.2 From the 2011 census Distance Travelled to Work, the proportion of trips under 5km was calculated to be 32%. This proportion was then applied to the forecast trips from the residential developments.

2.4.3 For each of the destination LSOA, the proportion of trips in the 2011 census to each of these destinations was calculated. The cycle and pedestrian mode shares were then applied. These values were then used to distribute the forecast trips from the residential developments.

2.4.4 The forecast trips from the residential developments were routed along the road network to the key destinations, using the centre of the development as origins.

2.4.5 The total demand was calculated across the network, including the 2011 census journey to work data routed on the future network, and the demand from the housing developments.

Figure 5: JtW + Housing – Newcastle-under-Lyme

2.5 Cycle-Rail Analysis

2.5.1 Cycle-Rail offers potential for cycling to substitute existing car trips (either to replace a car trip to access the local station, or for the combined cycle-rail trip to replace a longer car journey). The objective was to find all potential cycle-rail trips in the study area. Origin stations were selected in each of the six towns, as well as all OAs within 800m of destination stations a commuter can access via a direct train within a reasonable travel time. The origin and destination stations were selected by Staffordshire County Council.

2.5.2 The following origin stations were analysed:

- Stoke-on-Trent;
- Cannock;
- Stafford;
- Tamworth;
- Burton-on-Trent;
- Wilnecote;
- Lichfield Trent Valley;
- Lichfield City; and
- Hednesford.

2.5.3 All LSOA population-weighted centroids within 3km of the origin station were selected. This reflects the average home-to-station cycle distance as reported by ATOC (now the Rail Delivery Group) in their Bike-Rail programme monitoring.

2.5.4 All LSOAs within 800m of the destination stations were also be selected, reflecting a 10-minute walk from the station at the other end of the commute.

2.5.5 We then download the Location of Usual Residence and Place of Work, with the selected LSOAs as origins and destinations.

2.5.6 In order to understand the potential demand on the network, the potential cycle-rail trips were then routed on the road network using the closest facility tool, with the destination set as the respective origin station.

Figure 6: Cycle-Rail Analysis - Burton-upon-Trent

3 Analysis of Network Density

3.1.1 Gap analysis of the cycle network was undertaken using Mesh Density analysis from the London Cycle Design Standards (LCDS). LCDS (based on Dutch guidance) seeks to achieve a network with routes that form a mesh spaced at approximately 250m. A 'route' in this definition could include 'low traffic neighbourhoods' where all streets meet the design requirements for cycling because they are quiet and have low speed limits, greenways away from the highway and busier roads and junctions where cycle-specific infrastructure is needed.

3.1.2 Mesh density is a measure of the proximity of cycle routes to each other, and therefore how easy it is to reach them from an origin.

3.1.3 There are two forms of mesh density; cell analysis and area bound analysis. The analysis undertaken was with a $1km^2$ grid across the whole of Staffordshire. The length of cycle of cycle network within each grid square is calculated, which can then be represented as a heat map. According to LCDS, there should be at least 2km of cycle route within each 1km grid square in urban areas.

3.1.4 This was undertaken for the existing network in Staffordshire as well as the committed network.

Figure 8: Staffordshire Existing Cycle Network

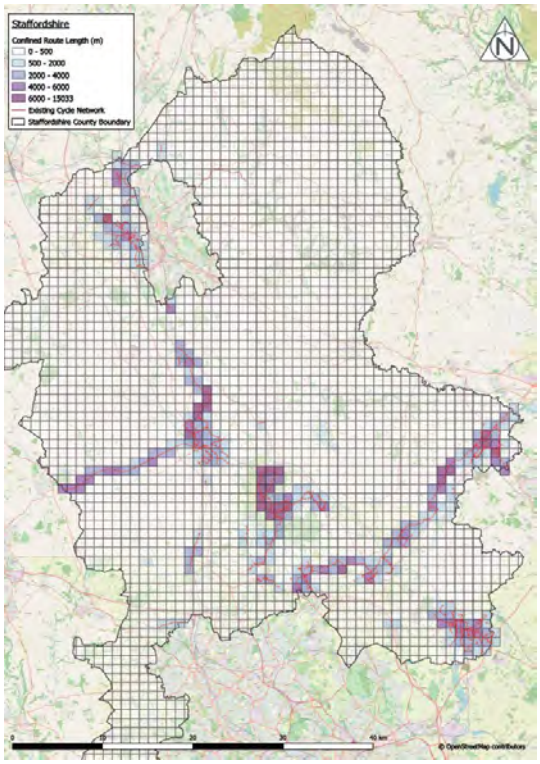
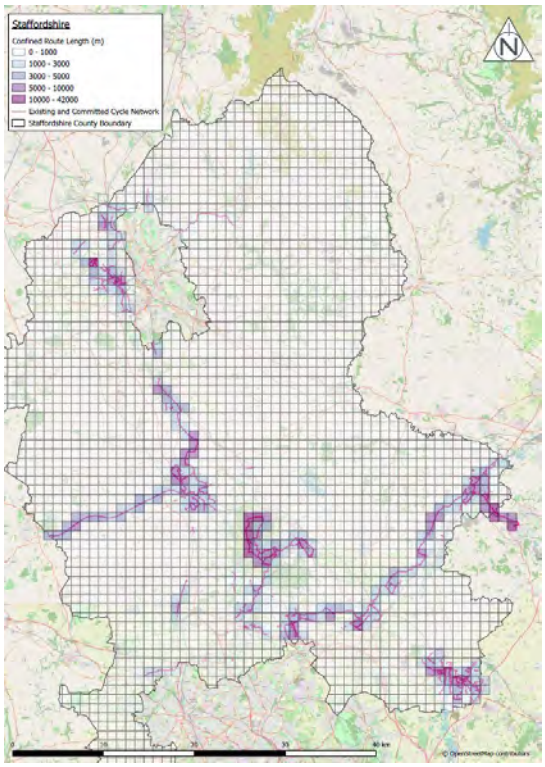


Figure 7: Staffordshire Committed & Existing Cycle Network



4 Prioritisation

4.1.1 The busier routes with most potential for cycling short trips were selected in the following way.

4.1.2 **Initial selection:** All sections of the network with over 101 cycle journeys to work forecast (including those from future housing) were selected to be put forward for prioritisation, as were all sections with over 101 cycle, walk or scoot school journeys. These sections of the network were then prioritised to decide which sections of the network should primarily be focussed on for new or improved cycle infrastructure.

4.1.3 **Prioritisation criteria:** The following factors were chosen for prioritising cycle network development:

- Proximity to employment development;
- Proximity to new schools;
- Personal Injury Accident (PIA) data including cyclists;
- Mesh density (gap) analysis; and
- Cycle-rail analysis.

4.1.4 A proximity raster surface was created for each of the datasets to be included in the prioritisation, apart from the mesh density analysis. A spatial join was performed between the additional network and each dataset, a mean value was taken from each surface, within 50m of each network section.

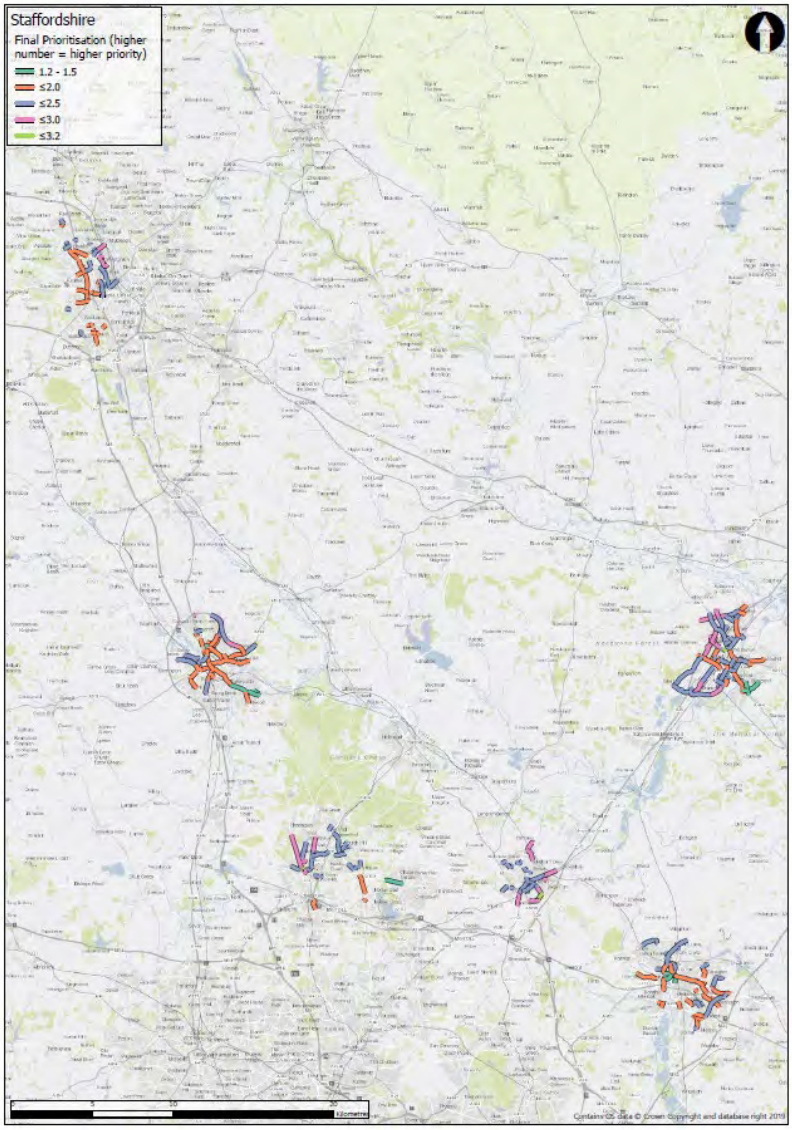
4.1.5 **Prioritisation calculation:** The result was exported to excel where the result for each priority was standardised between 0-1 so that every dataset is equally weighted. For each dataset, 1 represented:

- Proximity to employment development – closest proximity;
- Proximity to new schools – closest proximity;
- PIA data including cyclists – closest proximity;
- Mesh density analysis – least dense; and
- Cycle-rail analysis – proximity to highest numbers.

4.1.6 Within Excel, the total priority for each link was calculated from the standardised values, so the maximum possible value would be 5. This was then symbolised in ArcPro, to make decisions on which routes to audit.

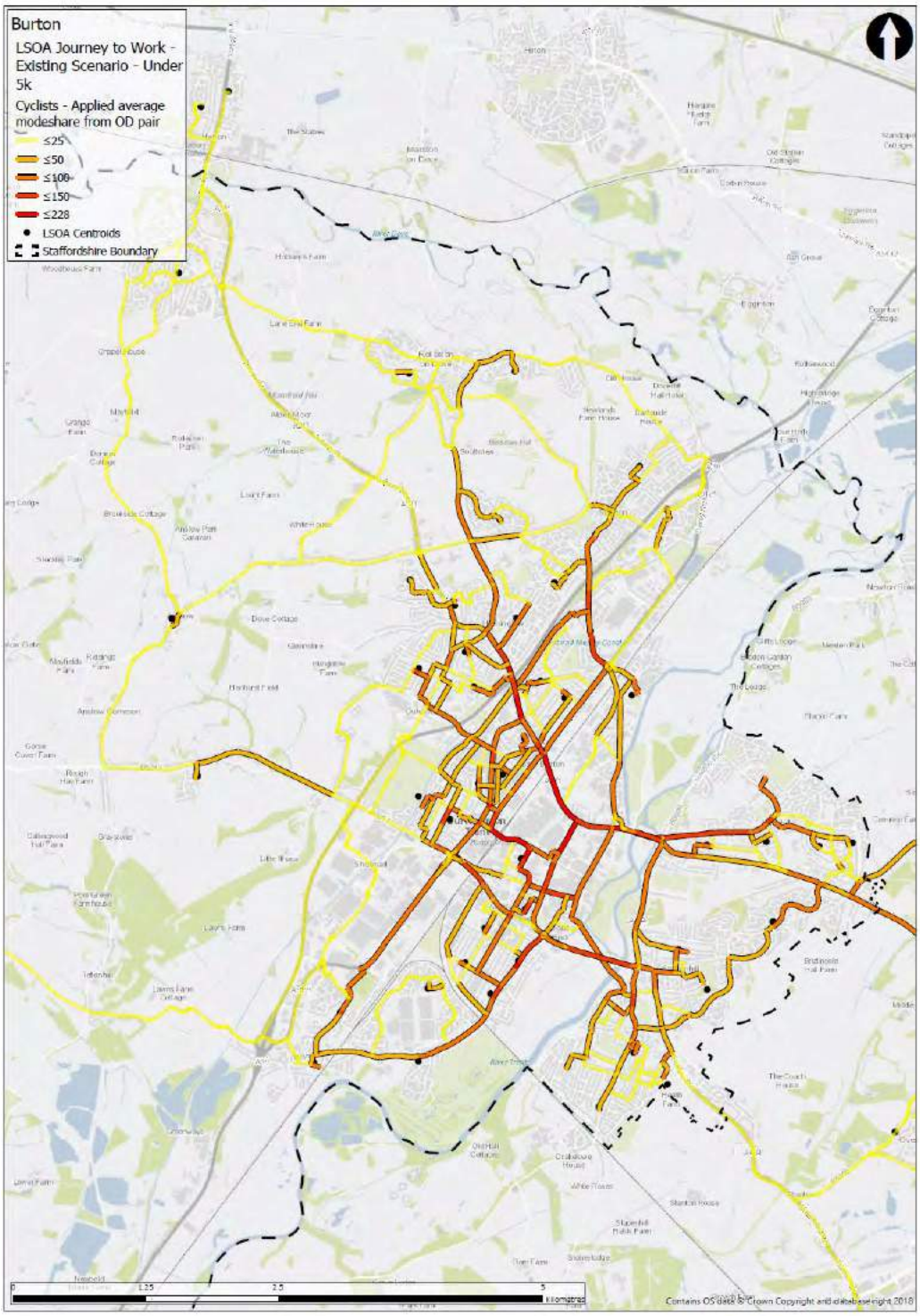
4.1.7 The routes shown on the Final Prioritised Network map in Figure 9 and for each town in Appendix A were then given a site audit to look for opportunities and constraints for infrastructure improvements.

Figure 9: Final Prioritisation - Staffordshire

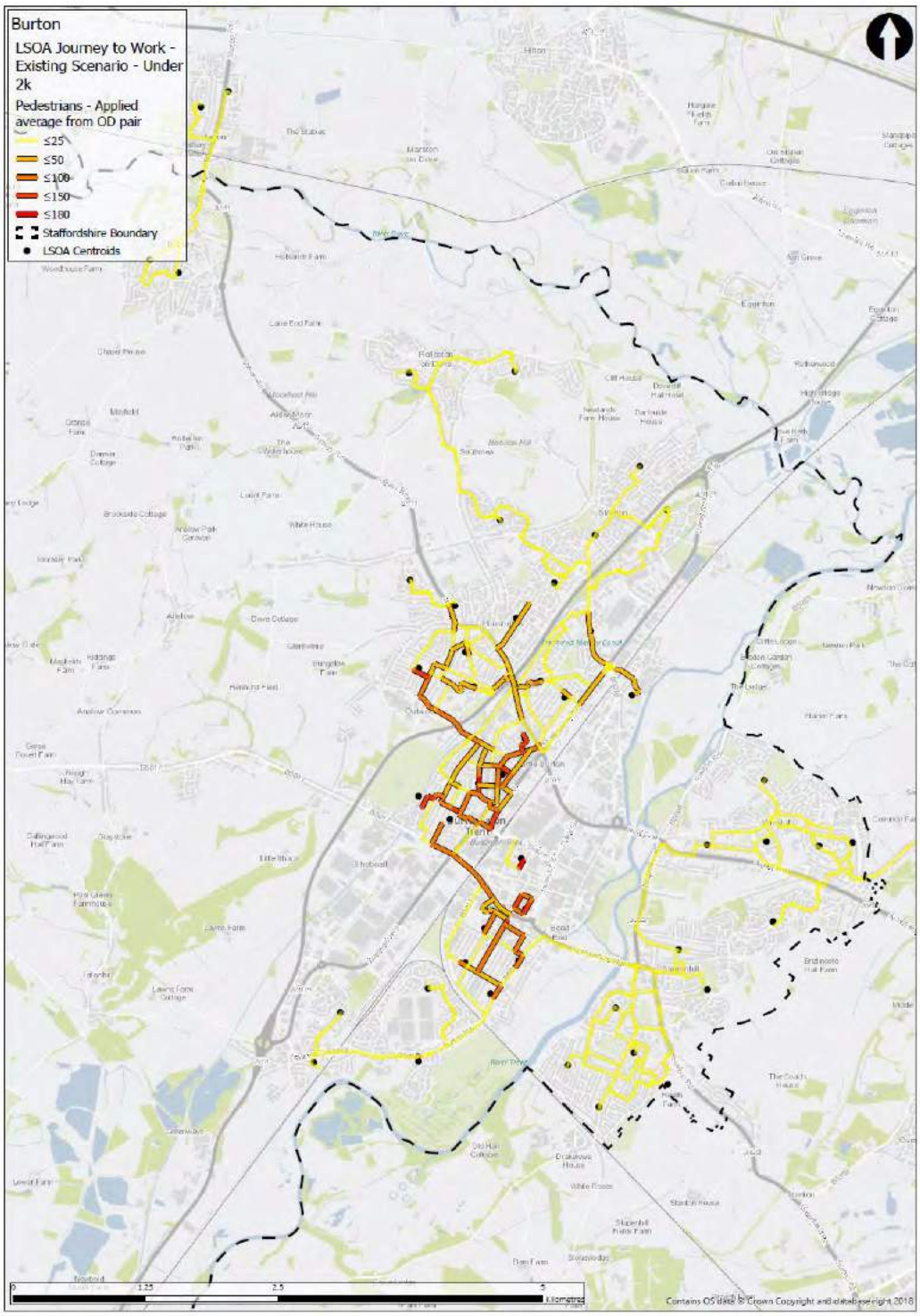


Appendix A GIS Trip Analysis and Prioritisation Outputs

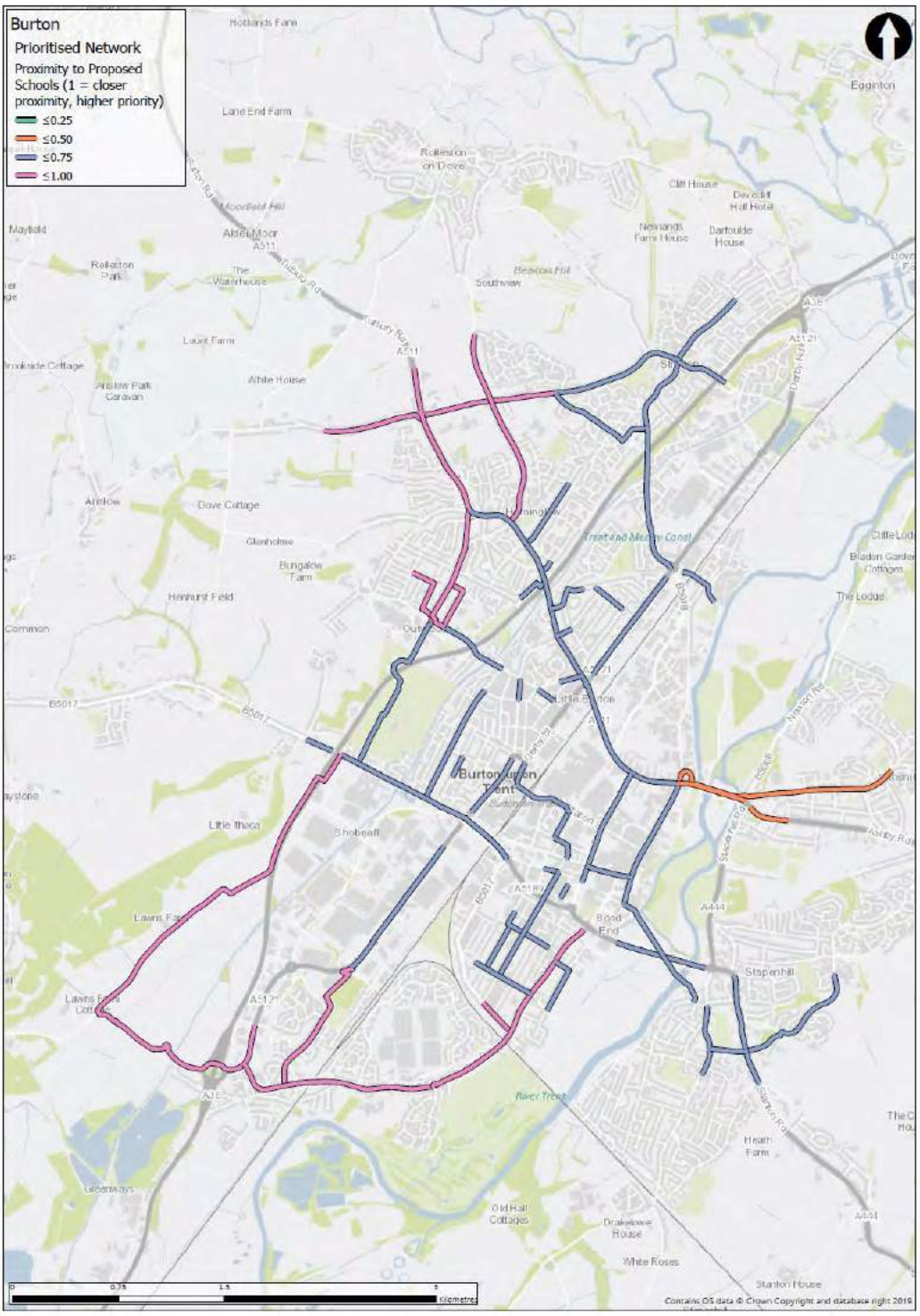
Burton – Existing Cycle Trips (2011 Census Journey to Work)



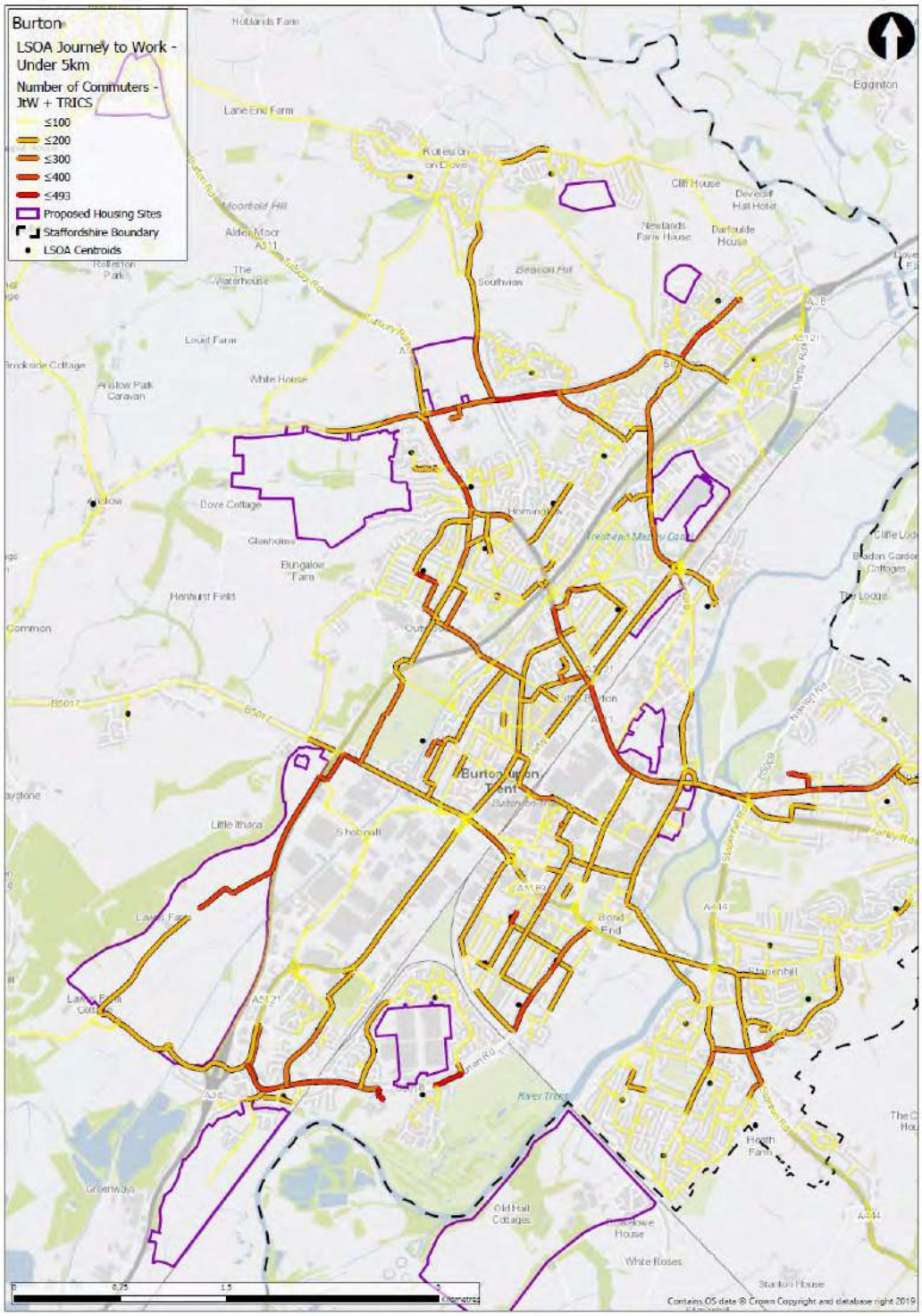
Burton – Existing Walking Trips (2011 Census Journey to Work)



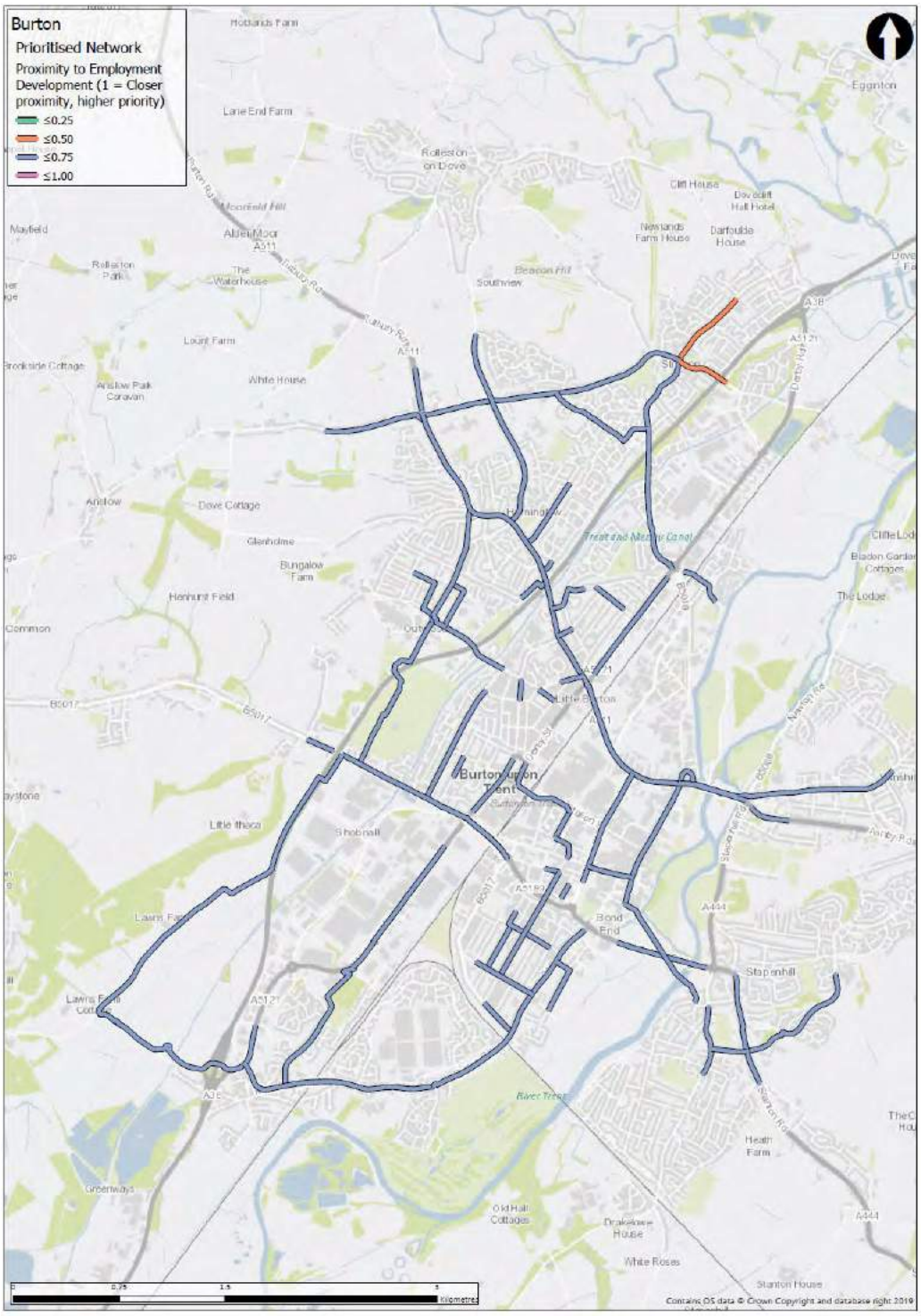
Burton –School Proximity (prioritised routes)



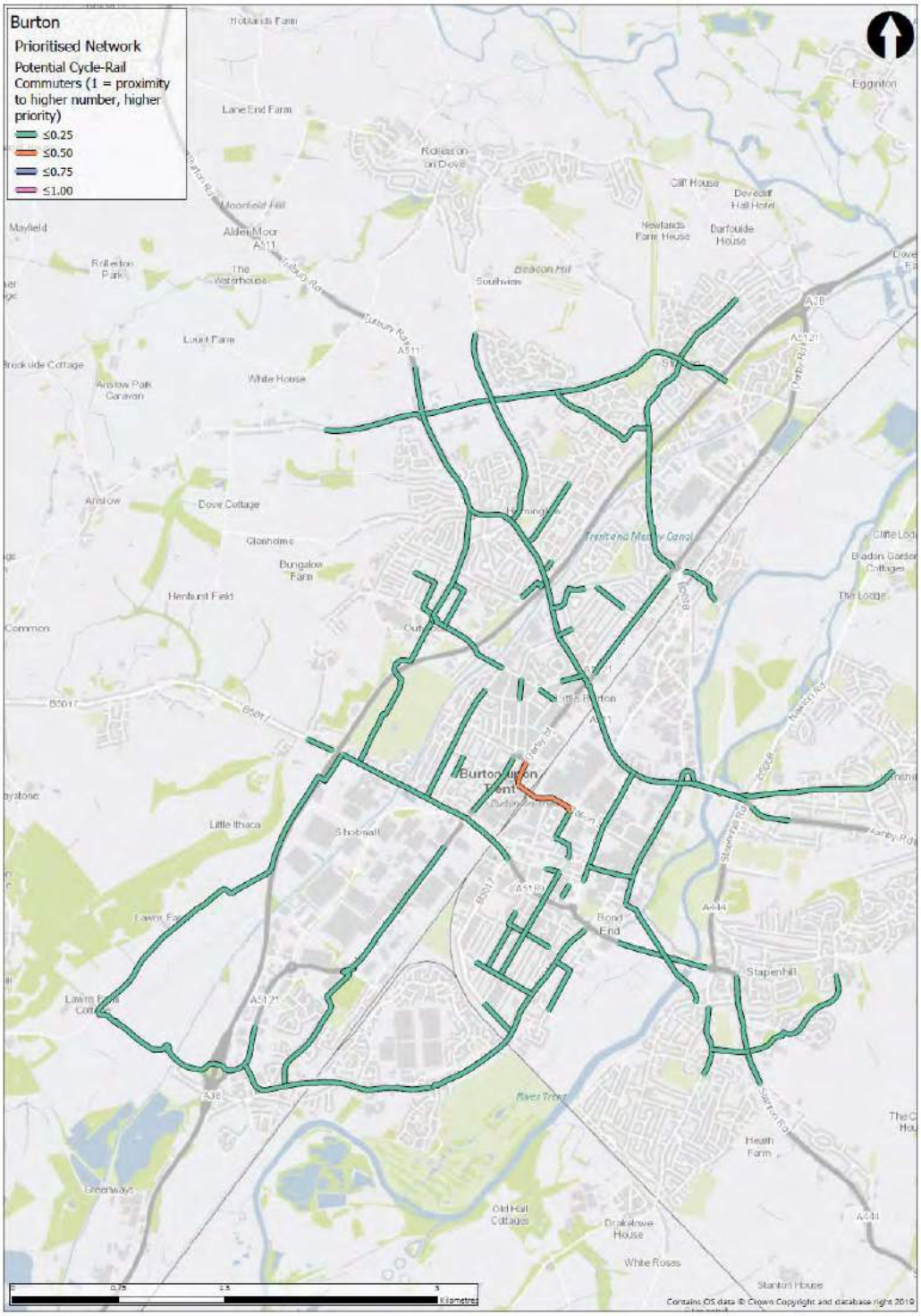
Burton – Housing Development Sites



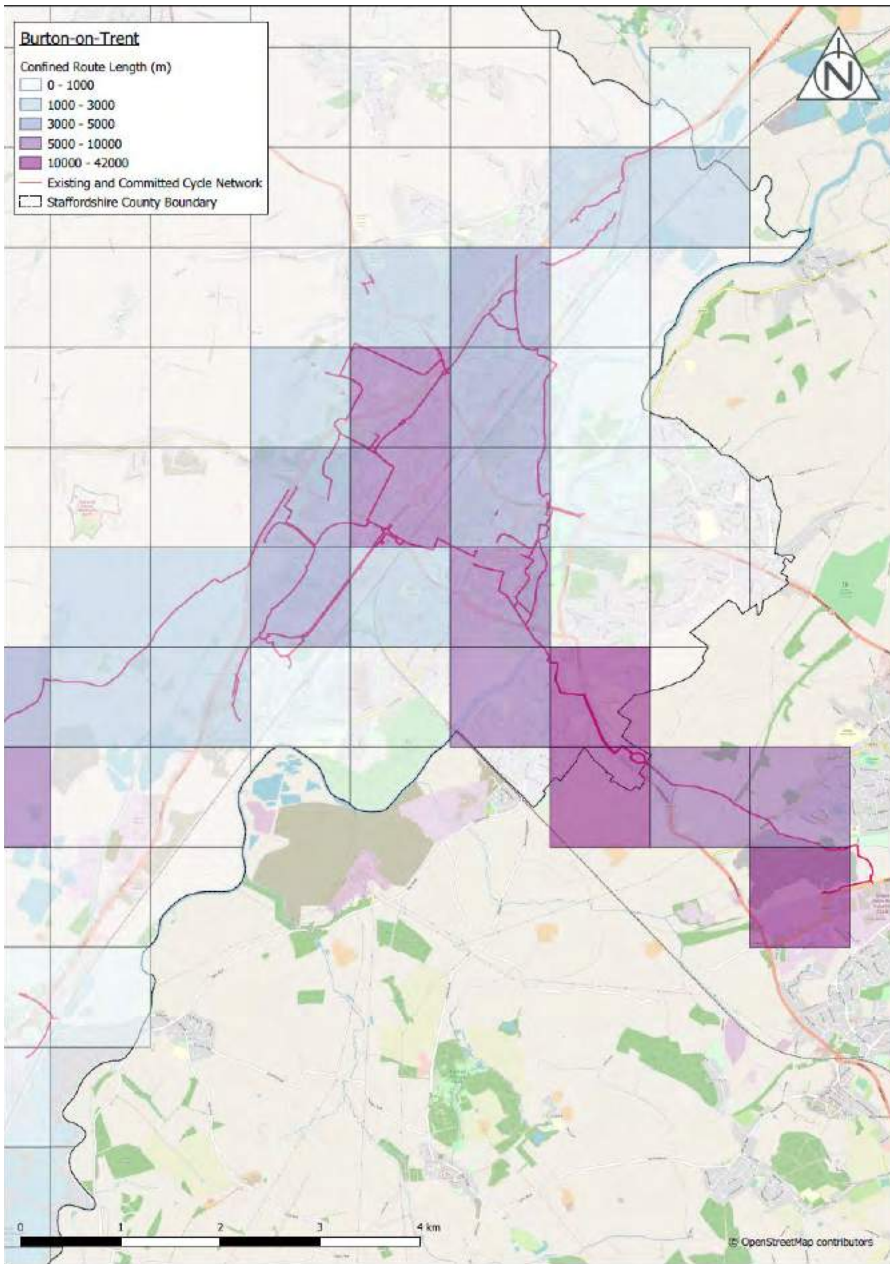
Burton – Proximity to Employment (prioritised routes)



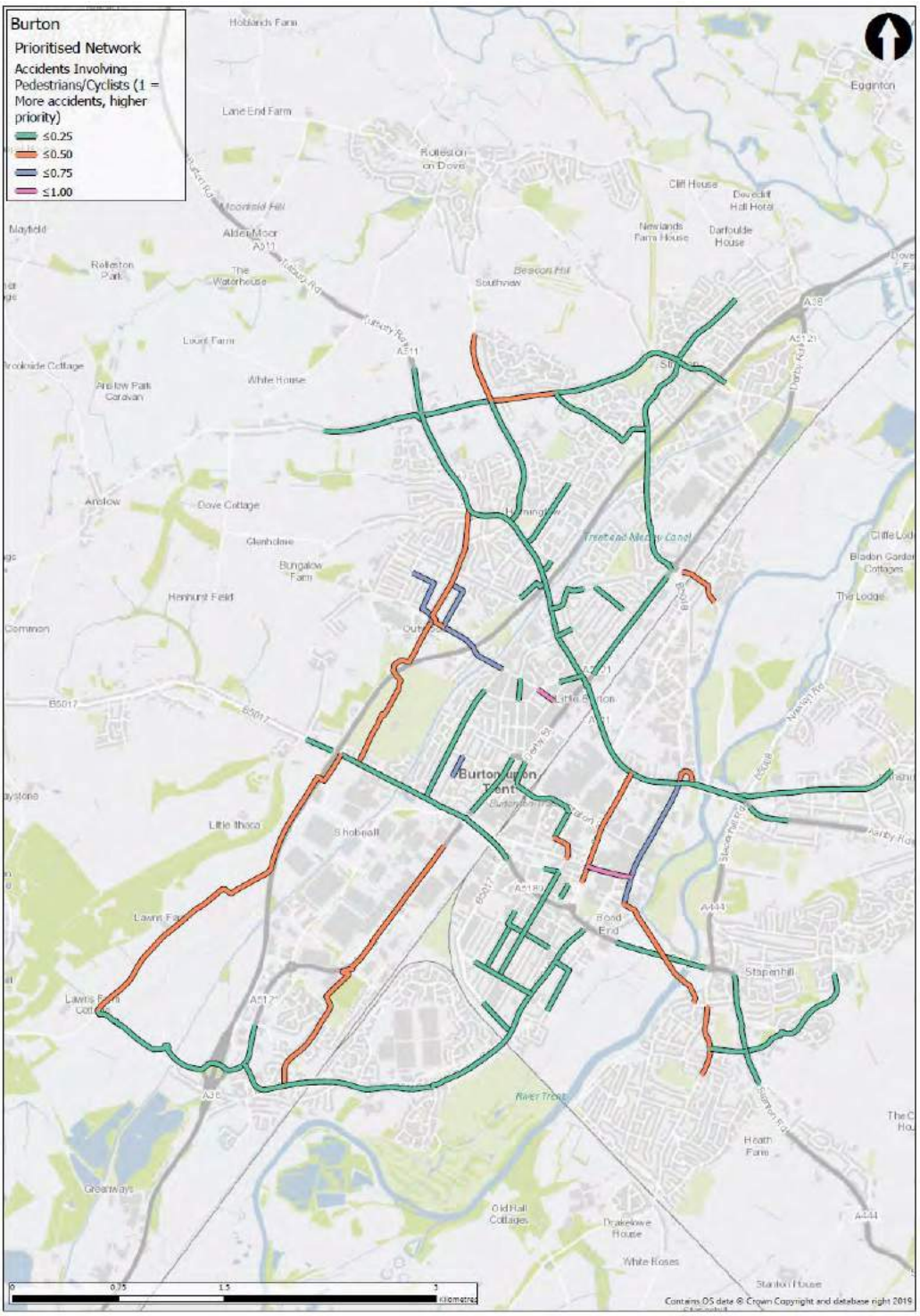
Burton – Cycle Rail (prioritised routes)



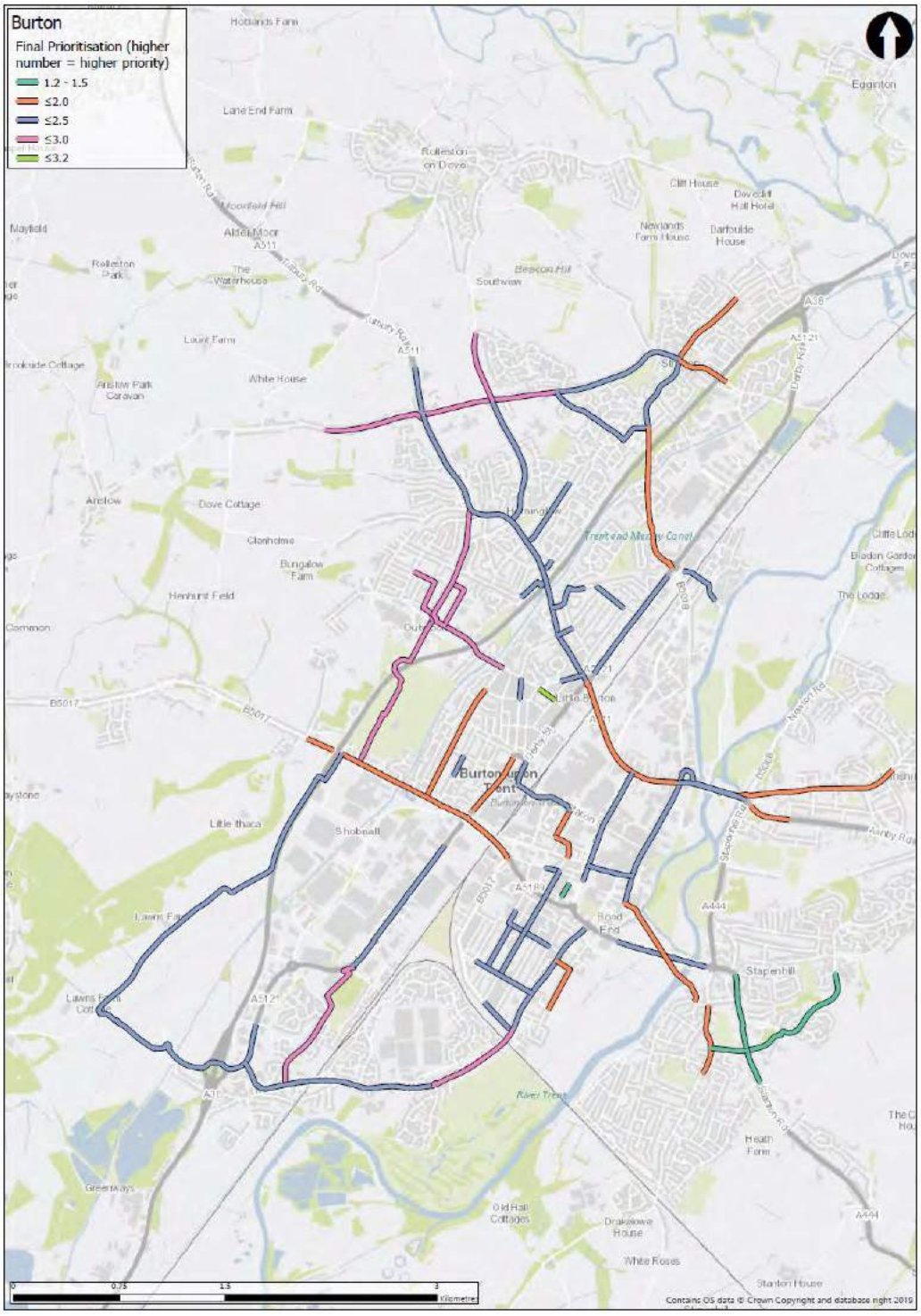
Burton – Network Density (including committed routes)



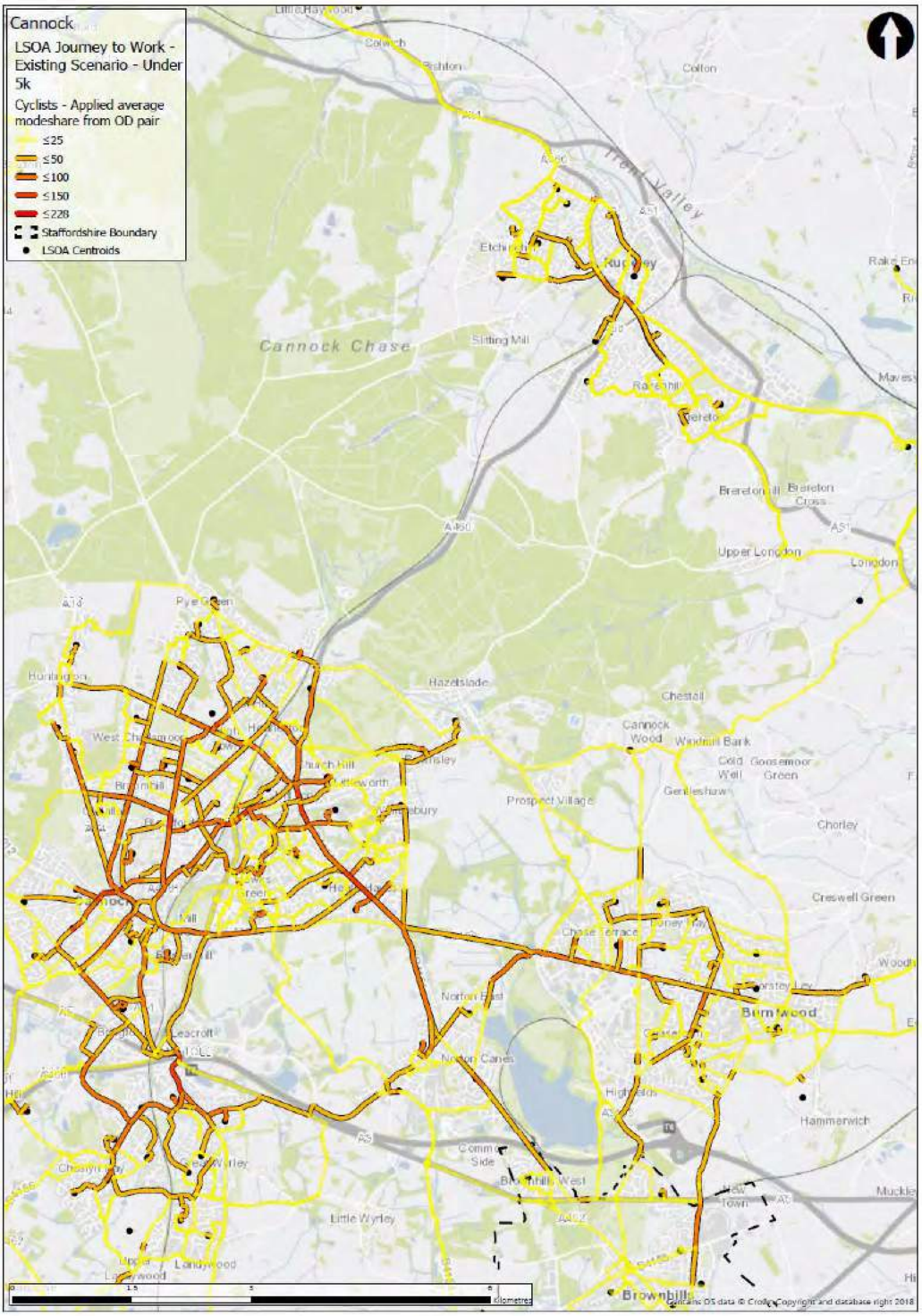
Burton - Personal Injury Accidents (prioritised routes)



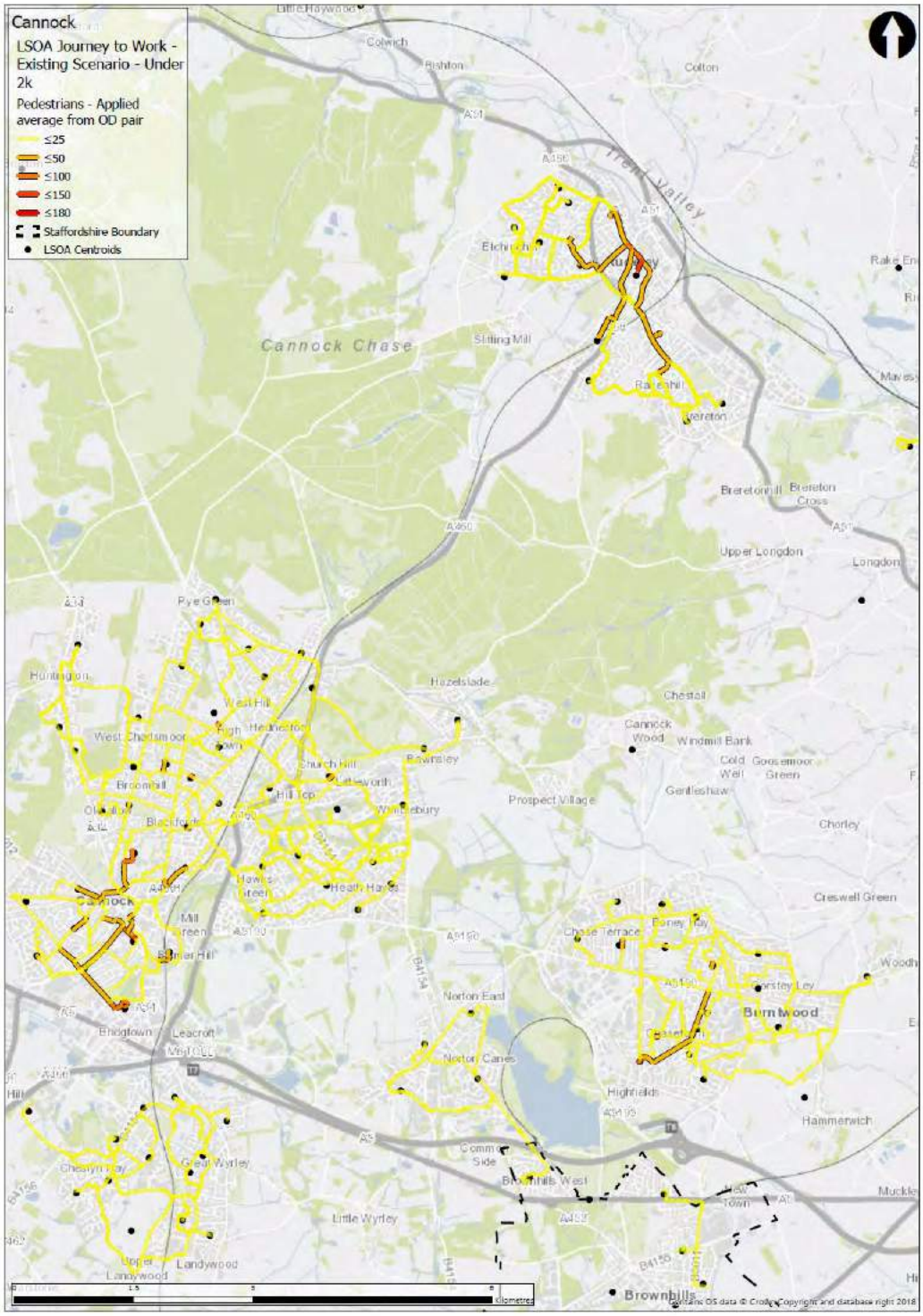
Burton – Final Prioritised Network



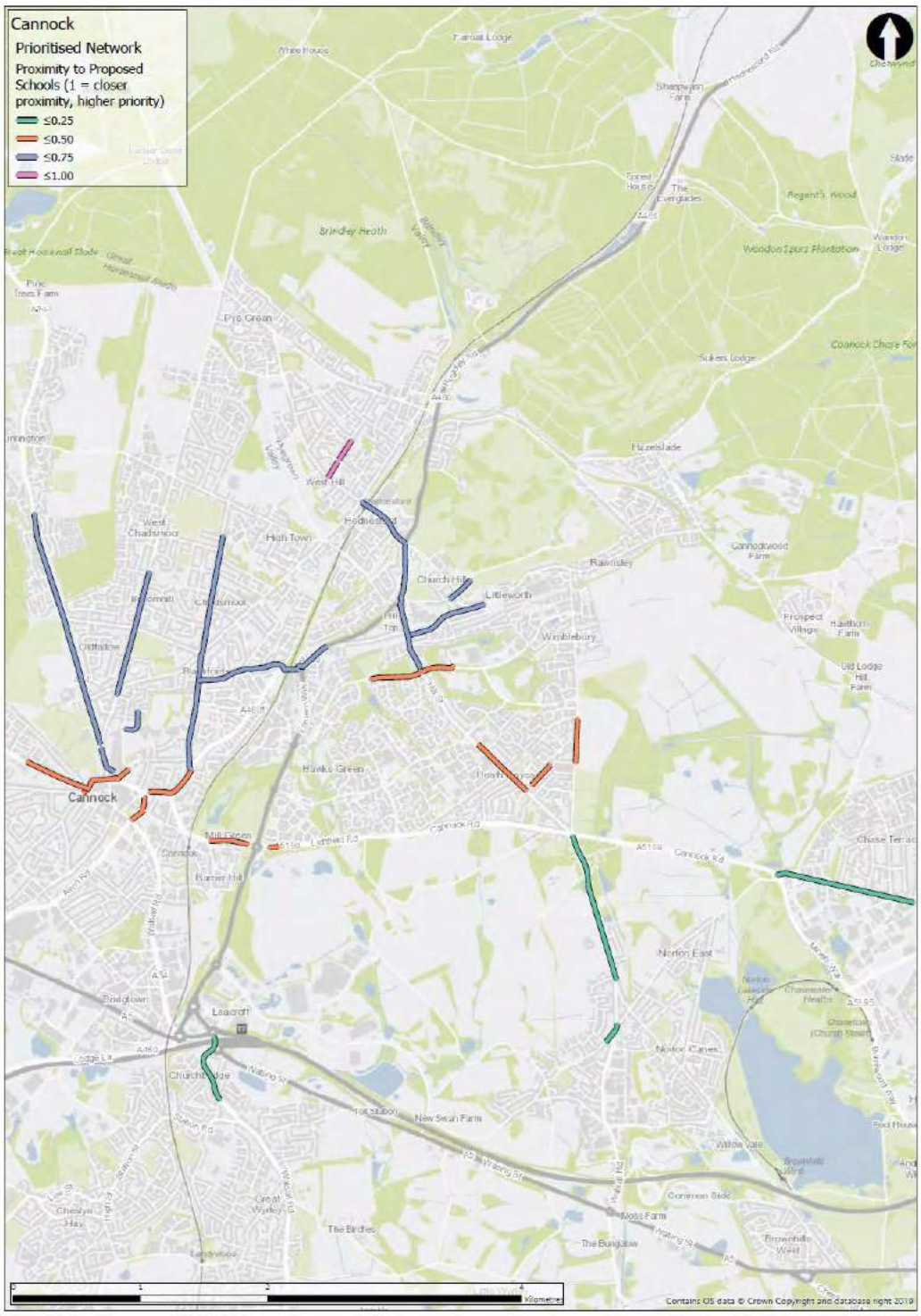
Cannock – Existing Cycle Trips (2011 Census Journey to Work)



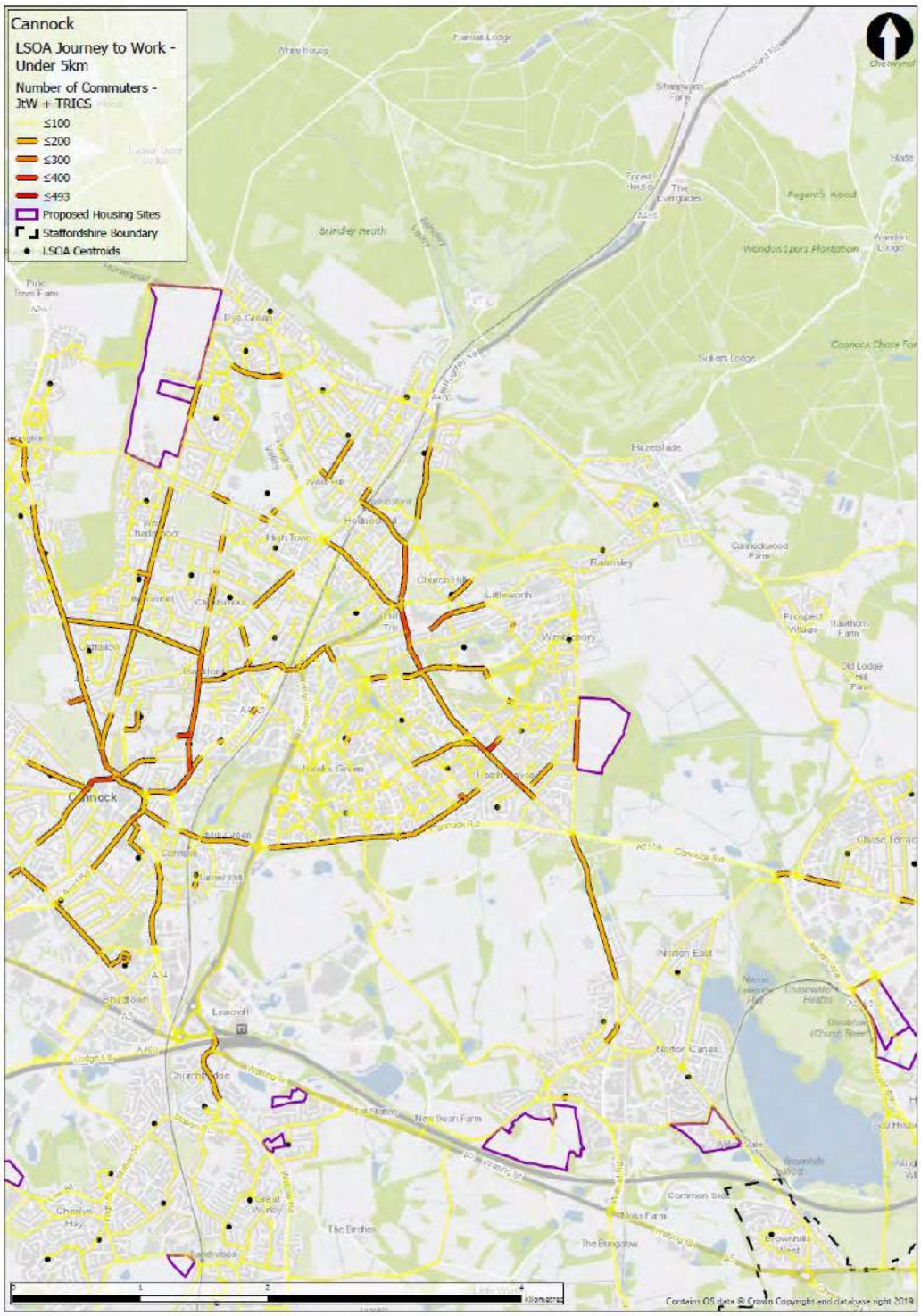
Cannock – Existing Walking Trips (2011 Census Journey to Work)



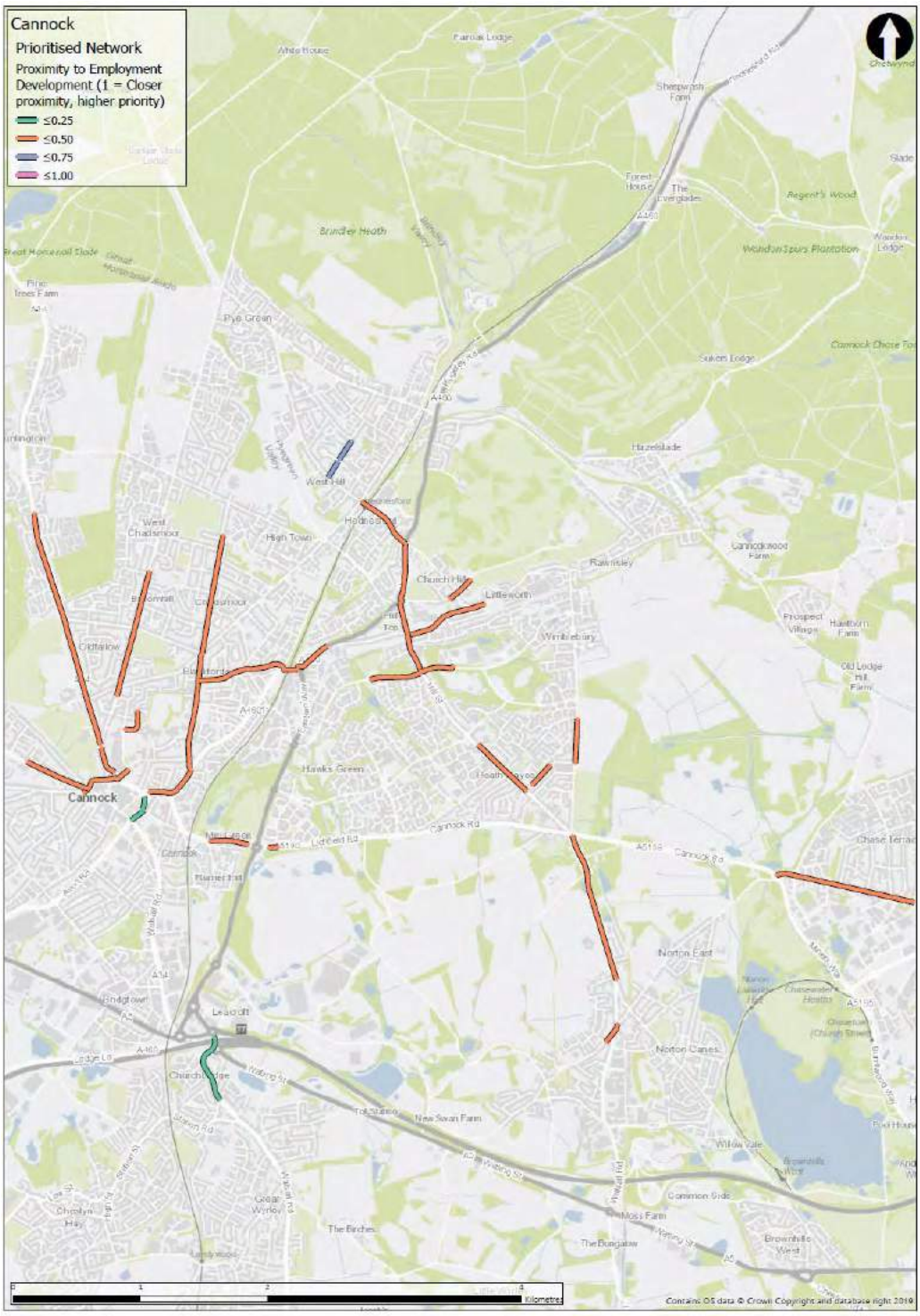
Cannock –School Proximity (prioritised)



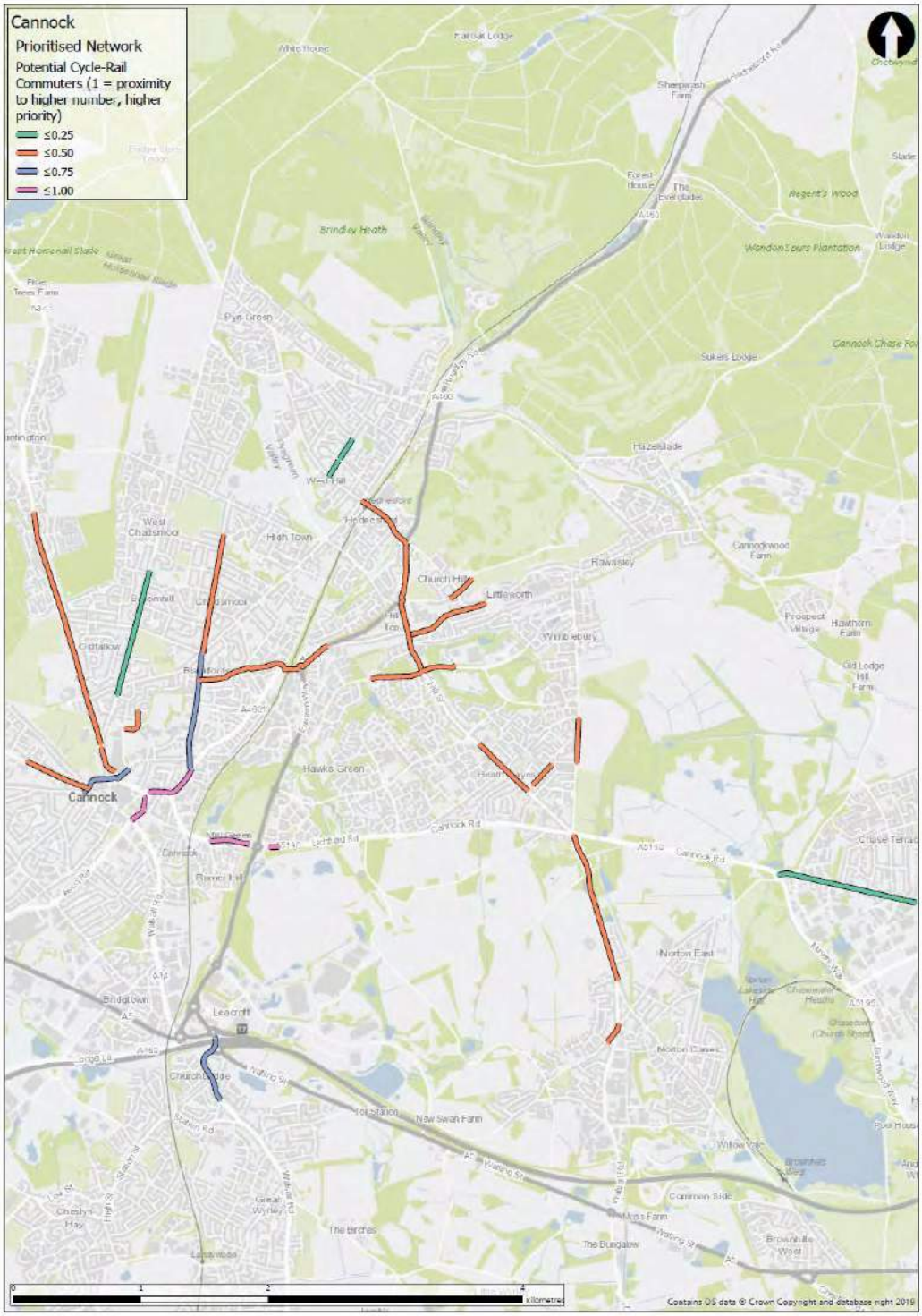
Cannock – Housing Development Sites



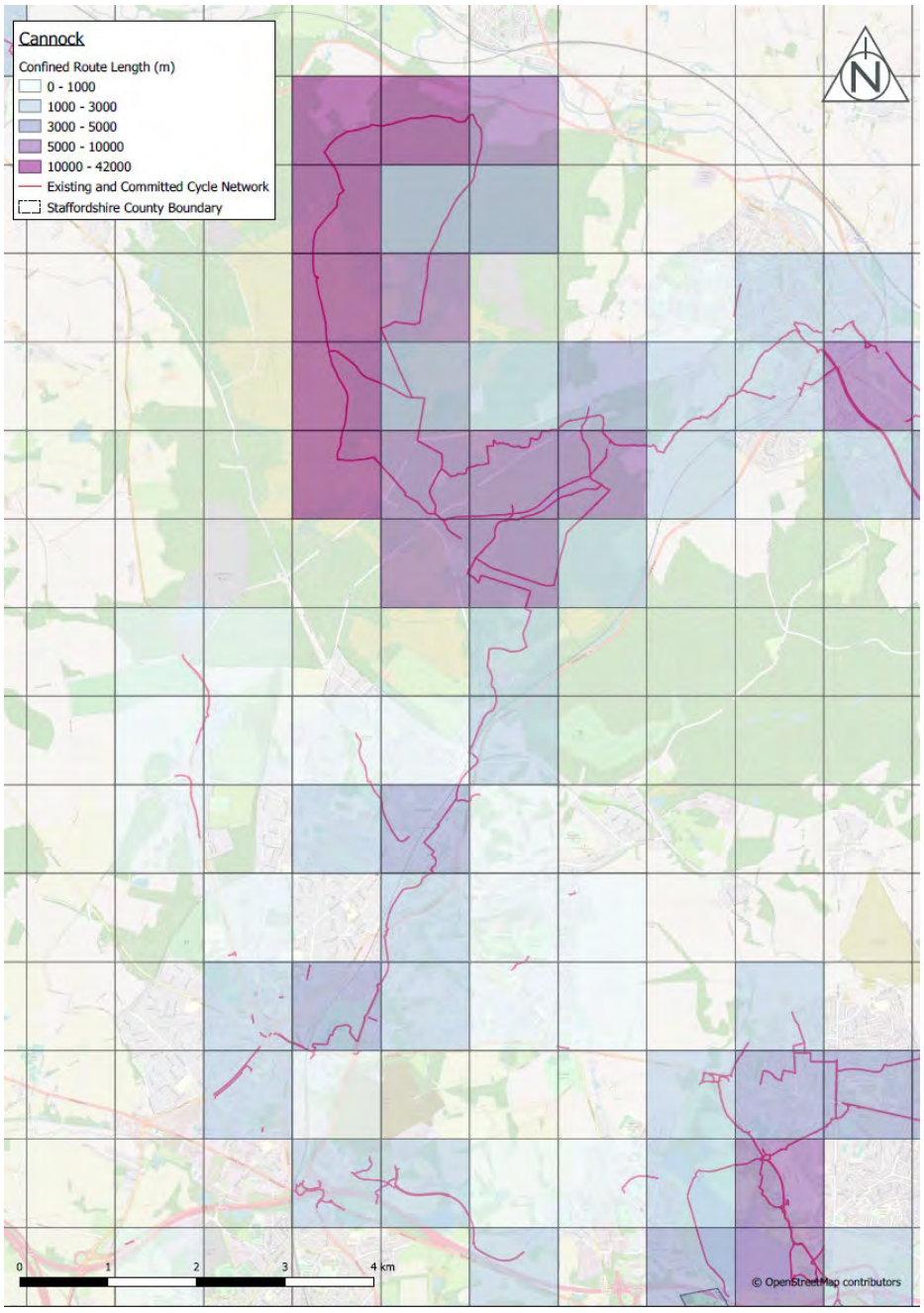
Cannock – Proximity to Employment (prioritised)



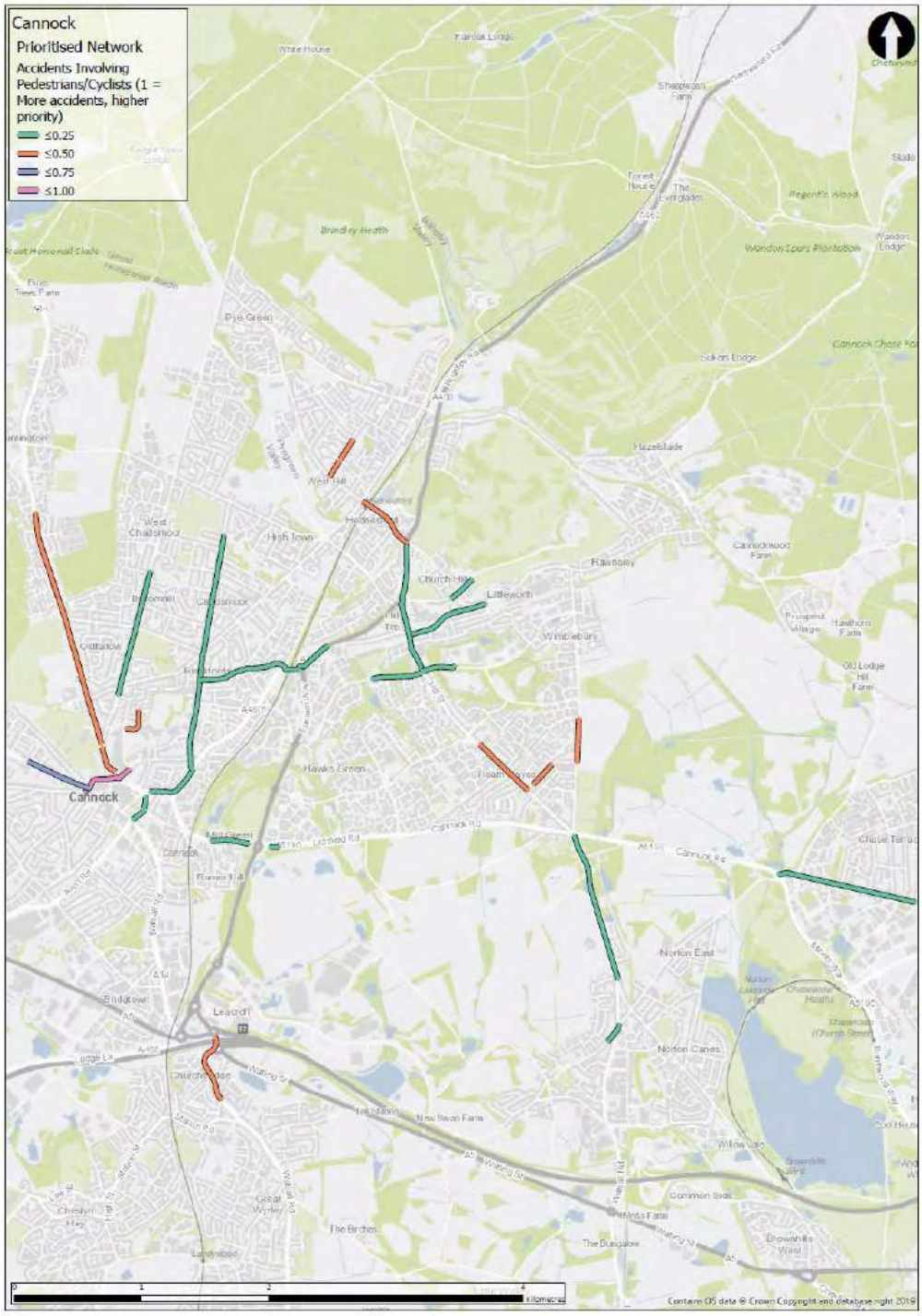
Cannock – Cycle Rail (prioritised)



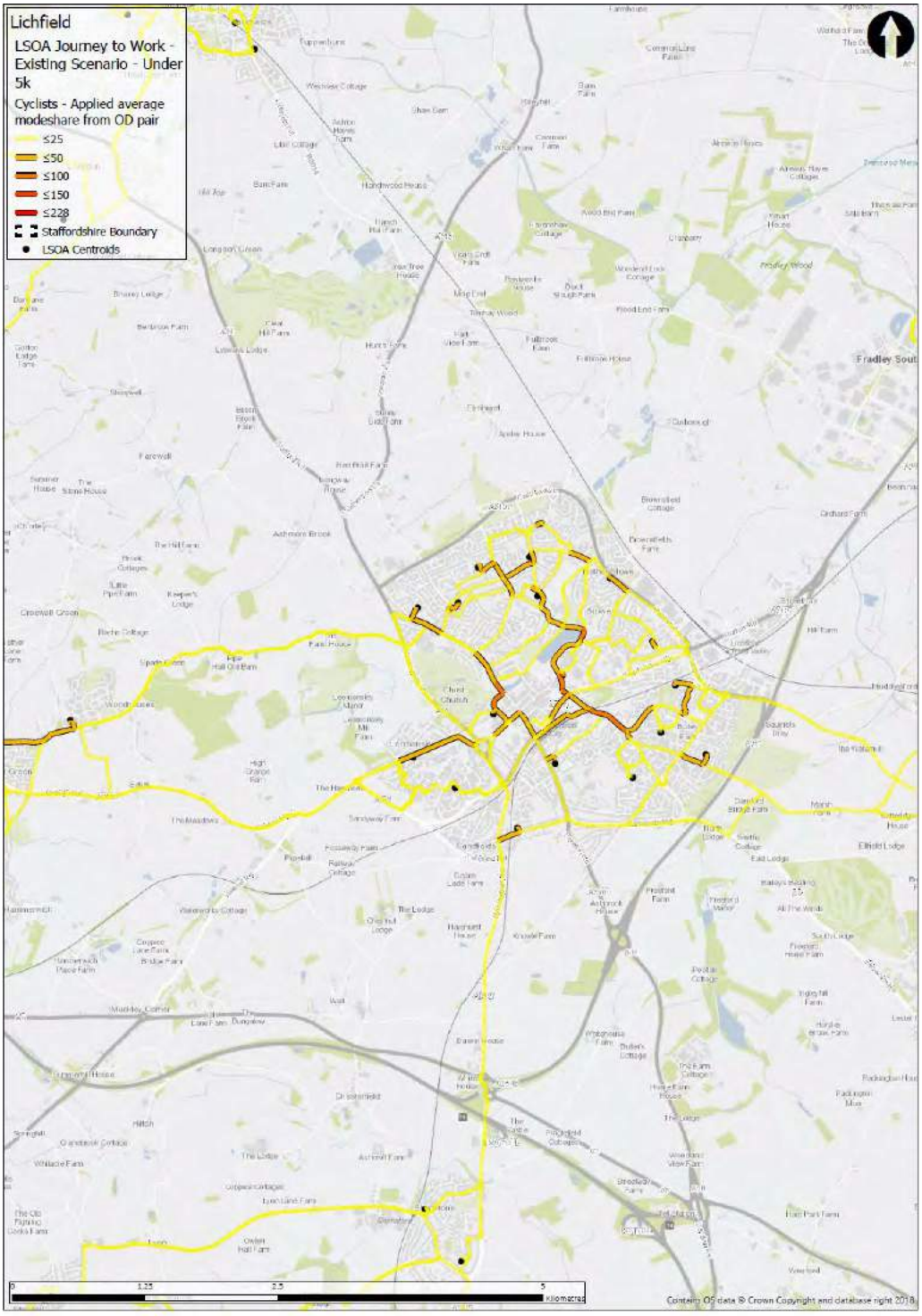
Cannock – Network Density (including committed routes)



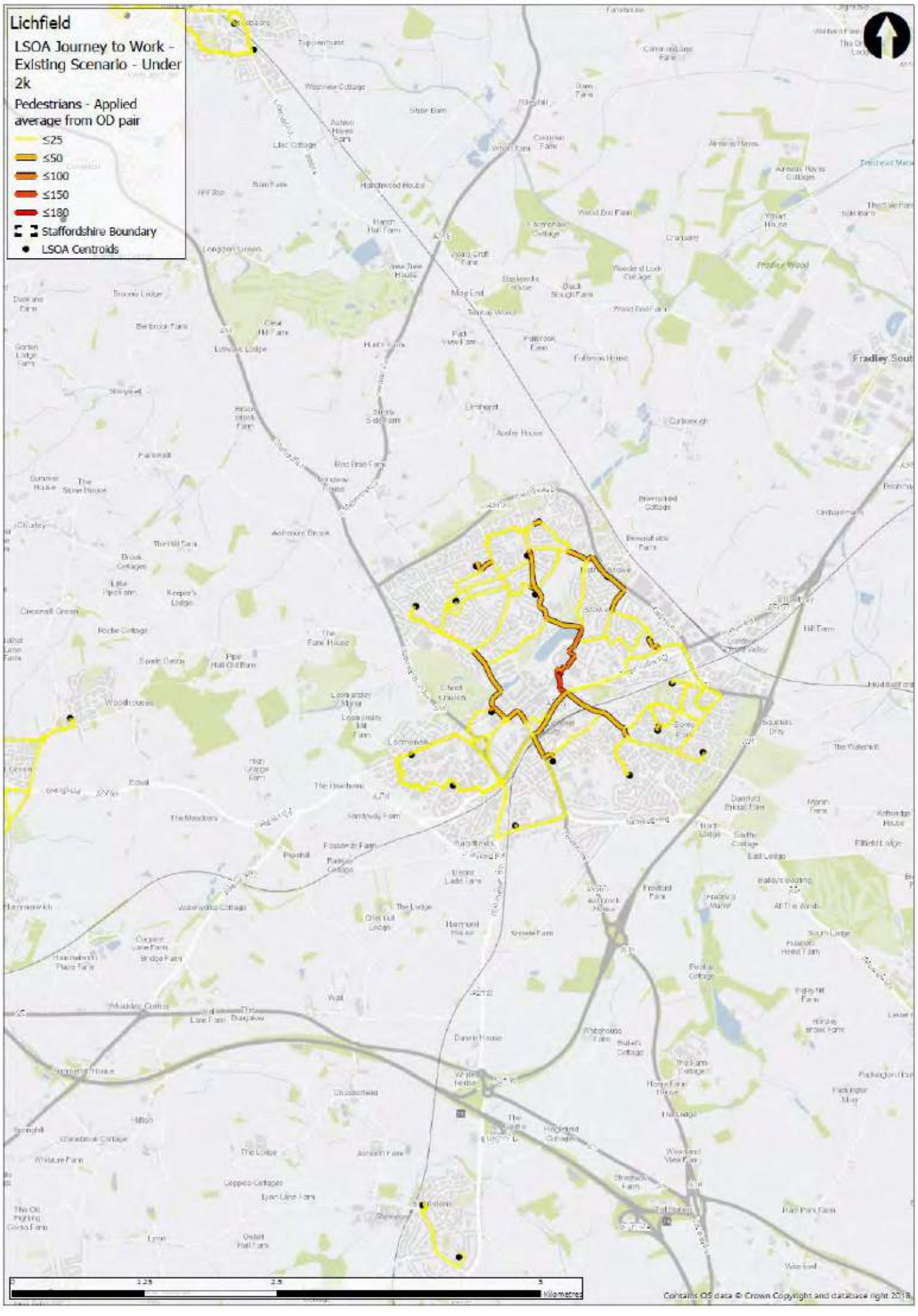
Cannock - Personal Injury Accidents (prioritised)



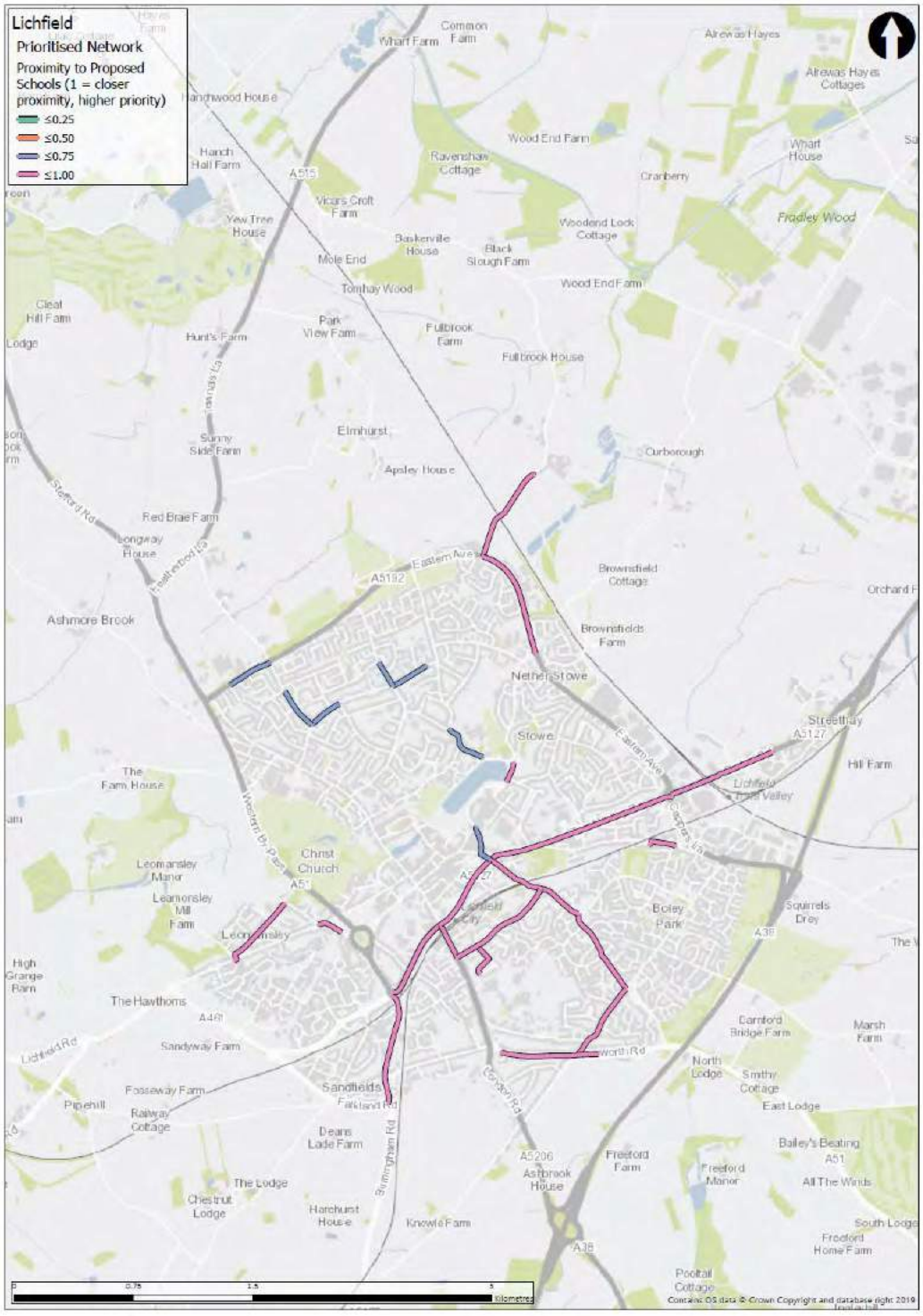
Lichfield – Existing Cycle Trips (2011 Census Journey to Work)



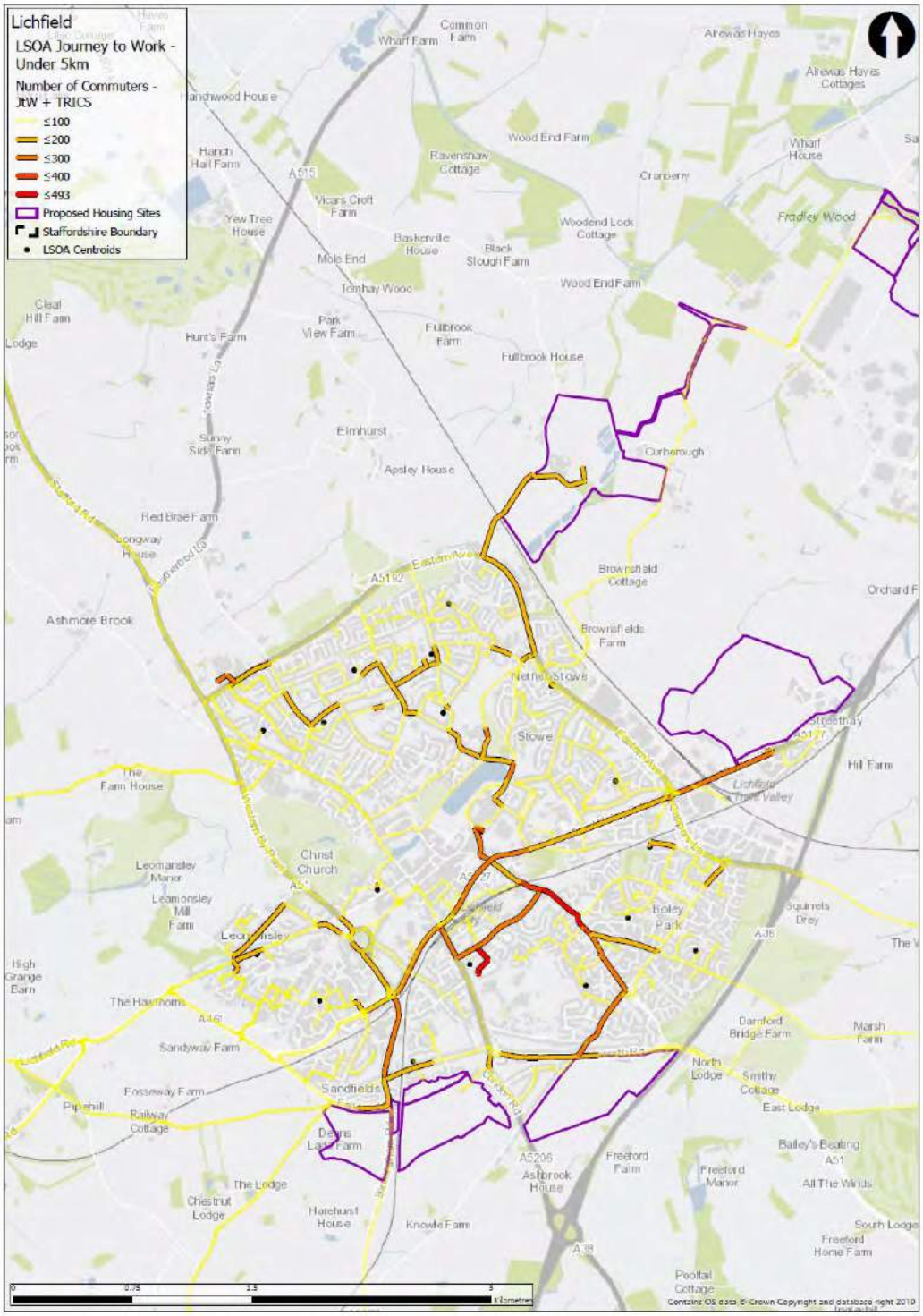
Lichfield – Existing Walk Trips (2011 Census Journey to Work)



Lichfield – School Proximity (prioritised)

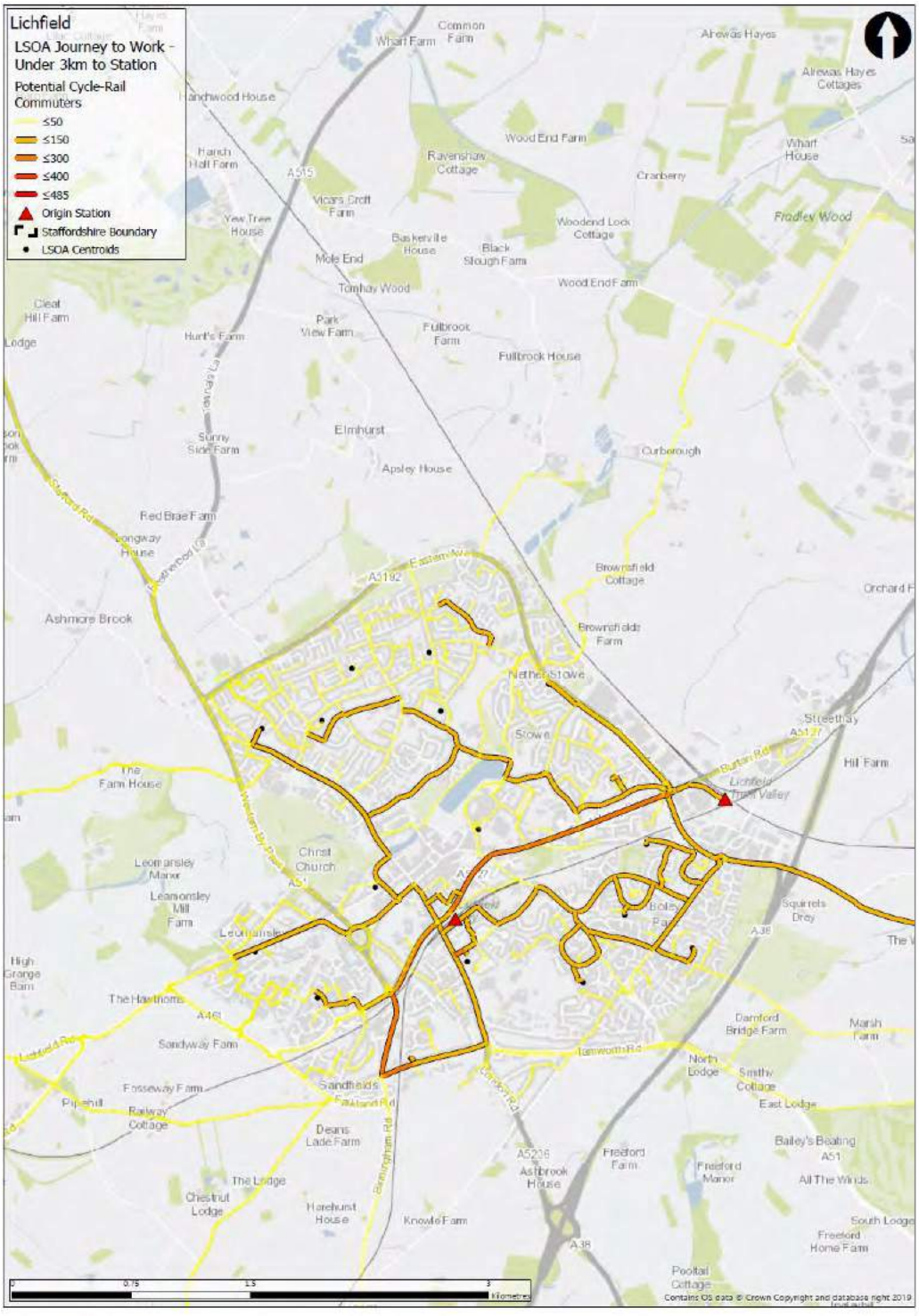


Lichfield – Housing Development Sites

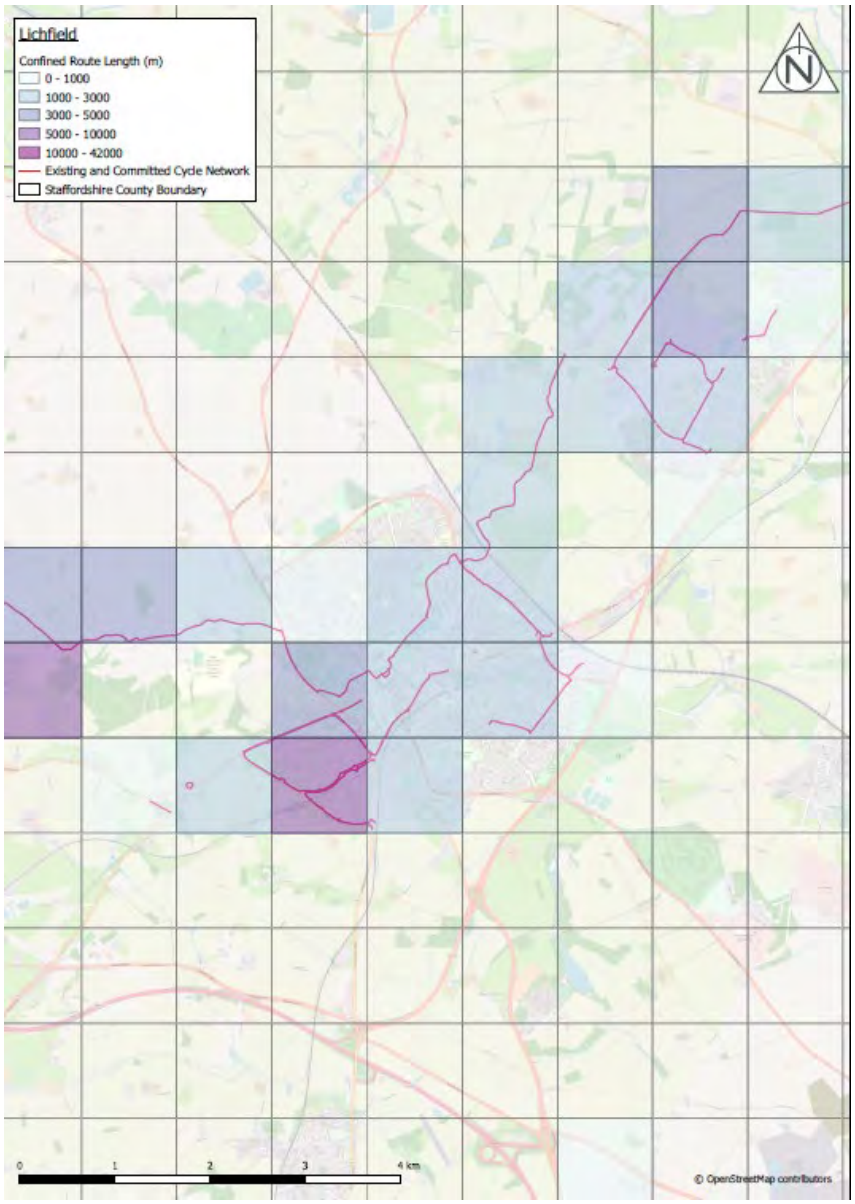


Lichfield – Proximity to Employment (prioritised)

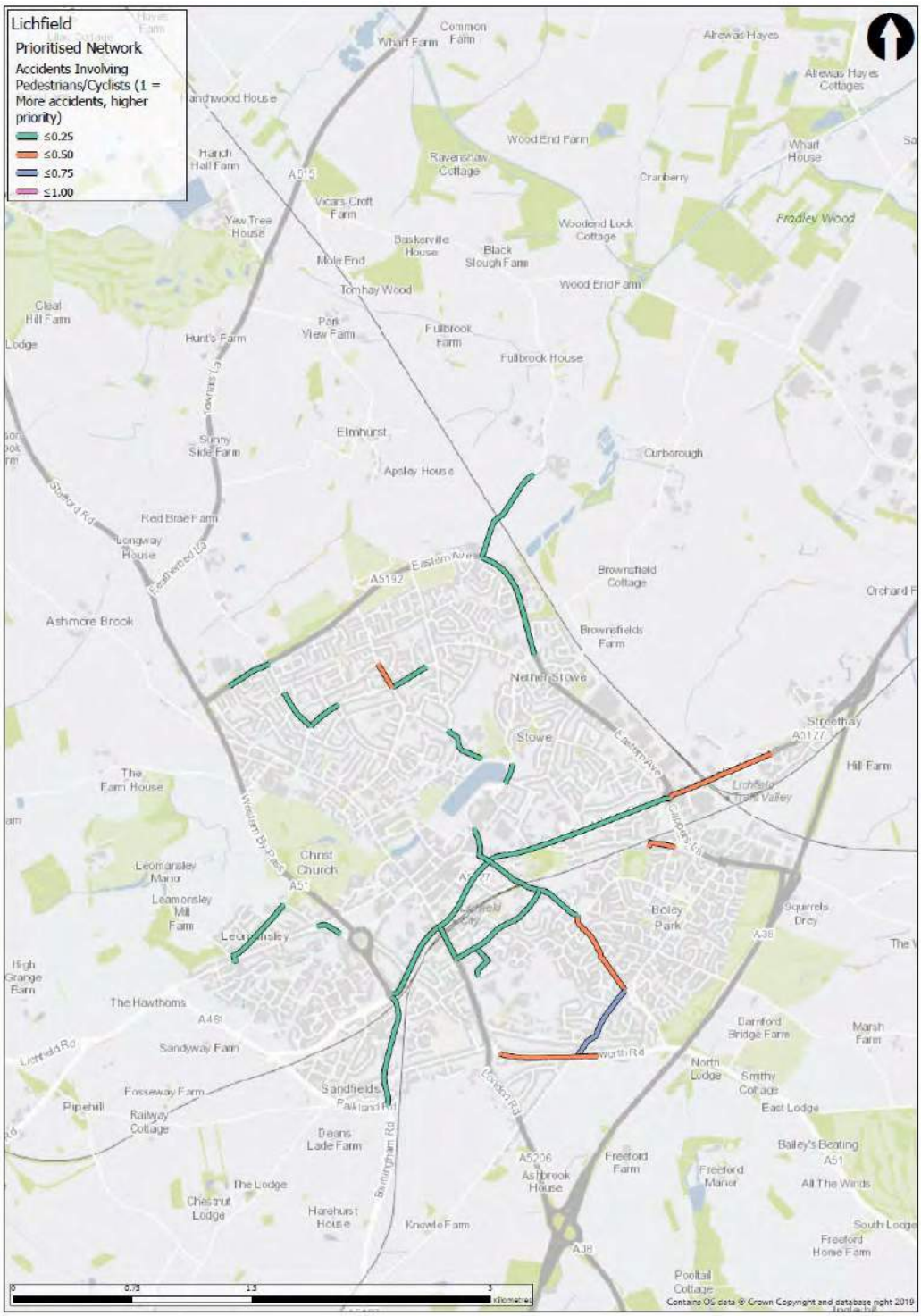
Lichfield - Cycle Rail



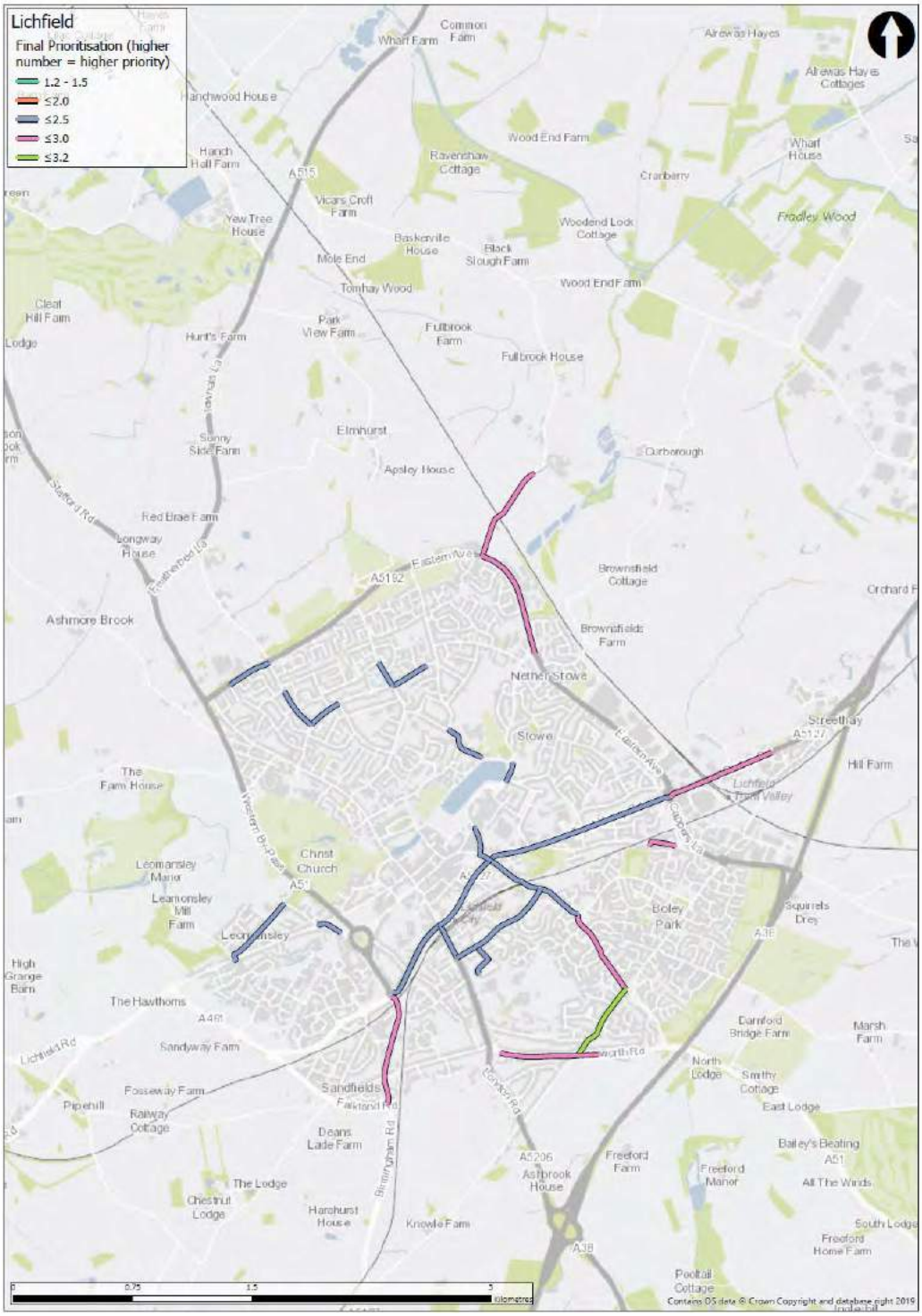
Lichfield – Network Density (including committed routes)



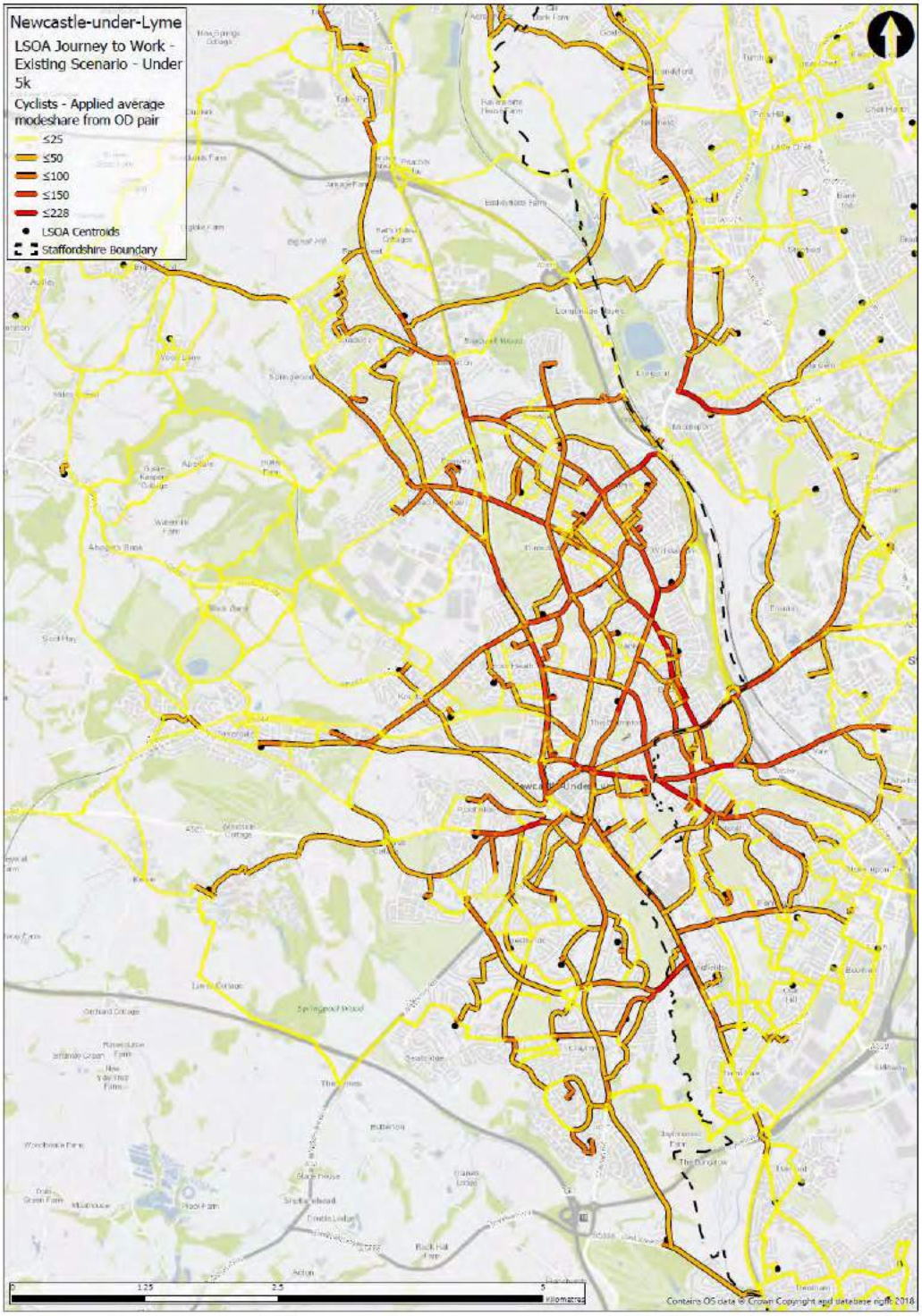
Lichfield - Personal Injury Accidents (prioritised)



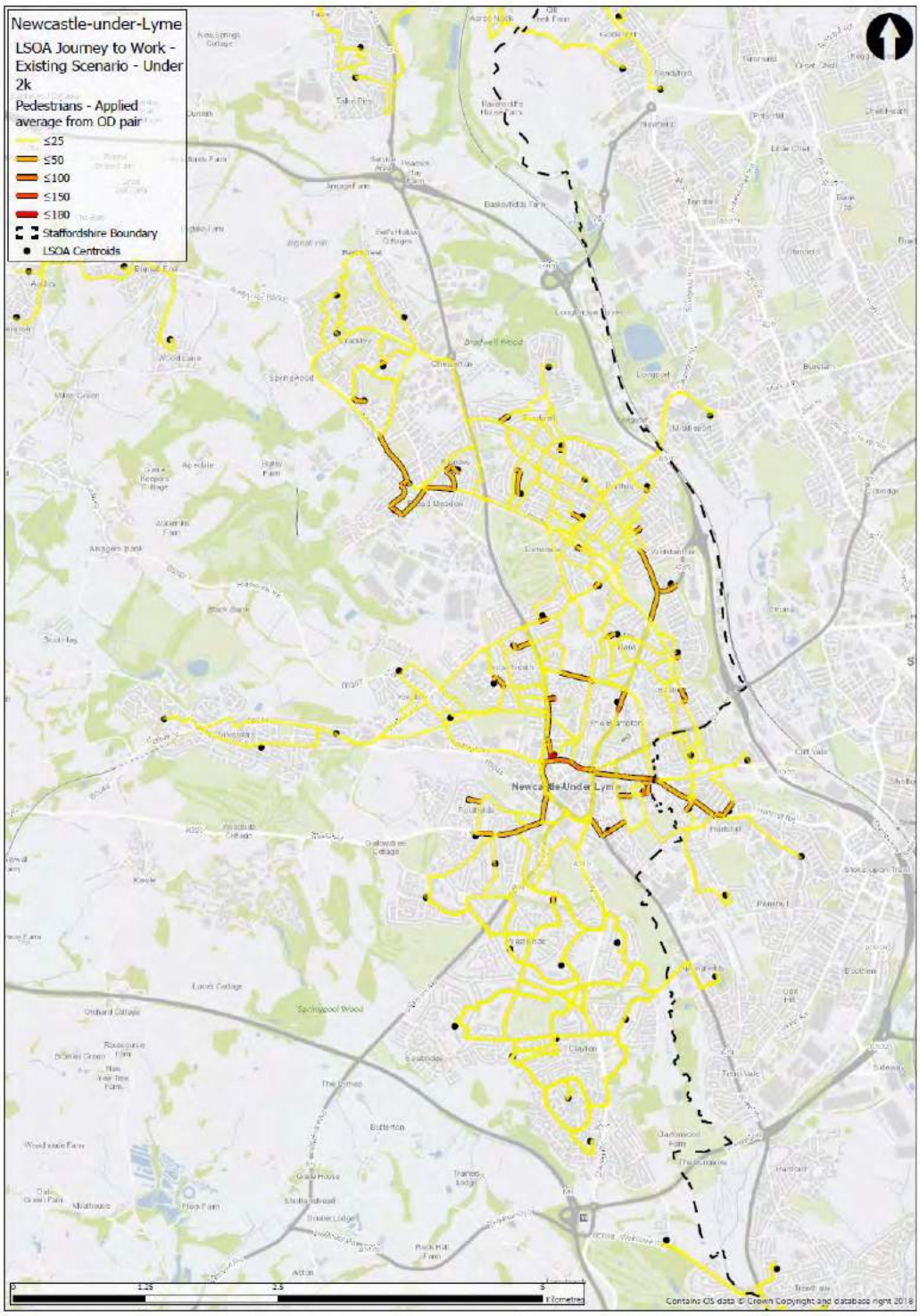
Lichfield – Final Network Prioritisation



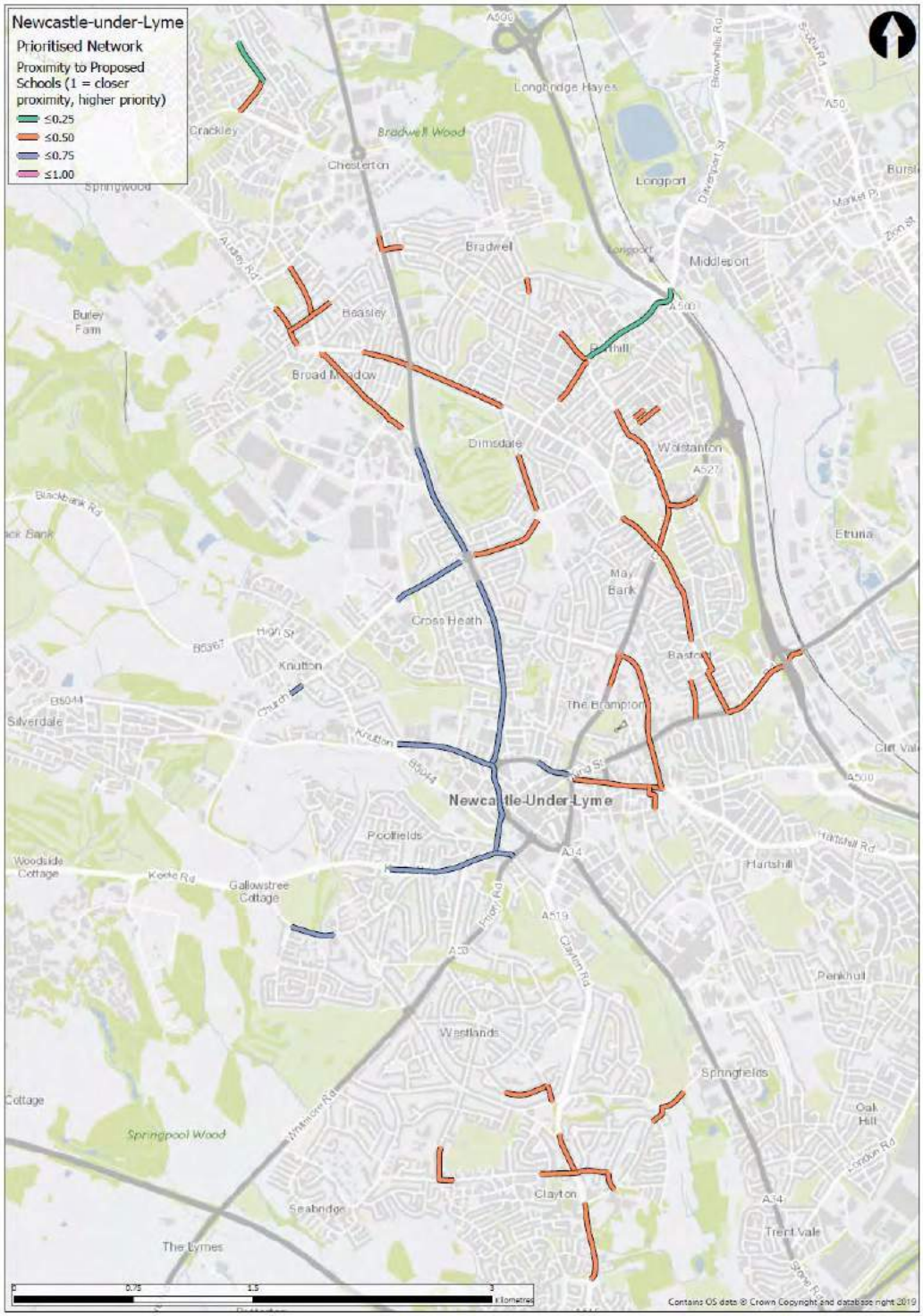
Newcastle – Existing Cycle Trips (2011 Census Journey to Work)



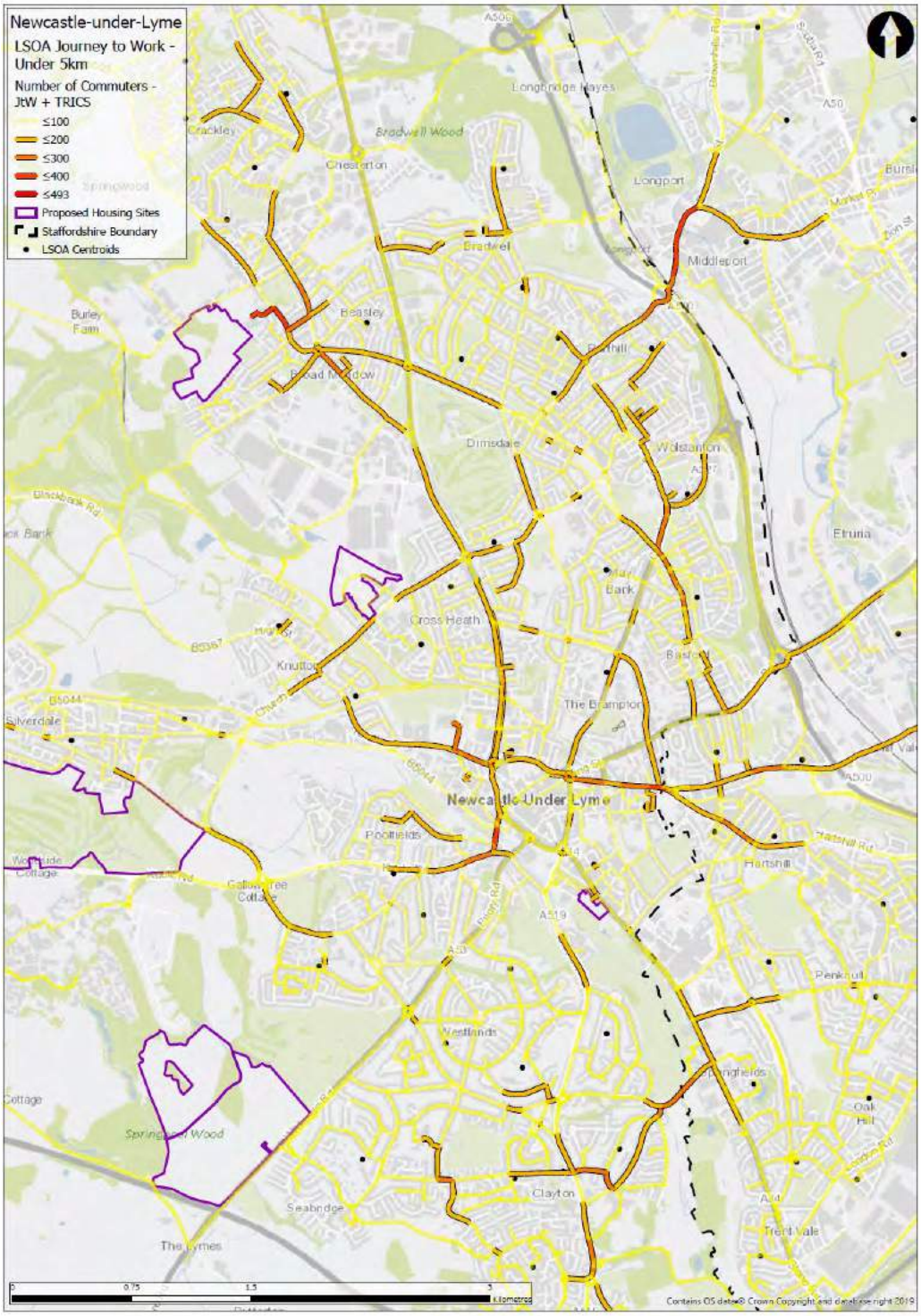
Newcastle – Existing Walk Trips (2011 Census Journey to Work)



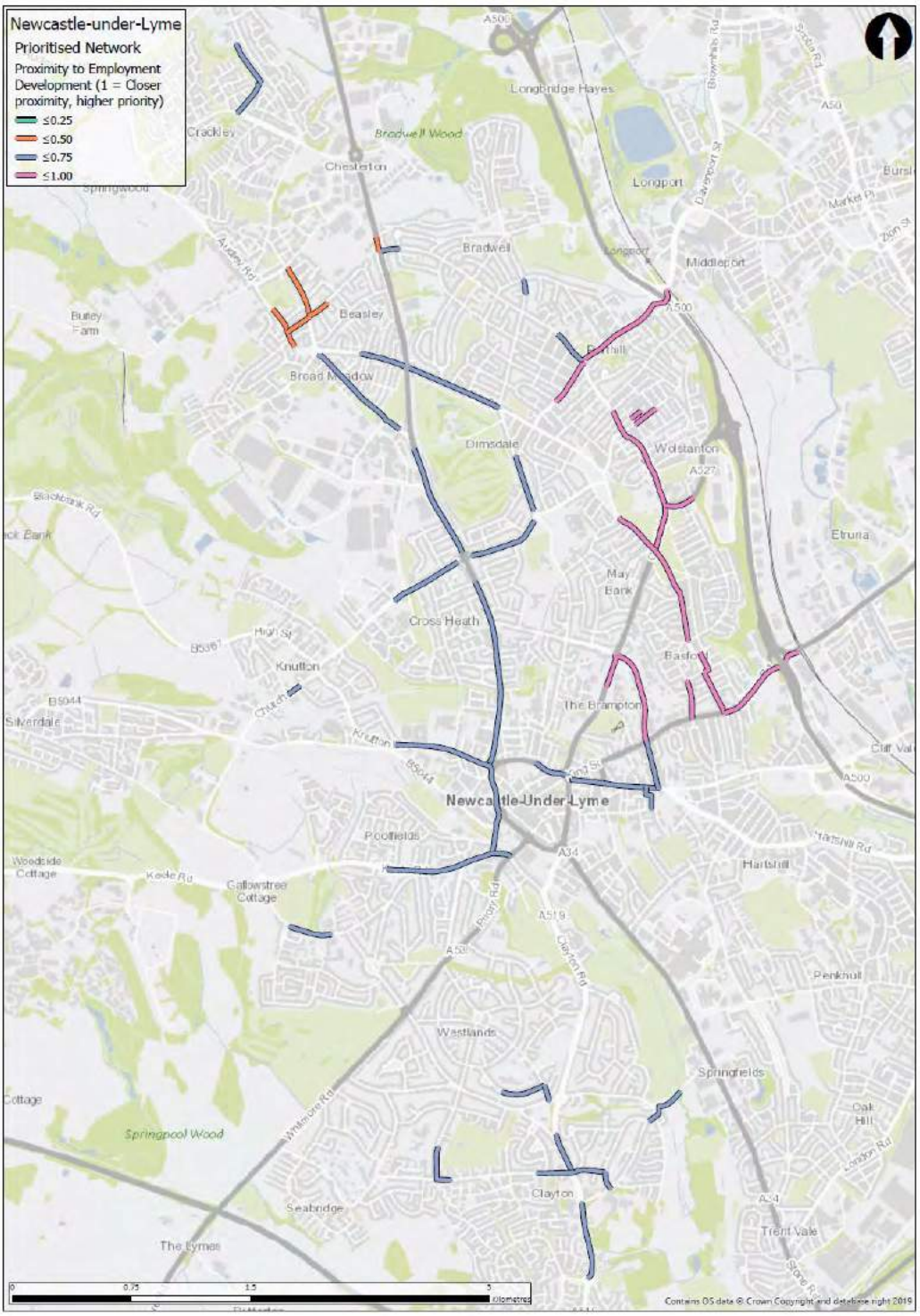
Newcastle – School Proximity (prioritised)



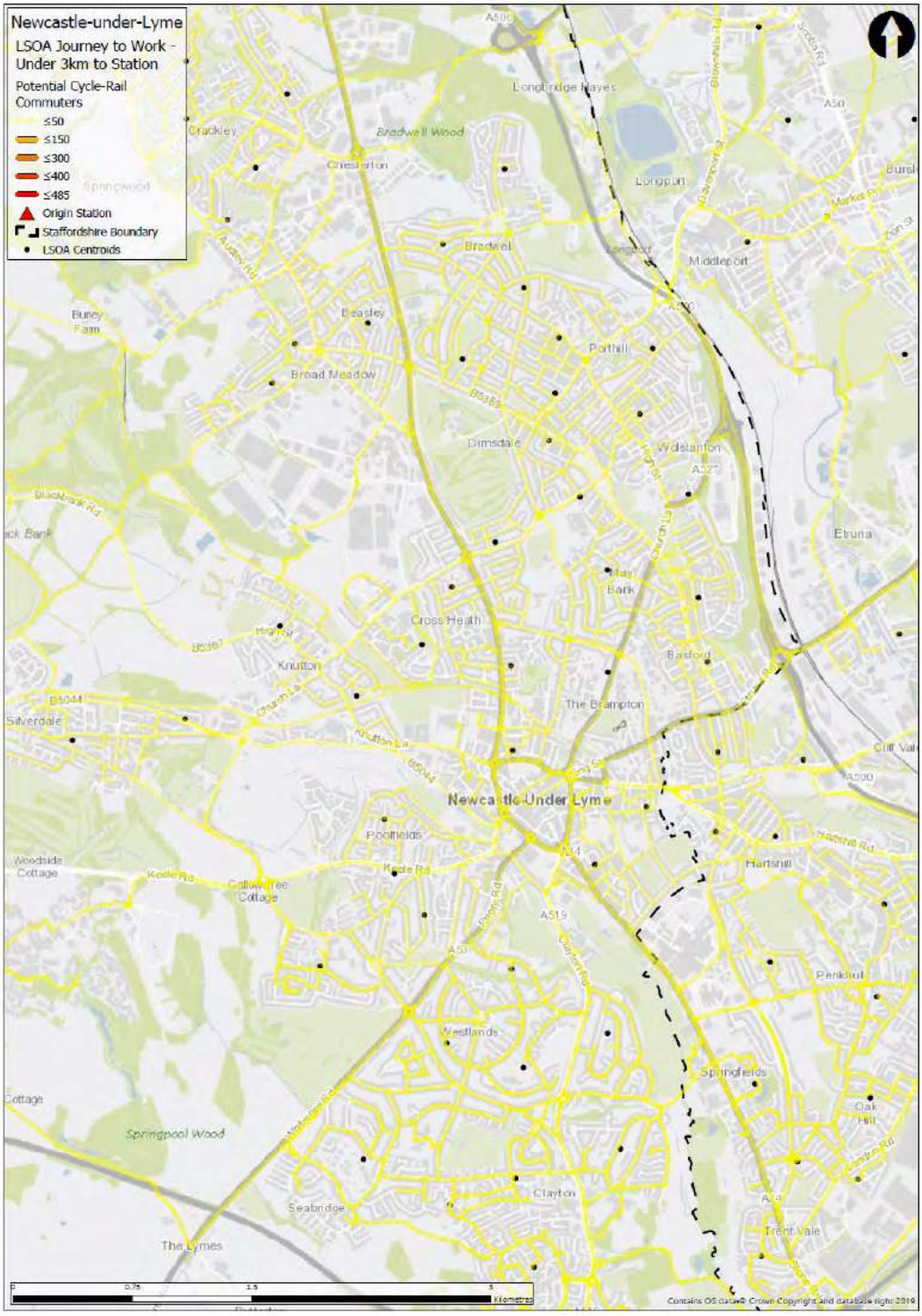
Newcastle – Housing Development Sites



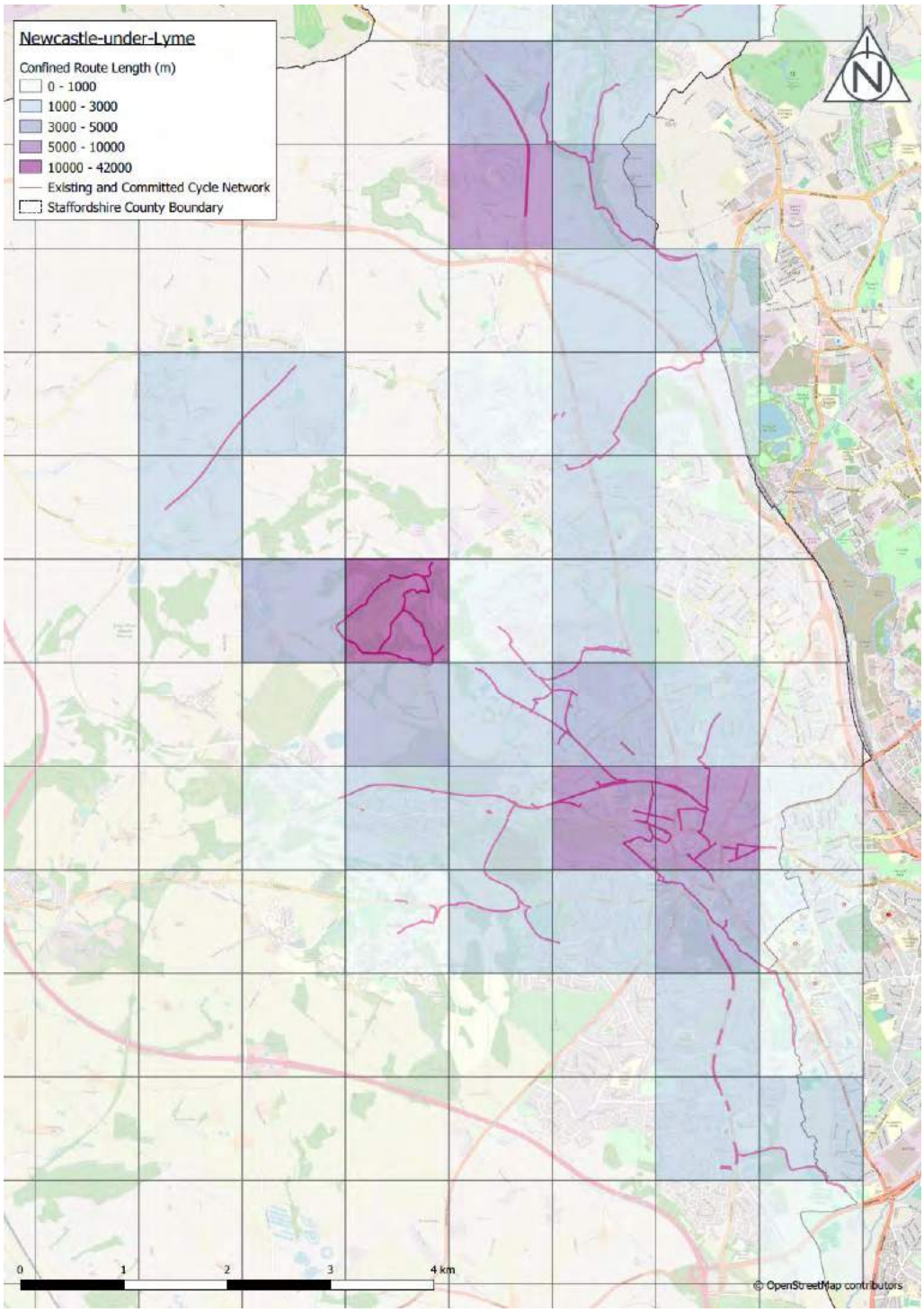
Newcastle – Proximity to Employment (prioritised)



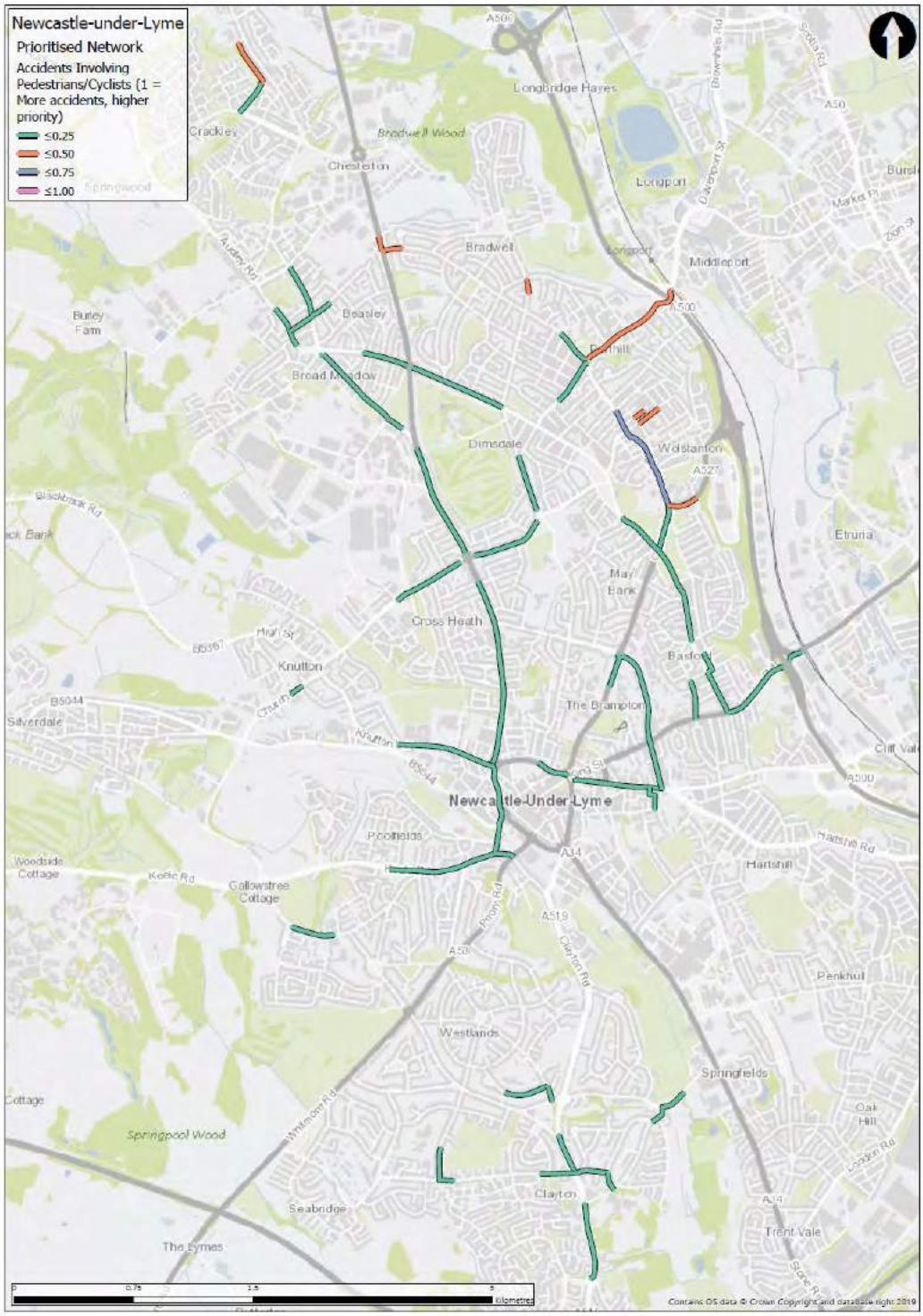
Newcastle – Cycle Rail



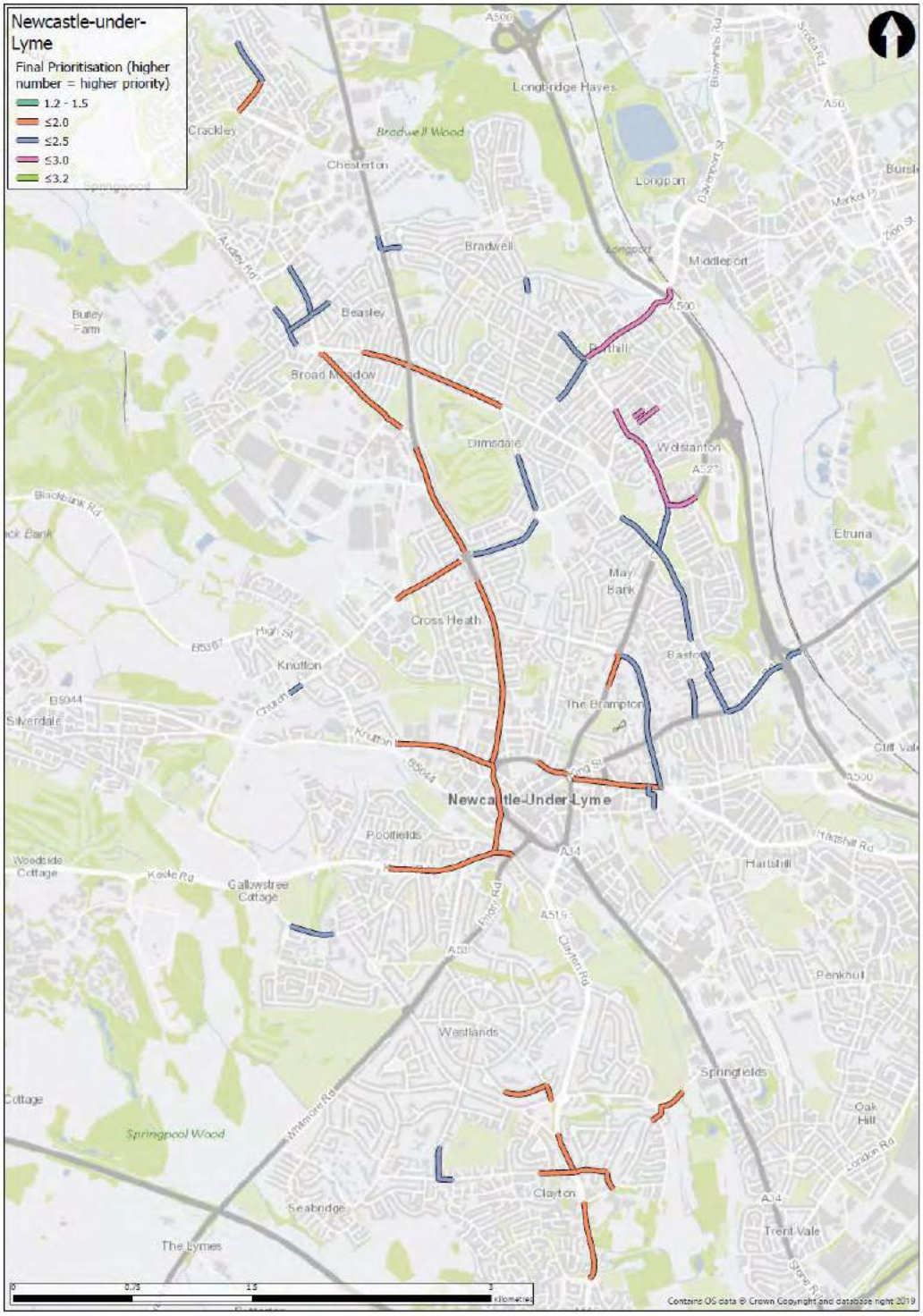
Newcastle – Network Density (including committed routes)



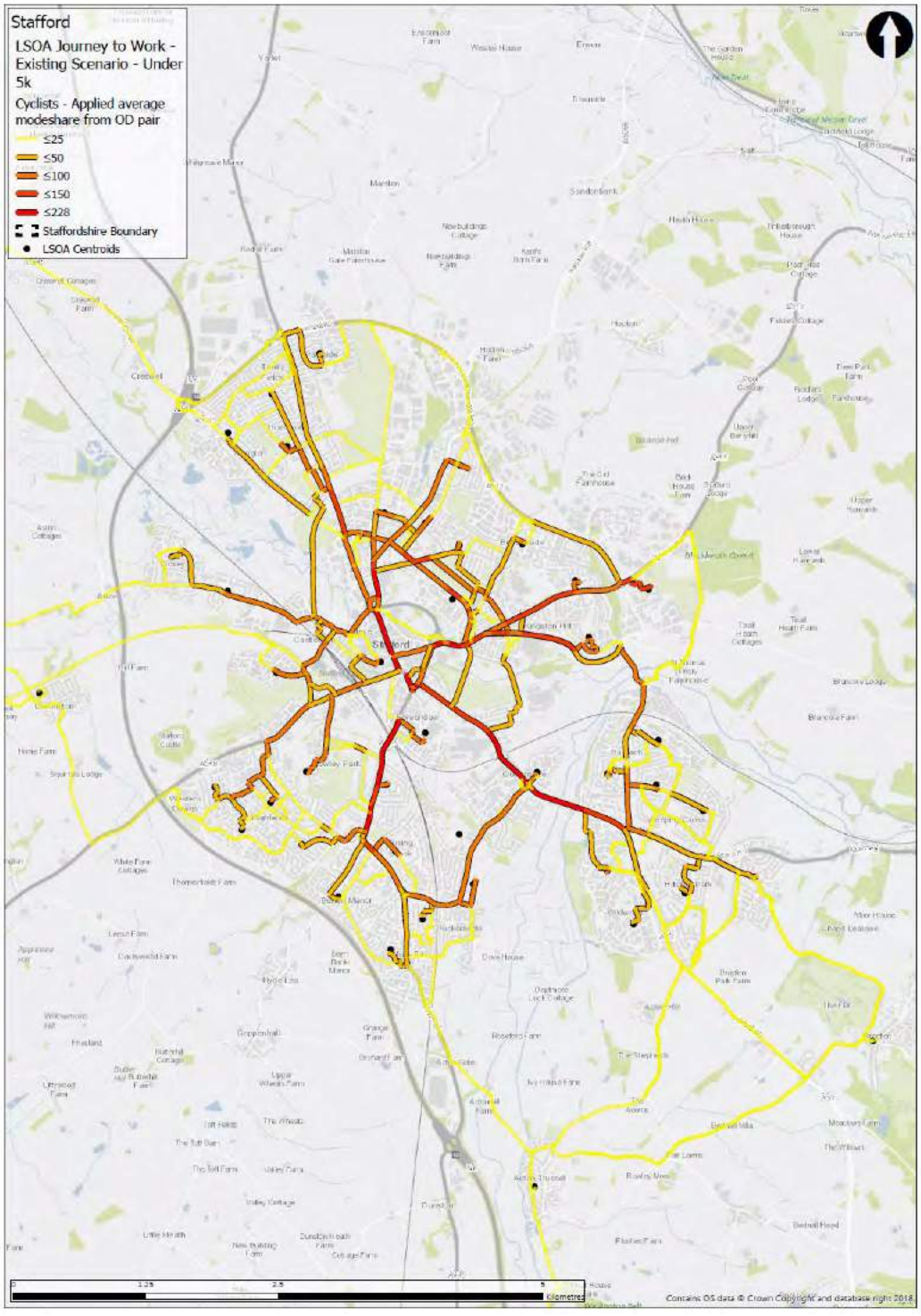
Newcastle - Personal Injury Accidents (prioritised)



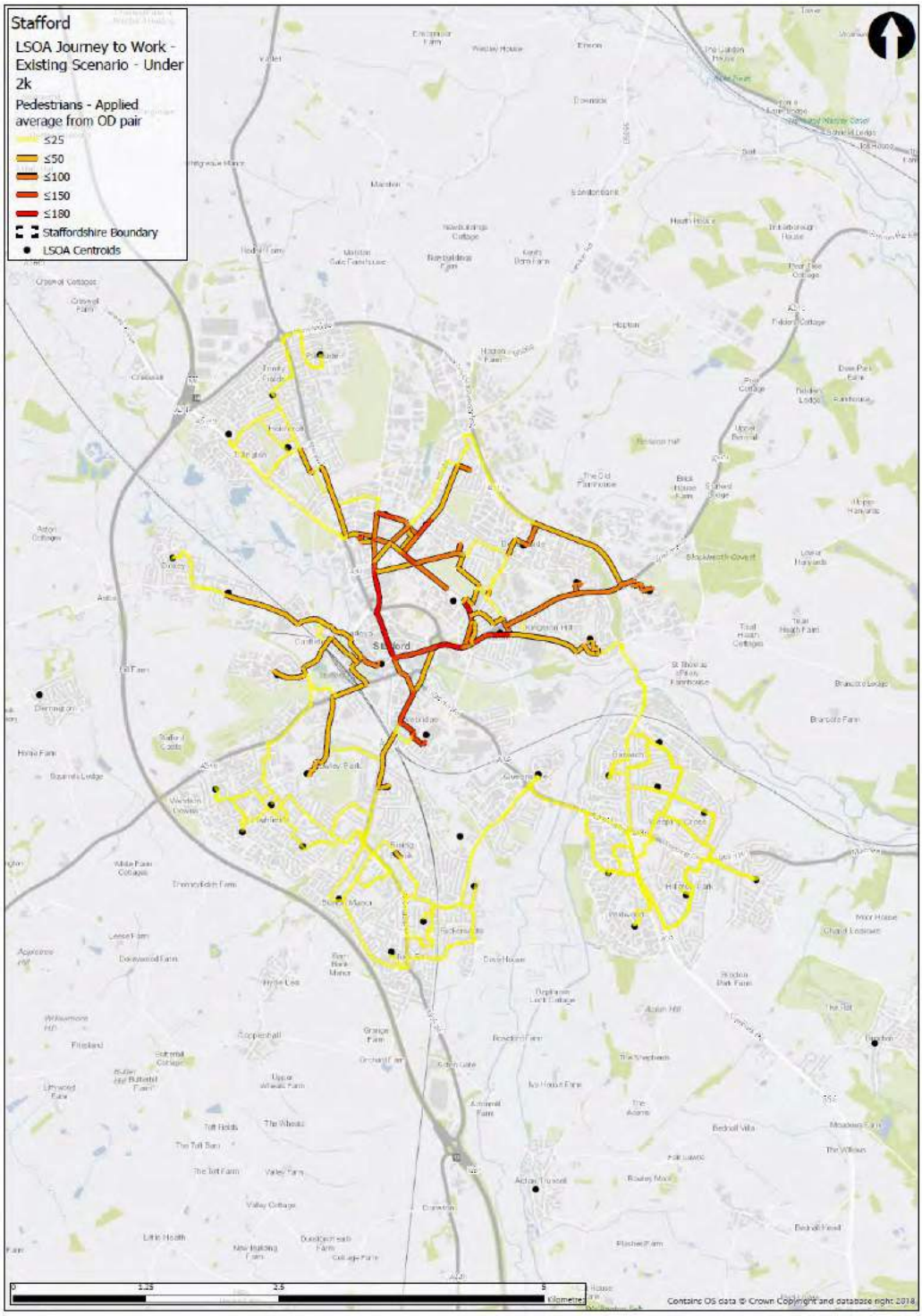
Newcastle – Final Prioritised Network



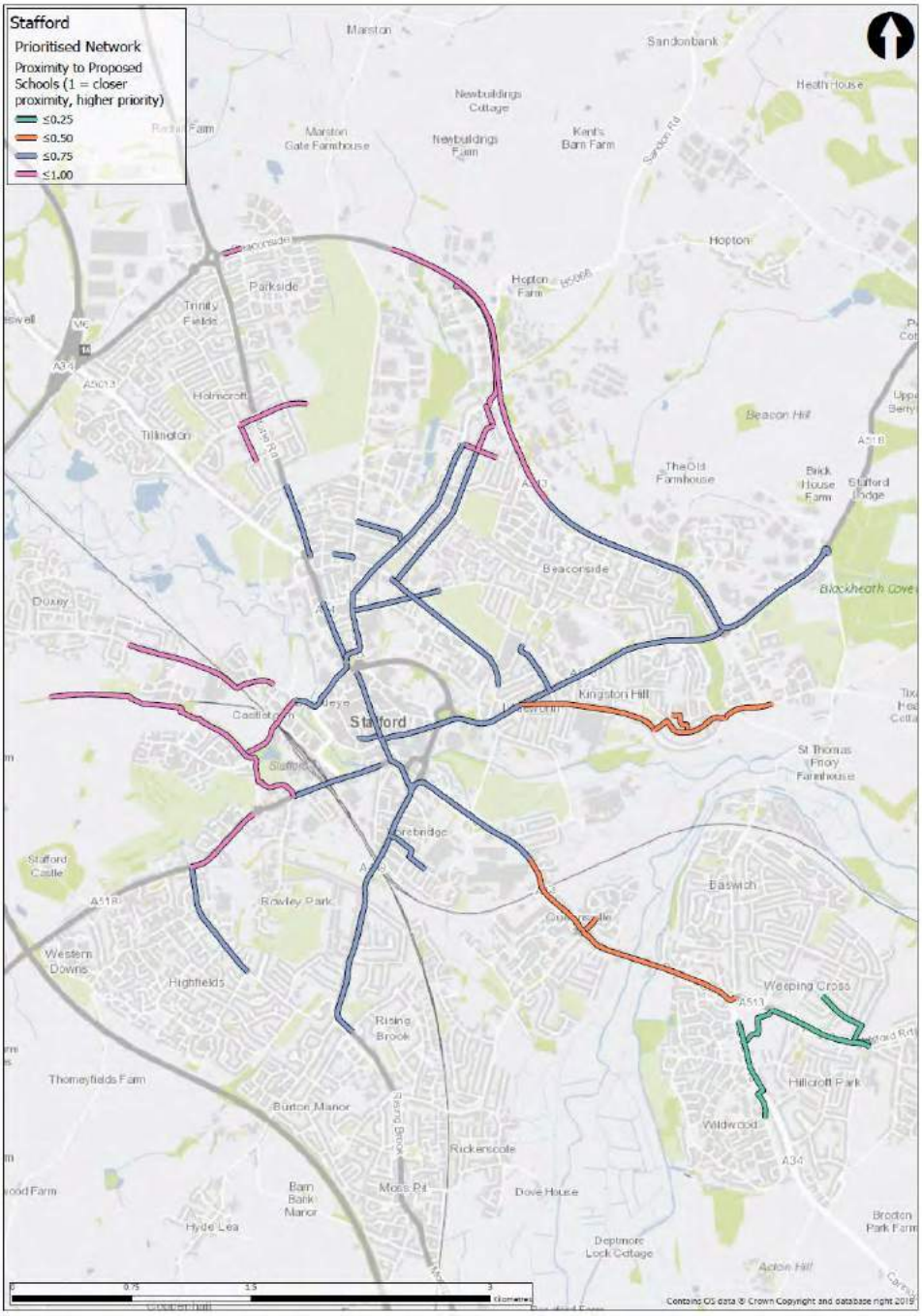
Stafford – Existing Cycle Trips (2011 Census Journey to Work)



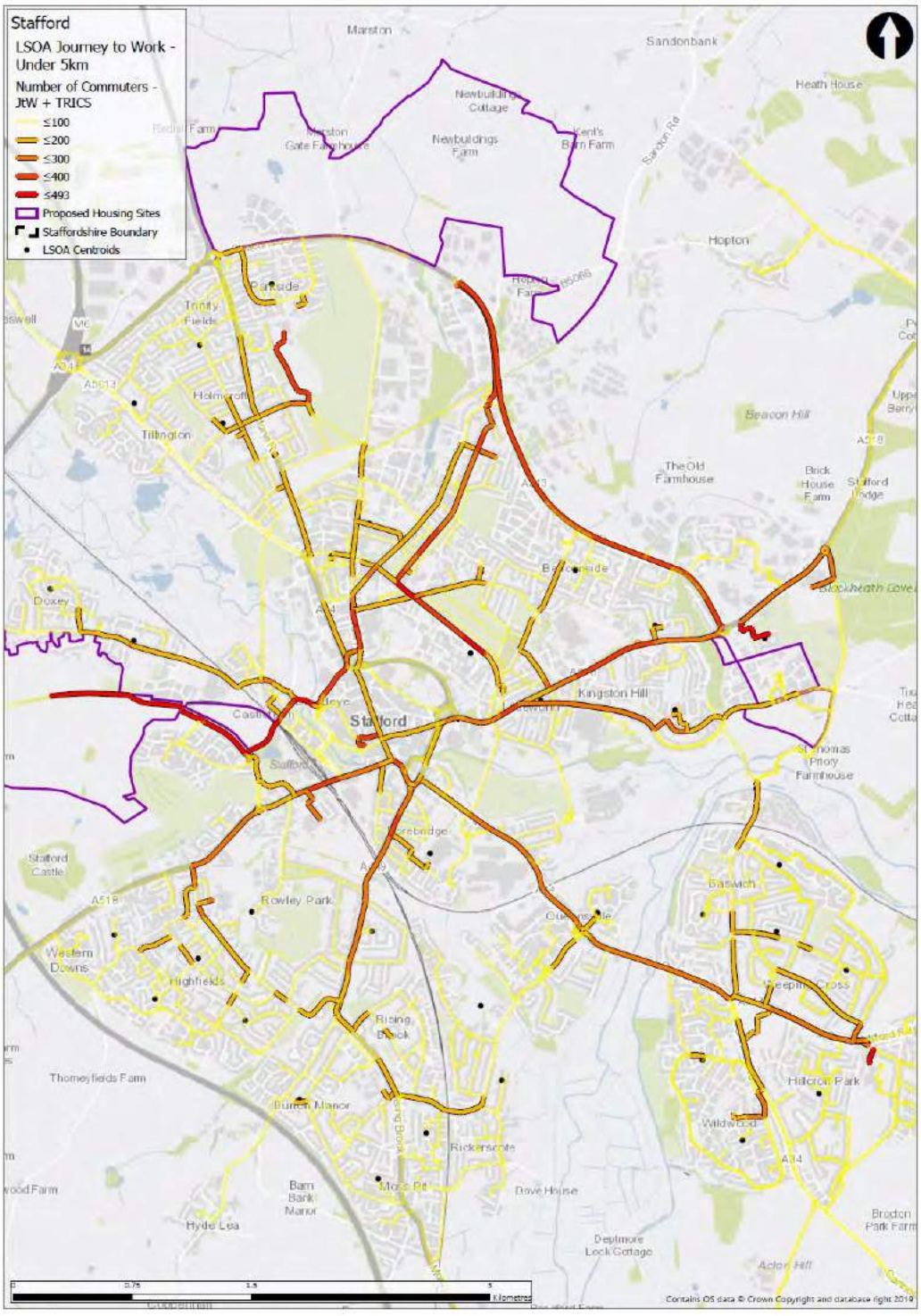
Stafford – Existing Walk Trips (2011 Census Journey to Work)



Stafford – School Proximity (prioritised)



Stafford – Housing Development Sites


Stafford
LSOA Journey to Work - Under 5km
Number of Commuters - JtW + TRICS
≤100
≤200
≤300
≤400
≤493
Proposed Housing Sites
Staffordshire Boundary
LSOA Centroids
Marston
Sandonbank
Heath House
Newbuildings Cottage
Newbuildings Farm
Kent's Barn Farm
Hopton
Parkside
Trinity Fields
Holmcroft
Tillington
Beacon Hill
The Old Farmhouse
Brick House Farm
Stafford Lodge
Doxey
Kingston Hill
Stafford
Stafford Castle
Rowley Park
Baswich
Western Downs
Highfields
Weeping Cross
Rising Brook
Thorneyfields Farm
Burton Manor
Hillcrest Park
Wildwood
Rickerscote
Barn Bank Manor
Moss Pit
Dove House
Hyde Lea
Deptmore Lock Cottage
Acton Hill
Broxton Park Farm
Kilometres
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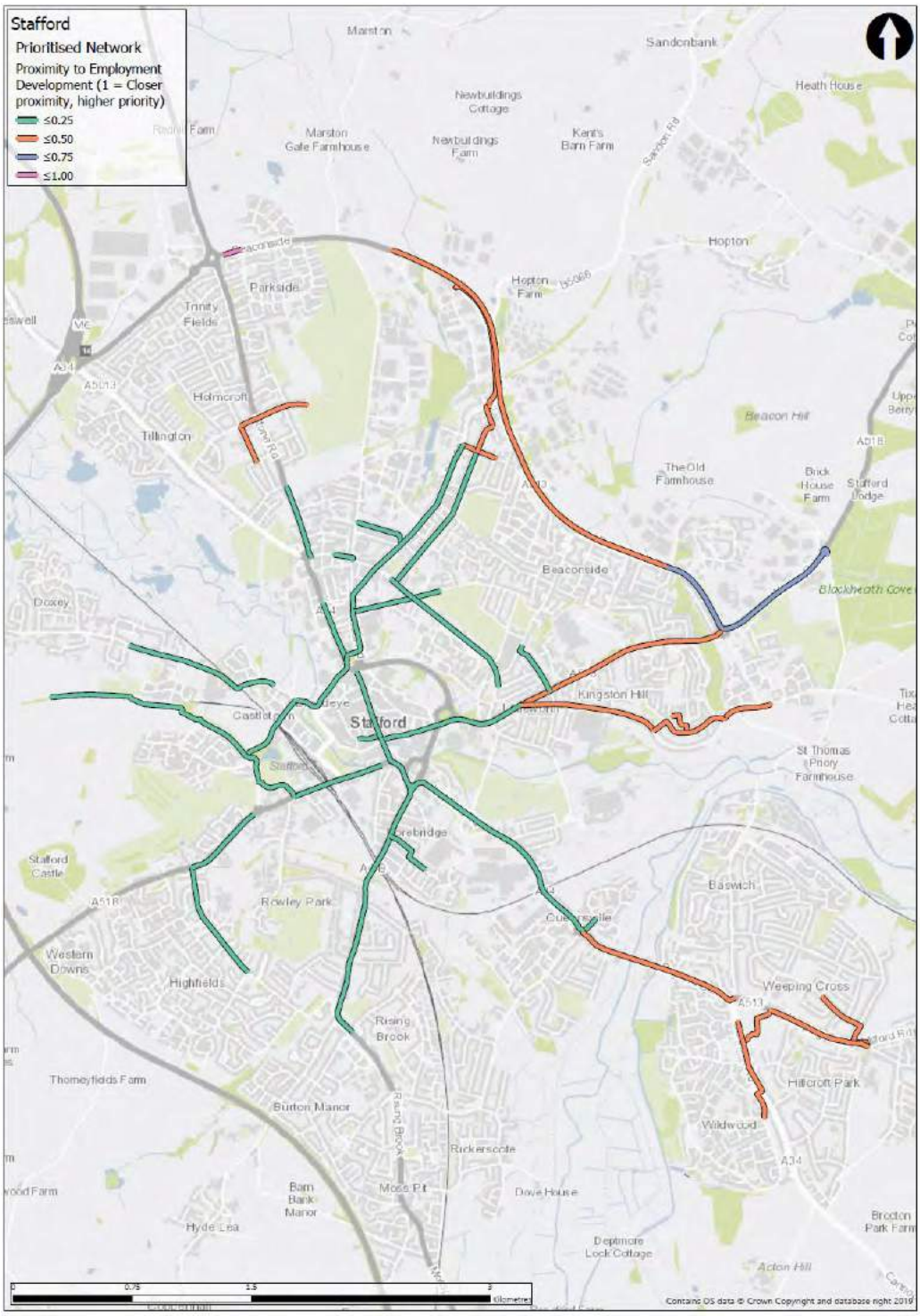
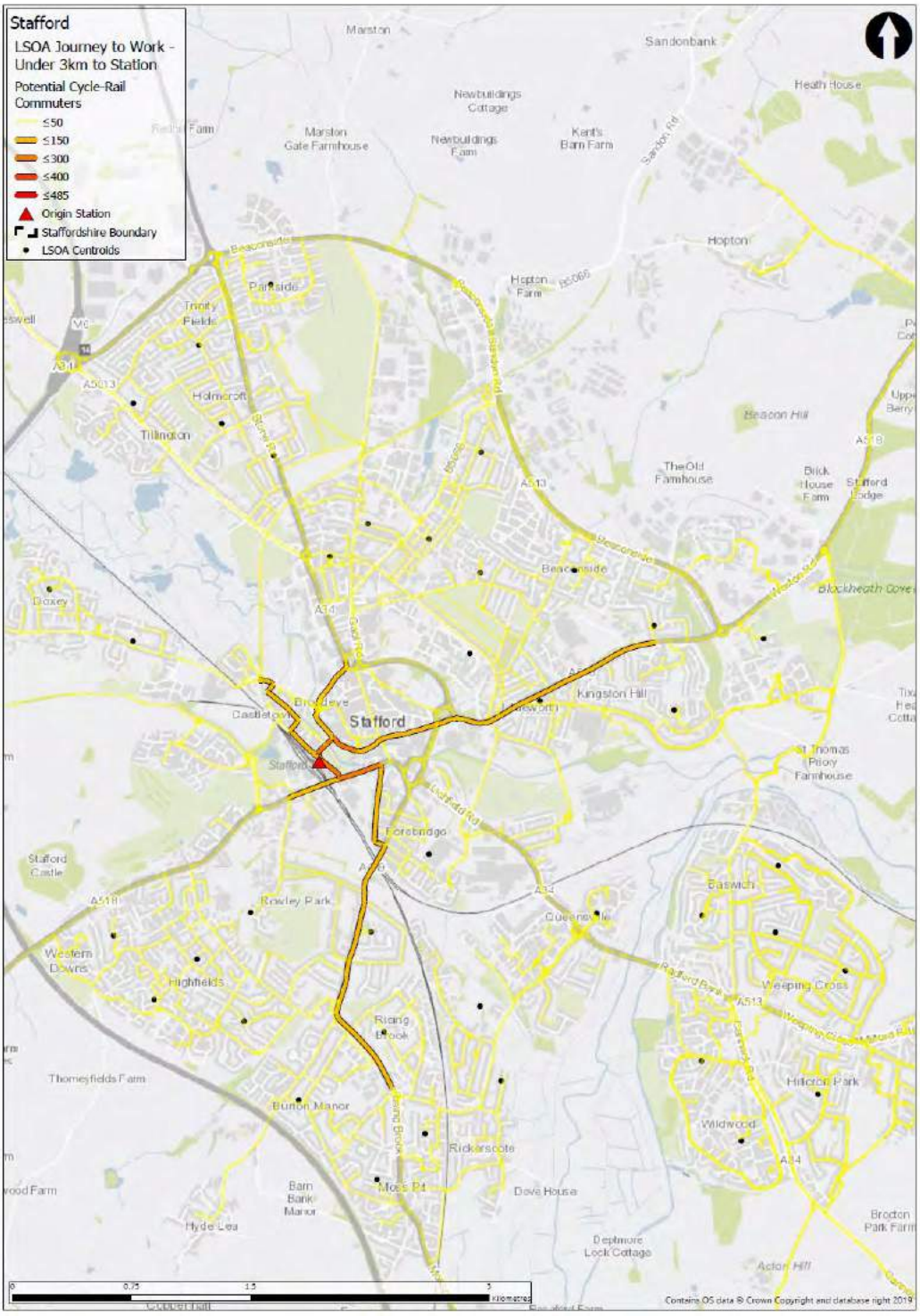
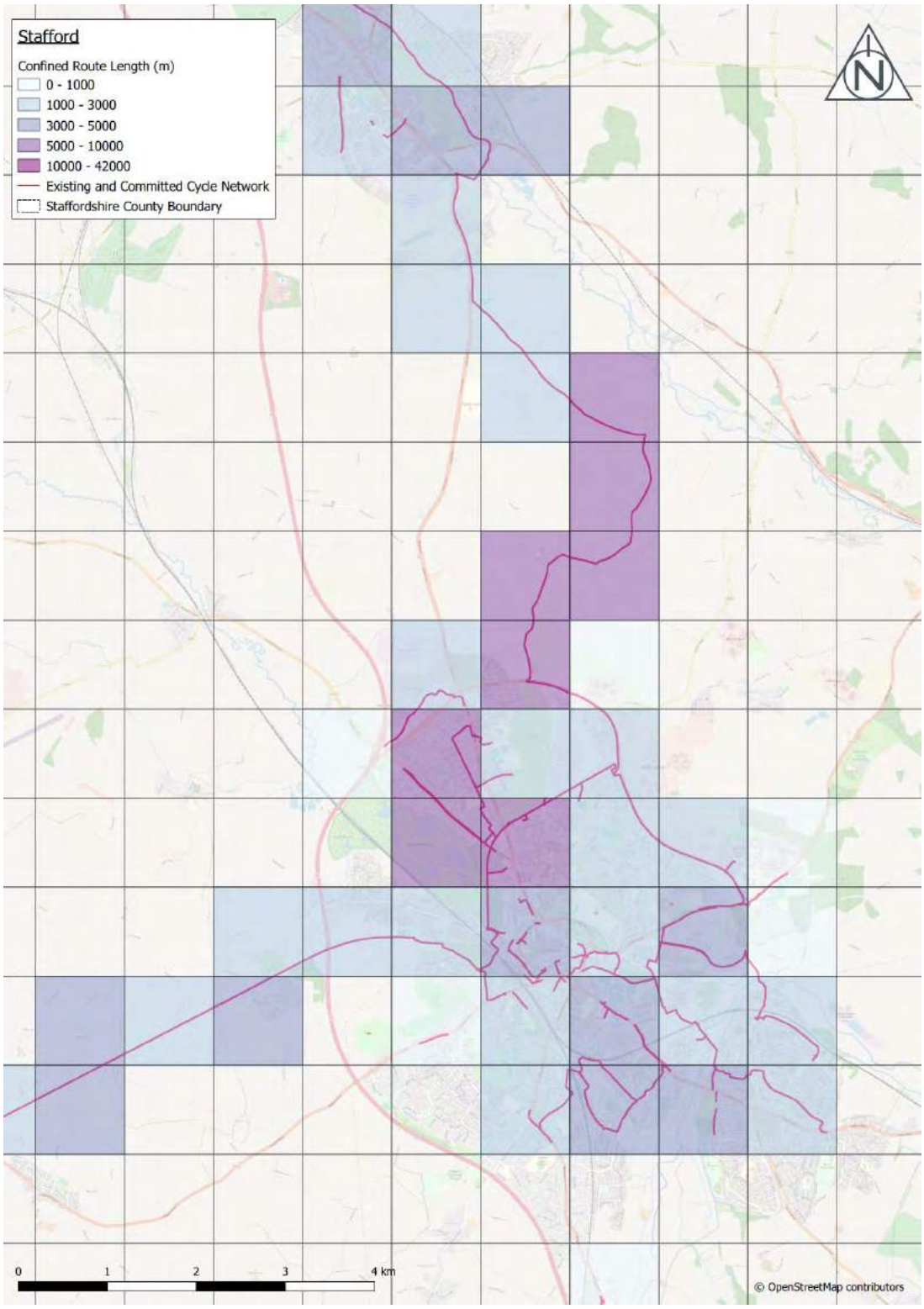
Stafford – Proximity to Employment (prioritised)



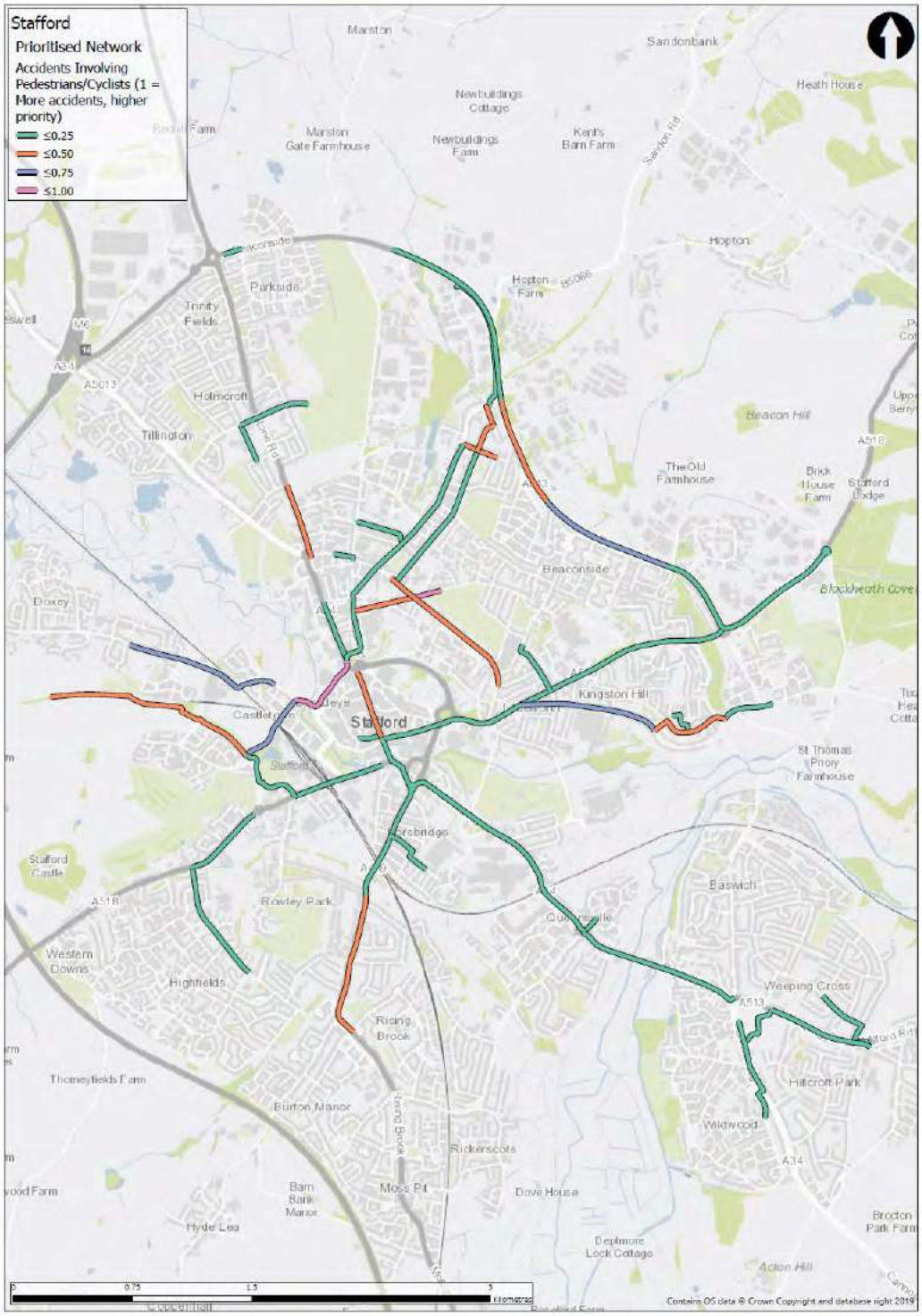
Stafford – Cycle Rail



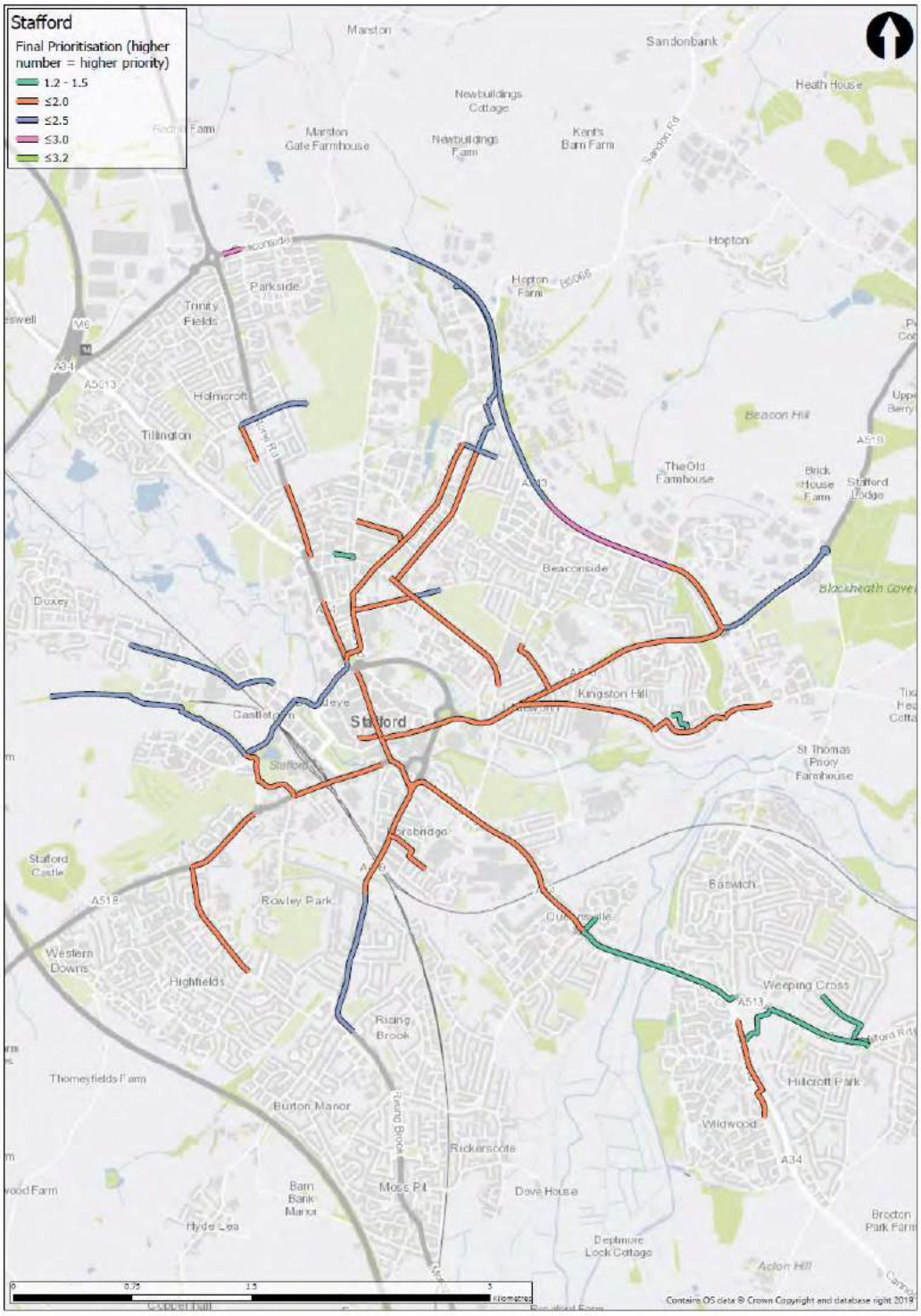
Stafford – Network Density (including committed routes)



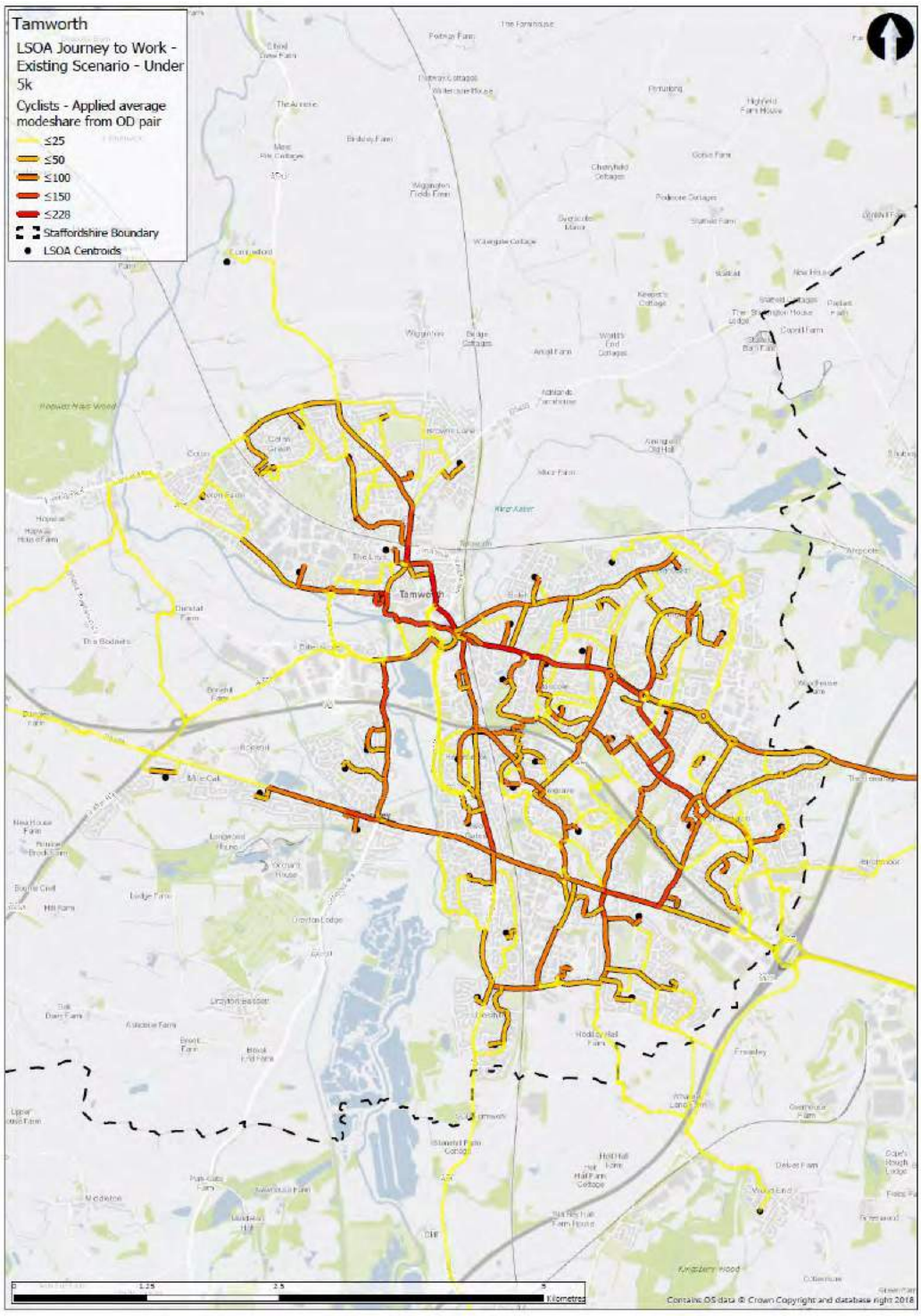
Stafford - Personal Injury Accidents (prioritised)



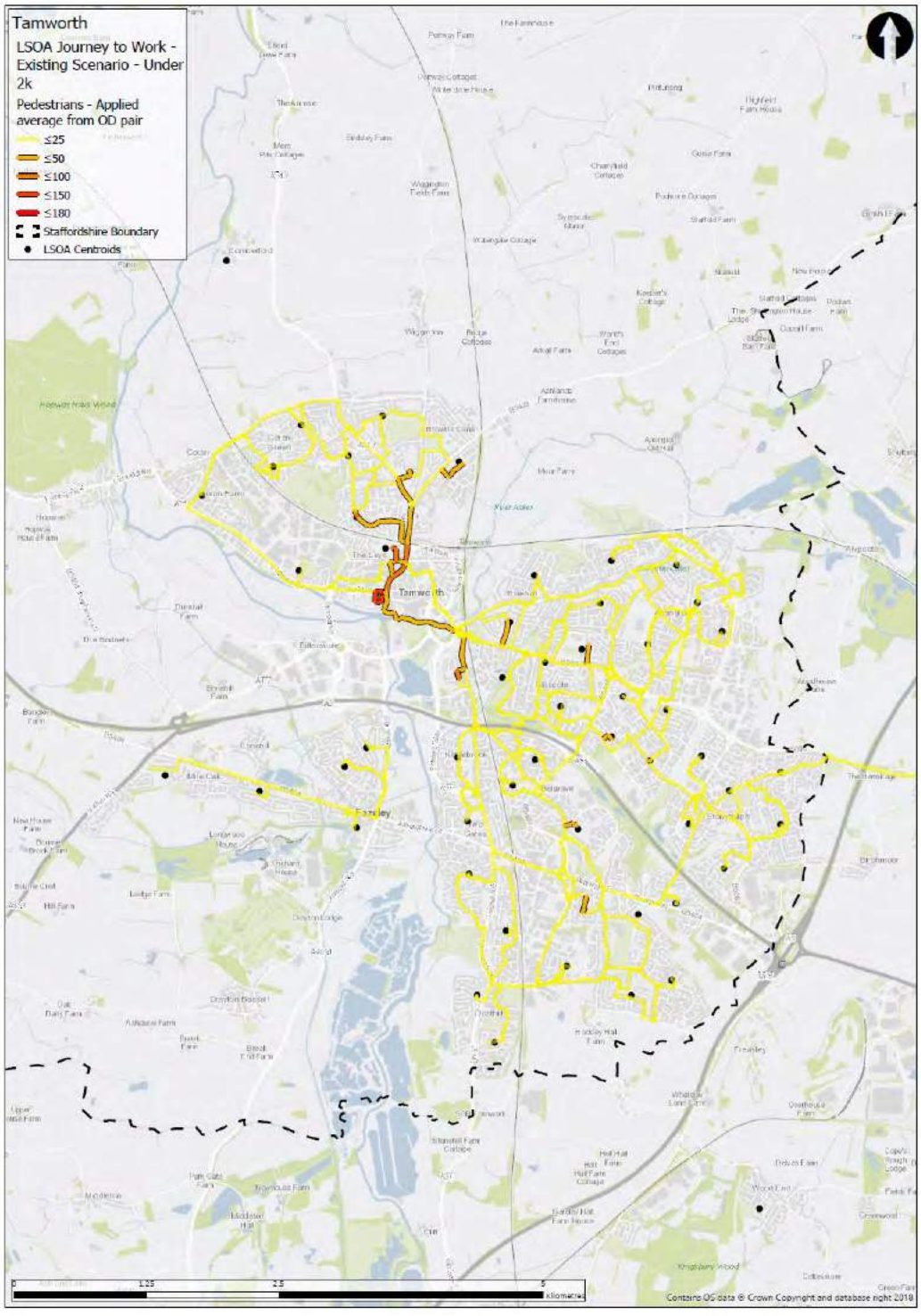
Stafford – Final Prioritised Network



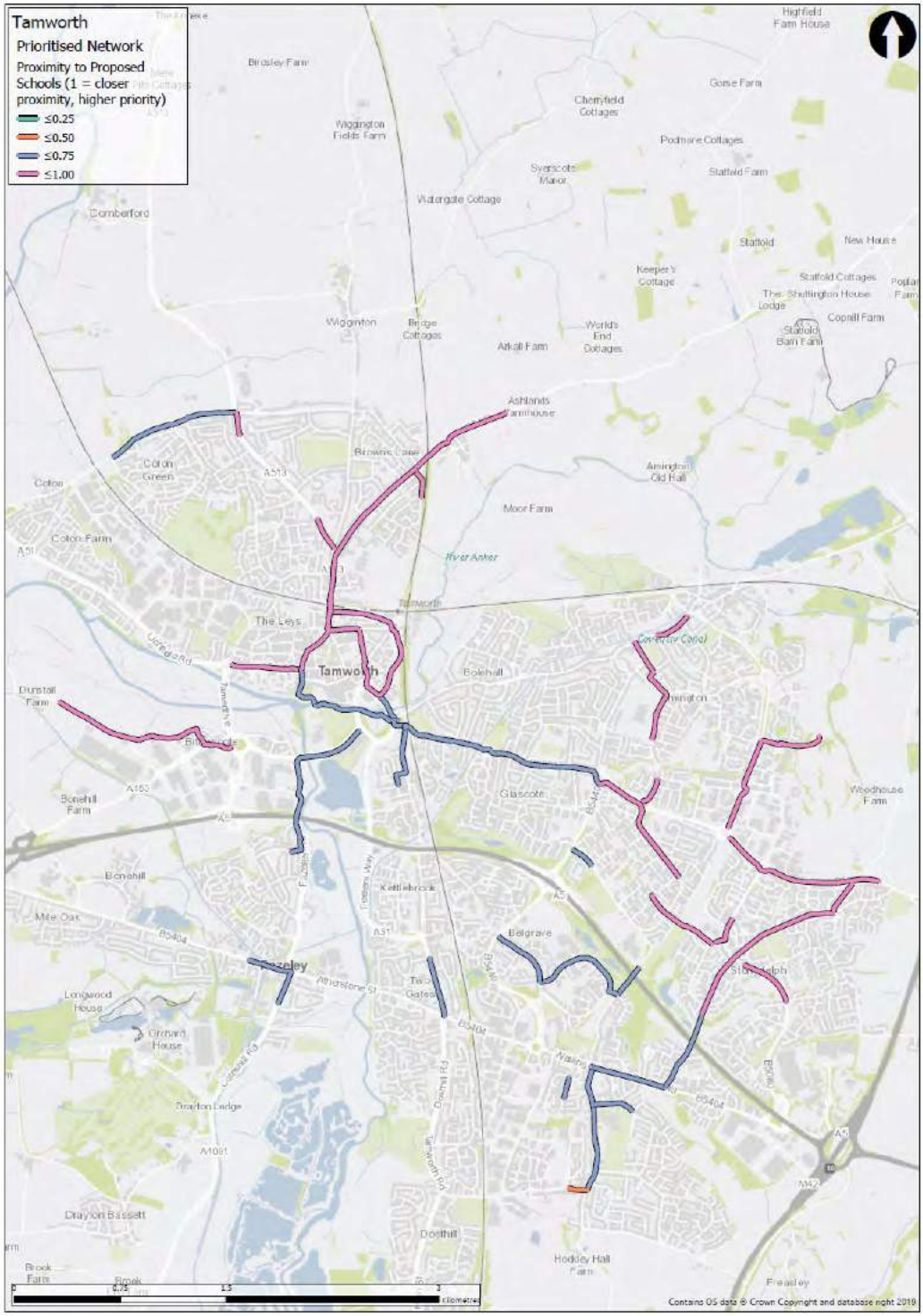
Tamworth – Existing Cycle Trips (2011 Census Journey to Work)



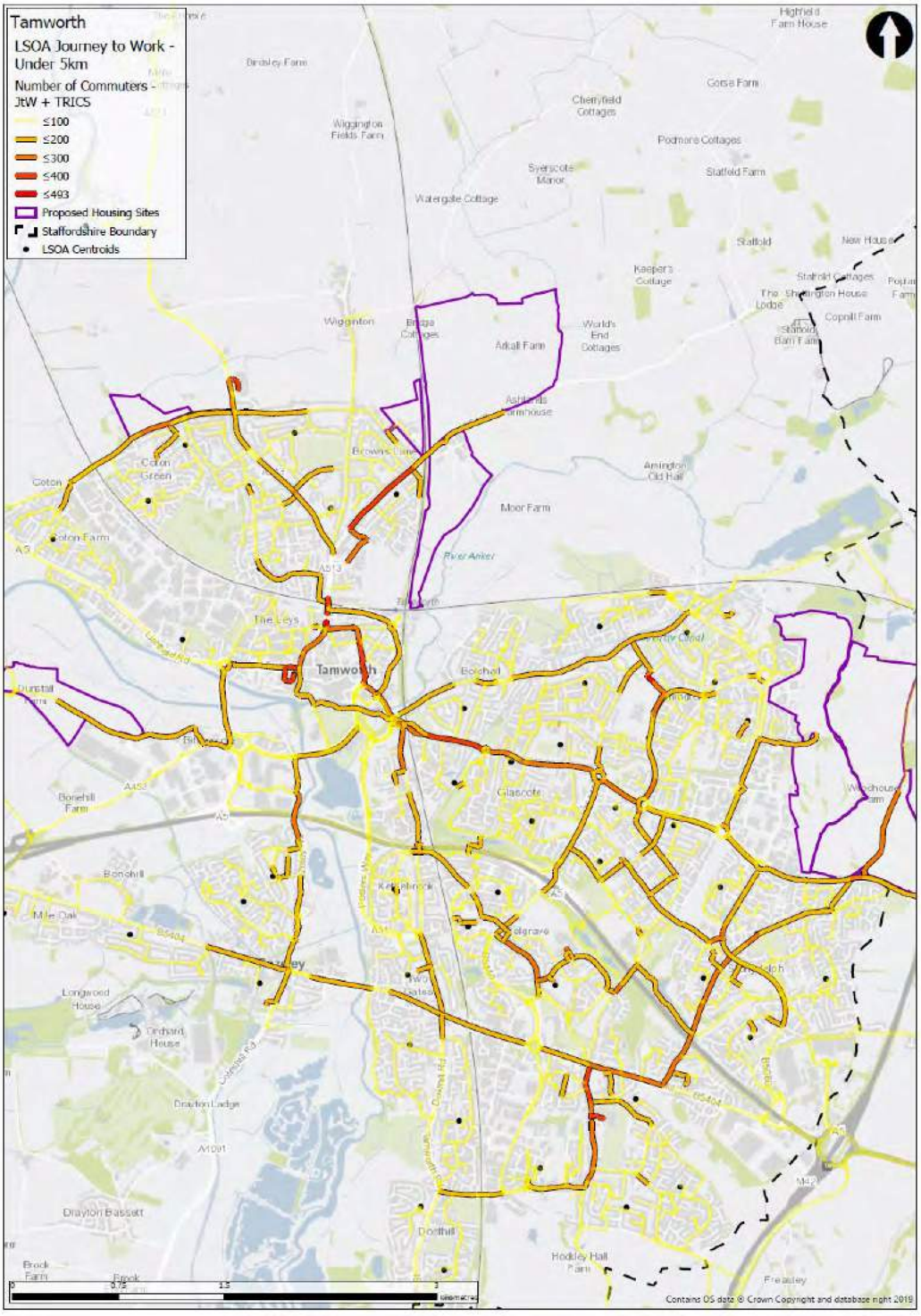
Tamworth – Existing Walk Trips (2011 Census Journey to Work)



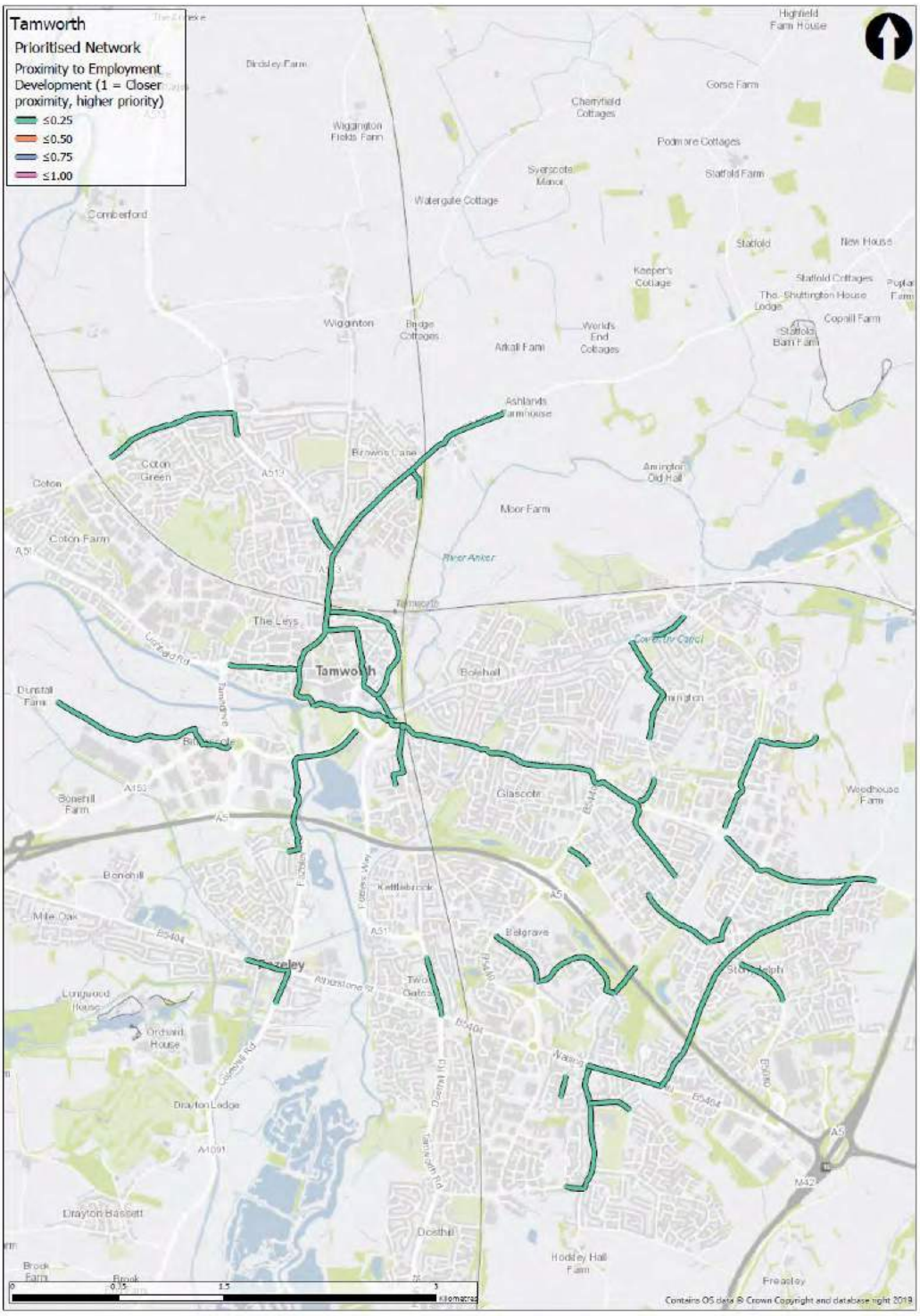
Tamworth –School Proximity (prioritised)



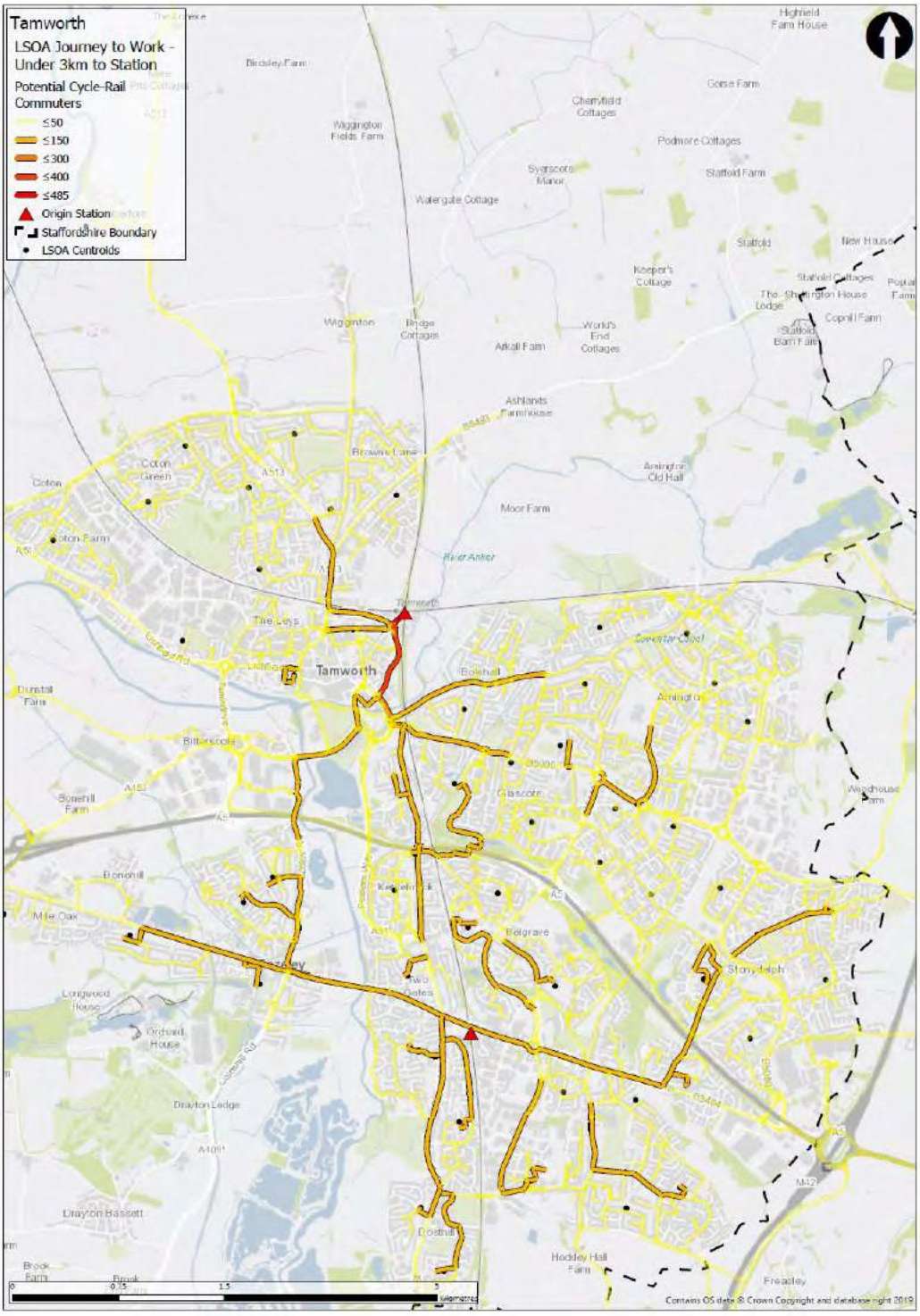
Tamworth – Housing Development Sites



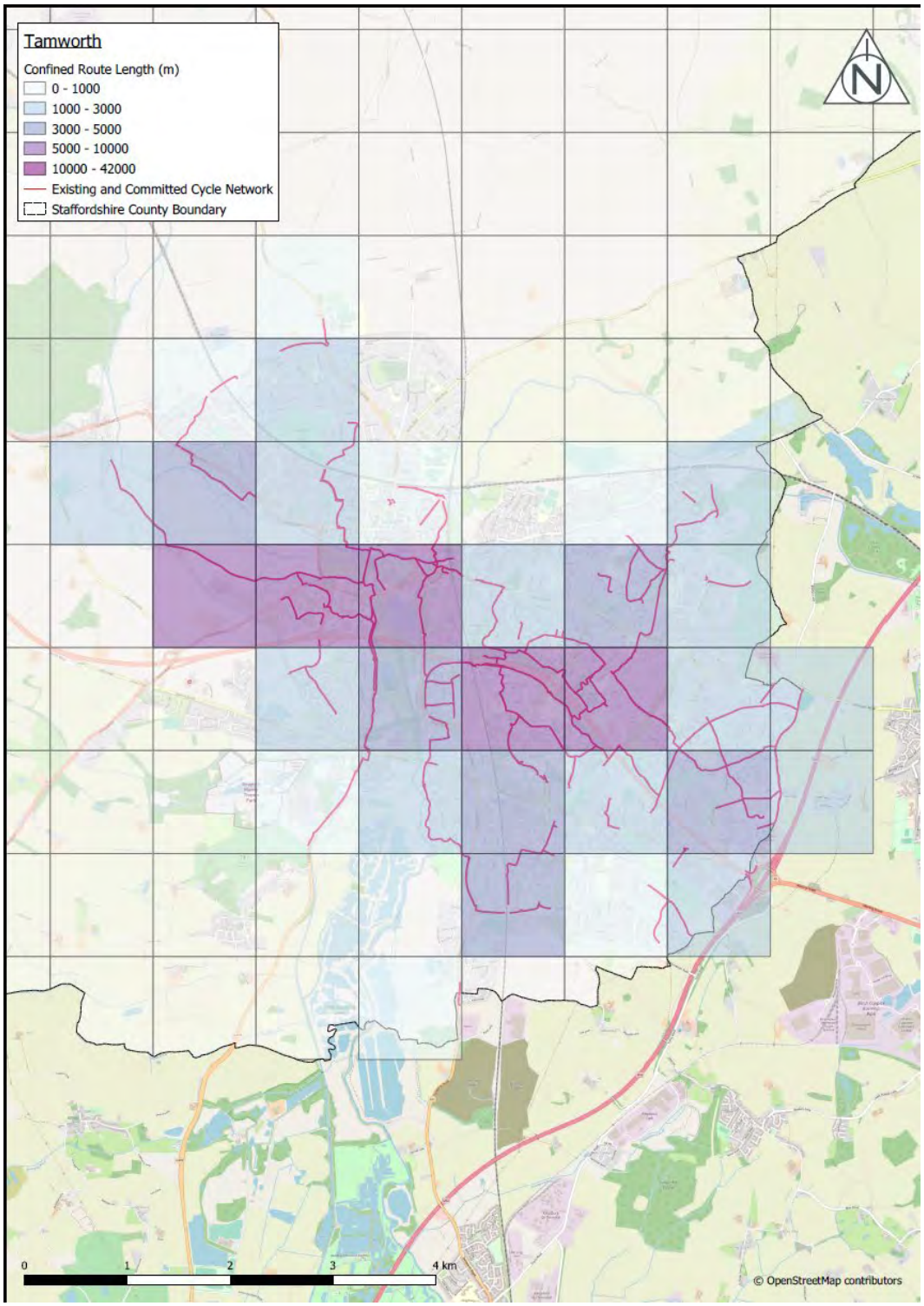
Tamworth – Proximity to Employment (prioritised)



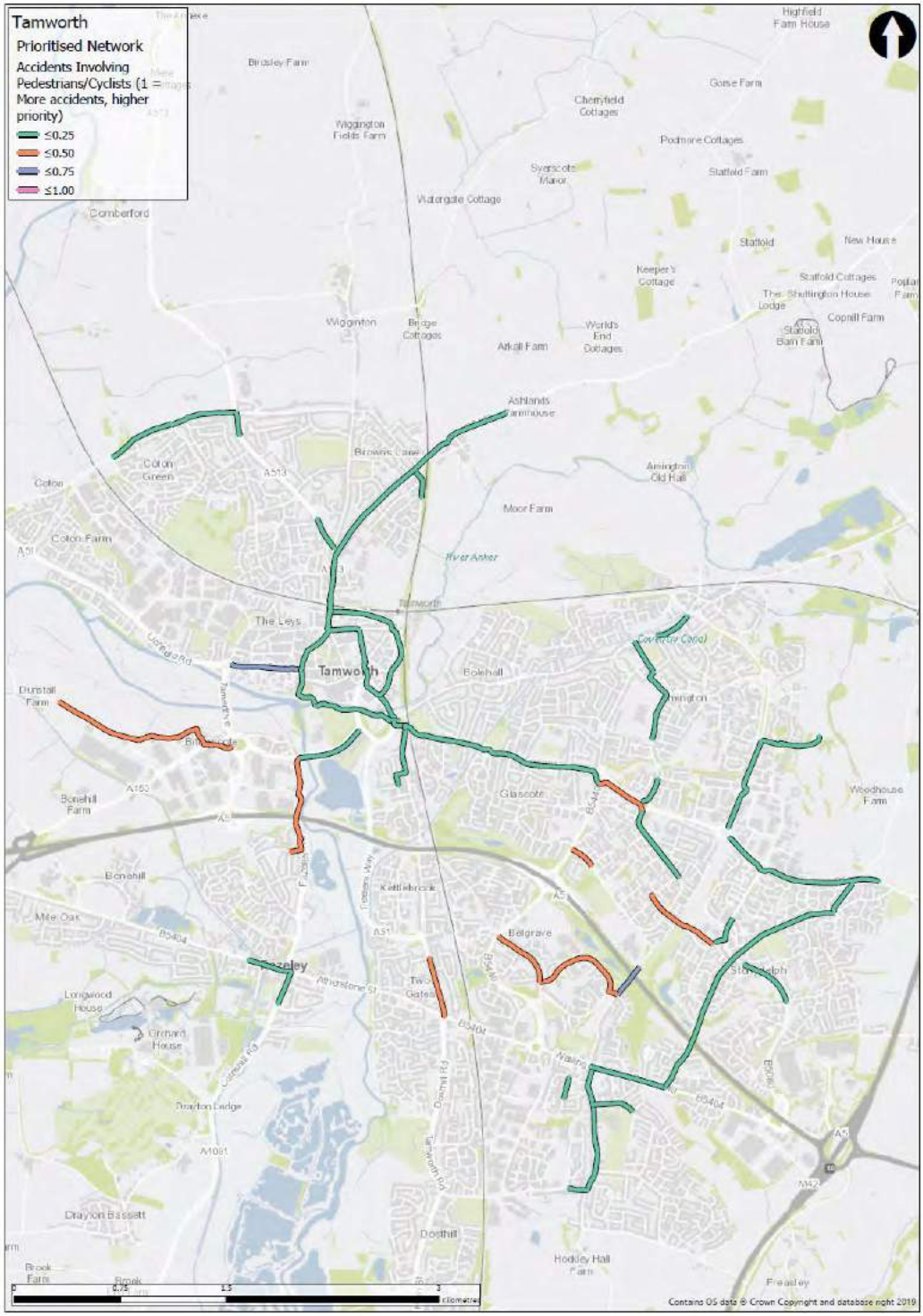
Tamworth - Cycle Rail



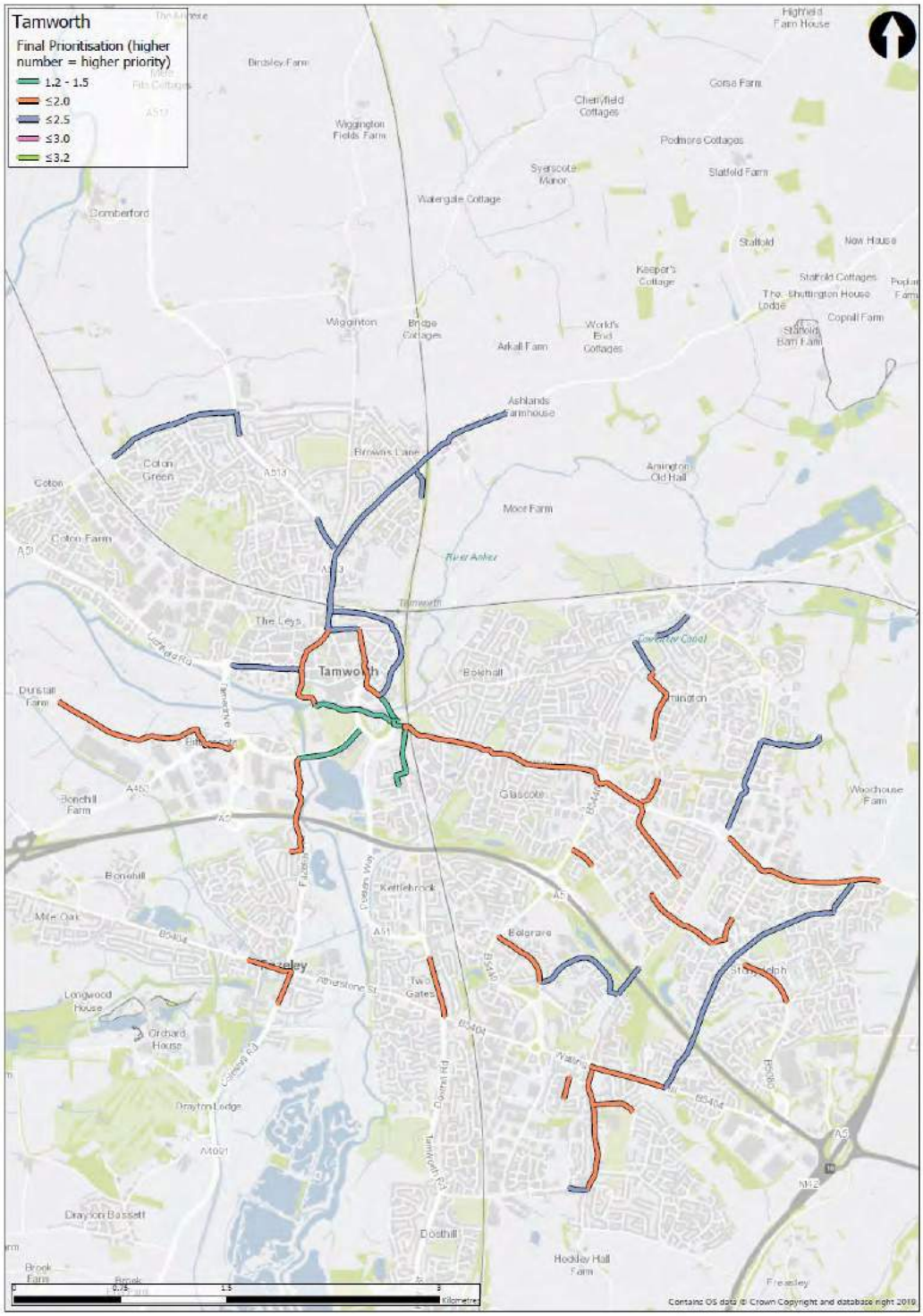
Tamworth – Network Density (including committed routes)



Tamworth - Personal Injury Accidents (prioritised)

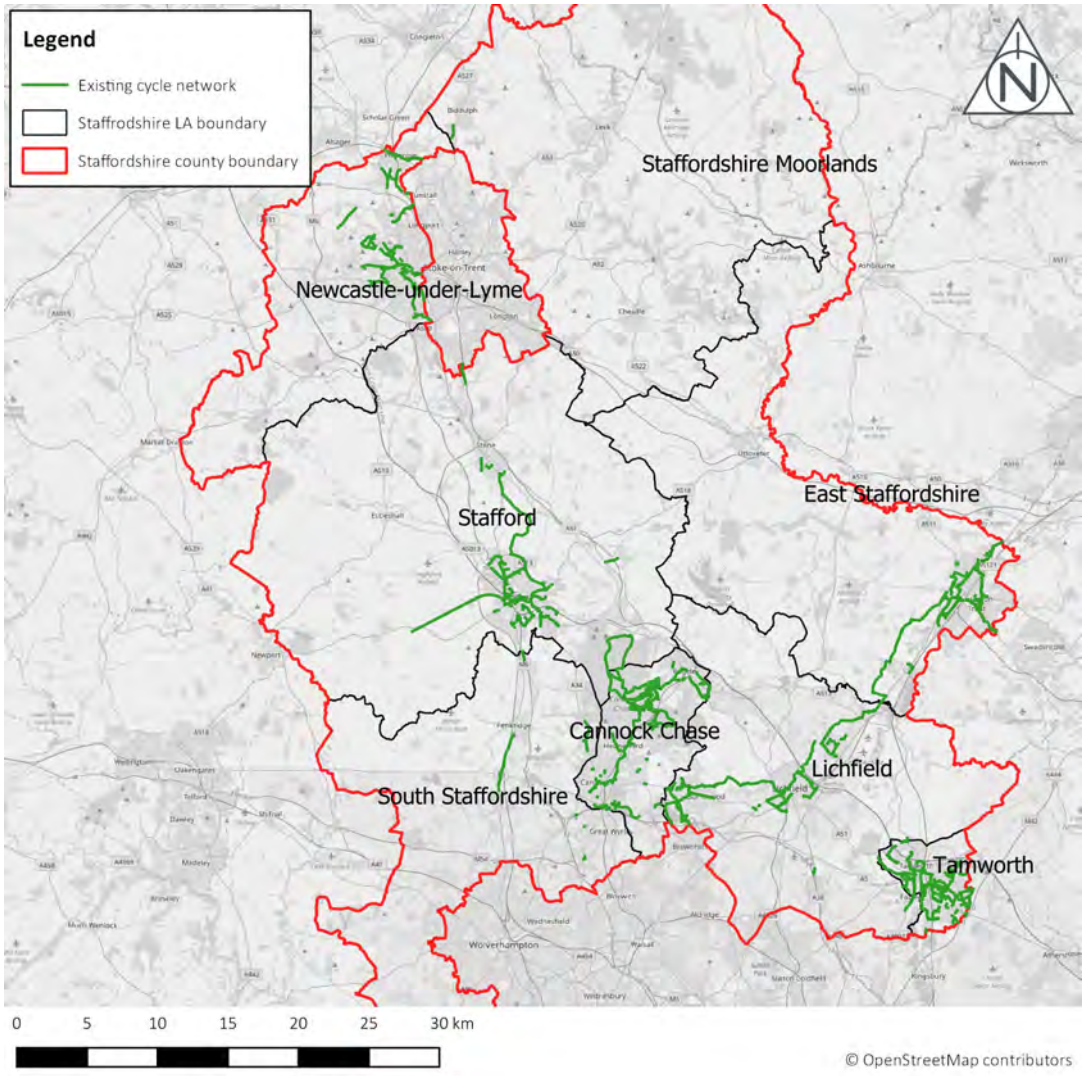


Tamworth – Final Network Prioritisation

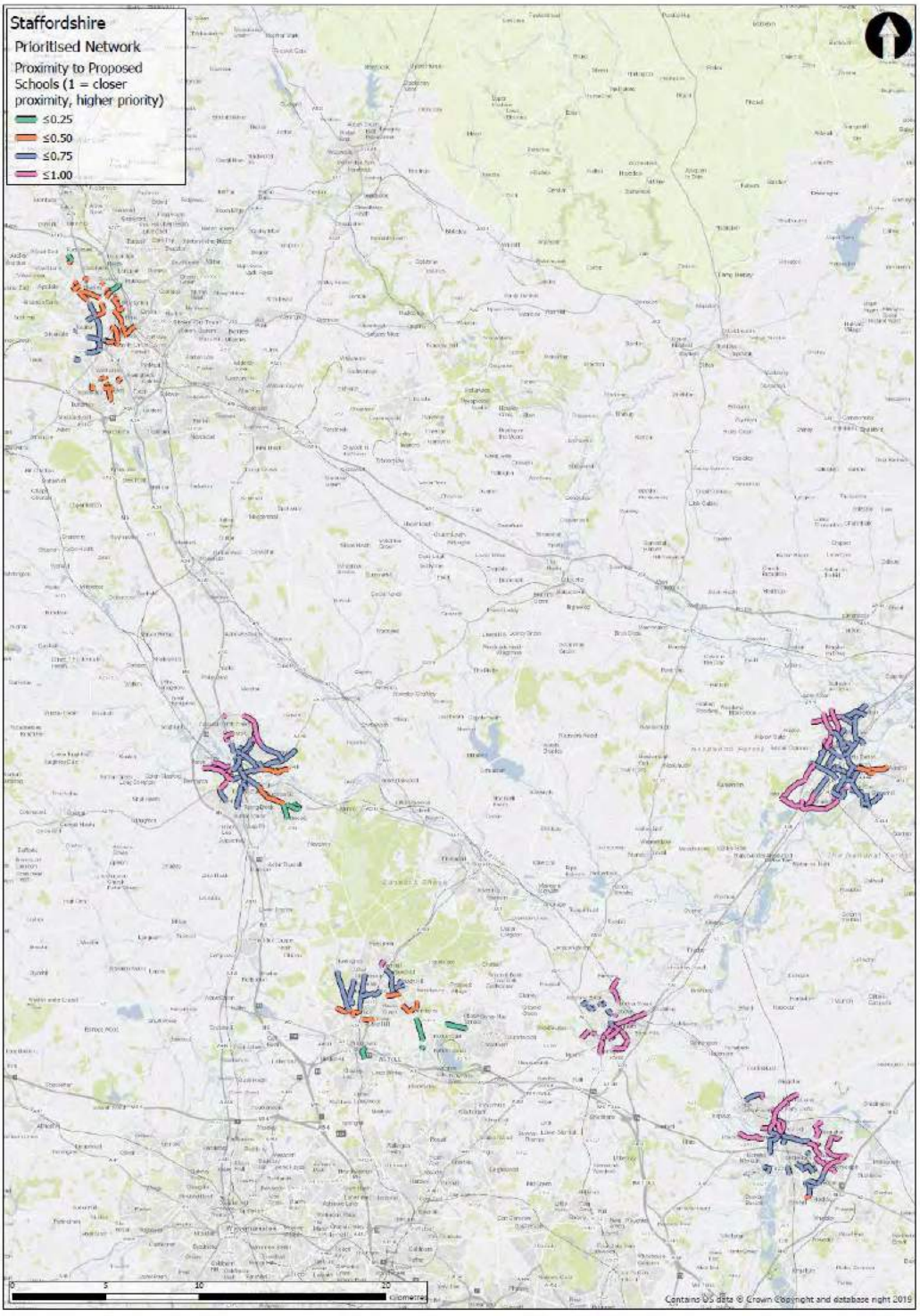


Appendix B County Level Outputs

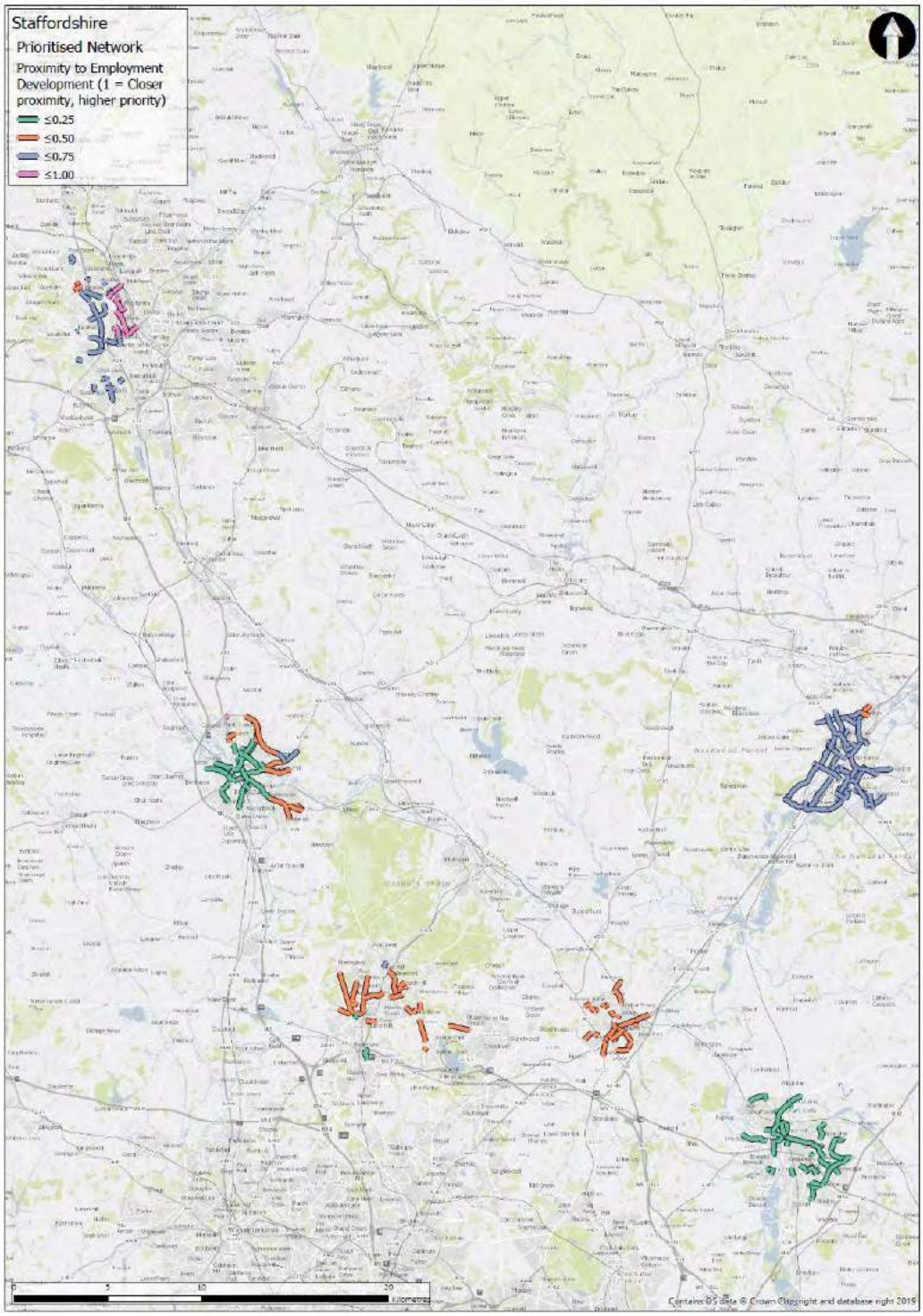
Staffordshire – Existing Cycle Route Network



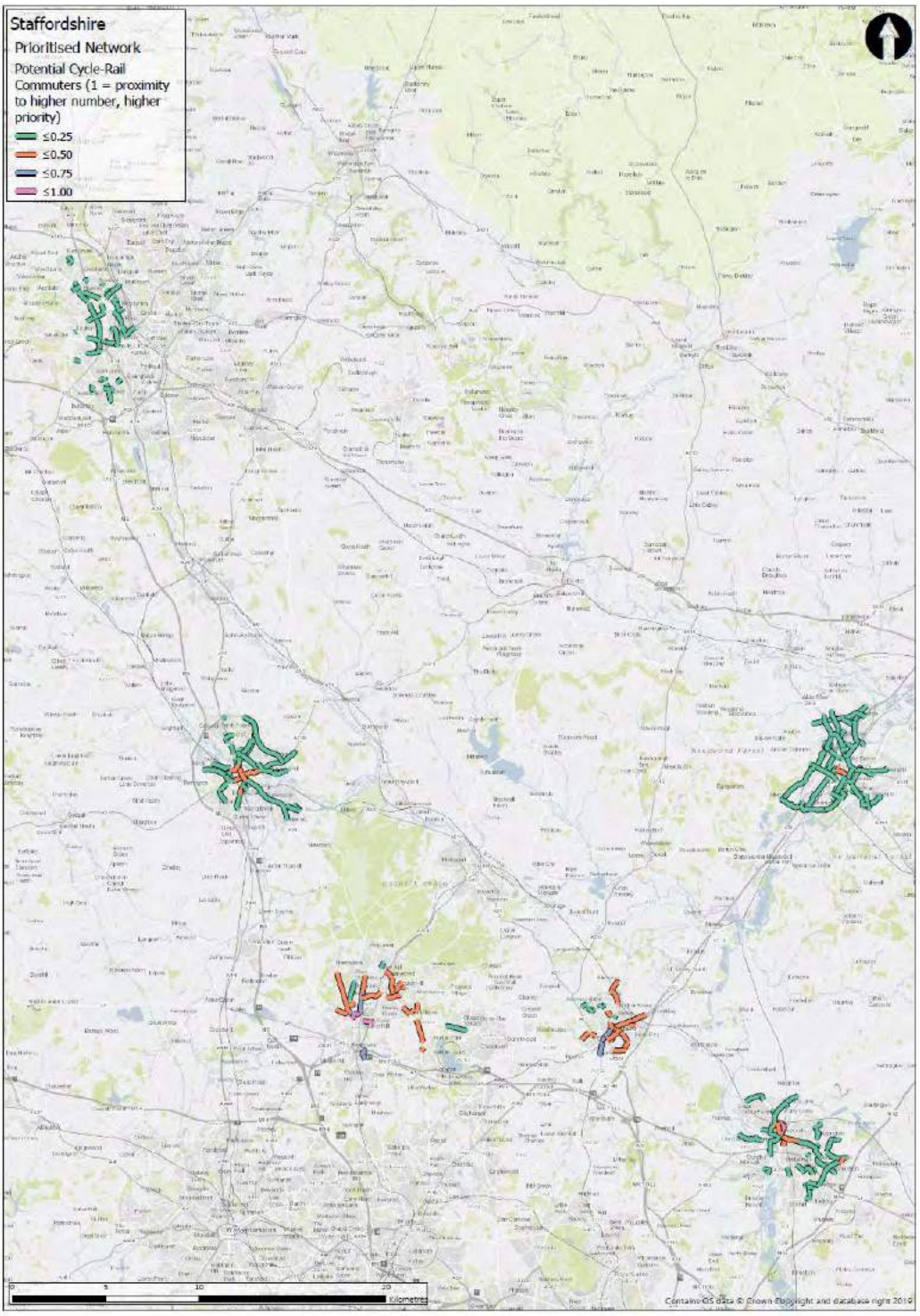
Staffordshire – Schools Proximity (prioritised)



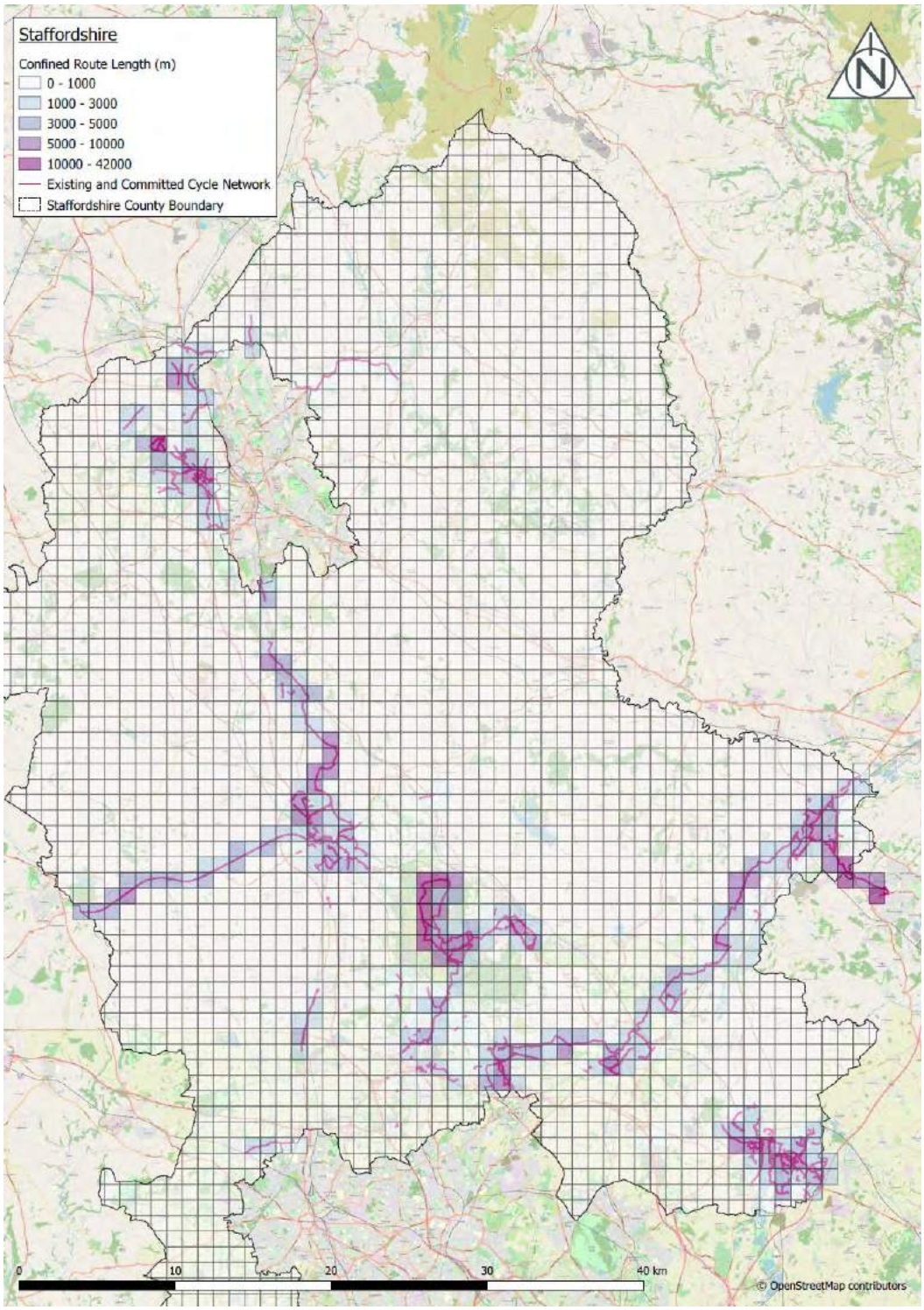
Staffordshire – Employment Development (prioritised)



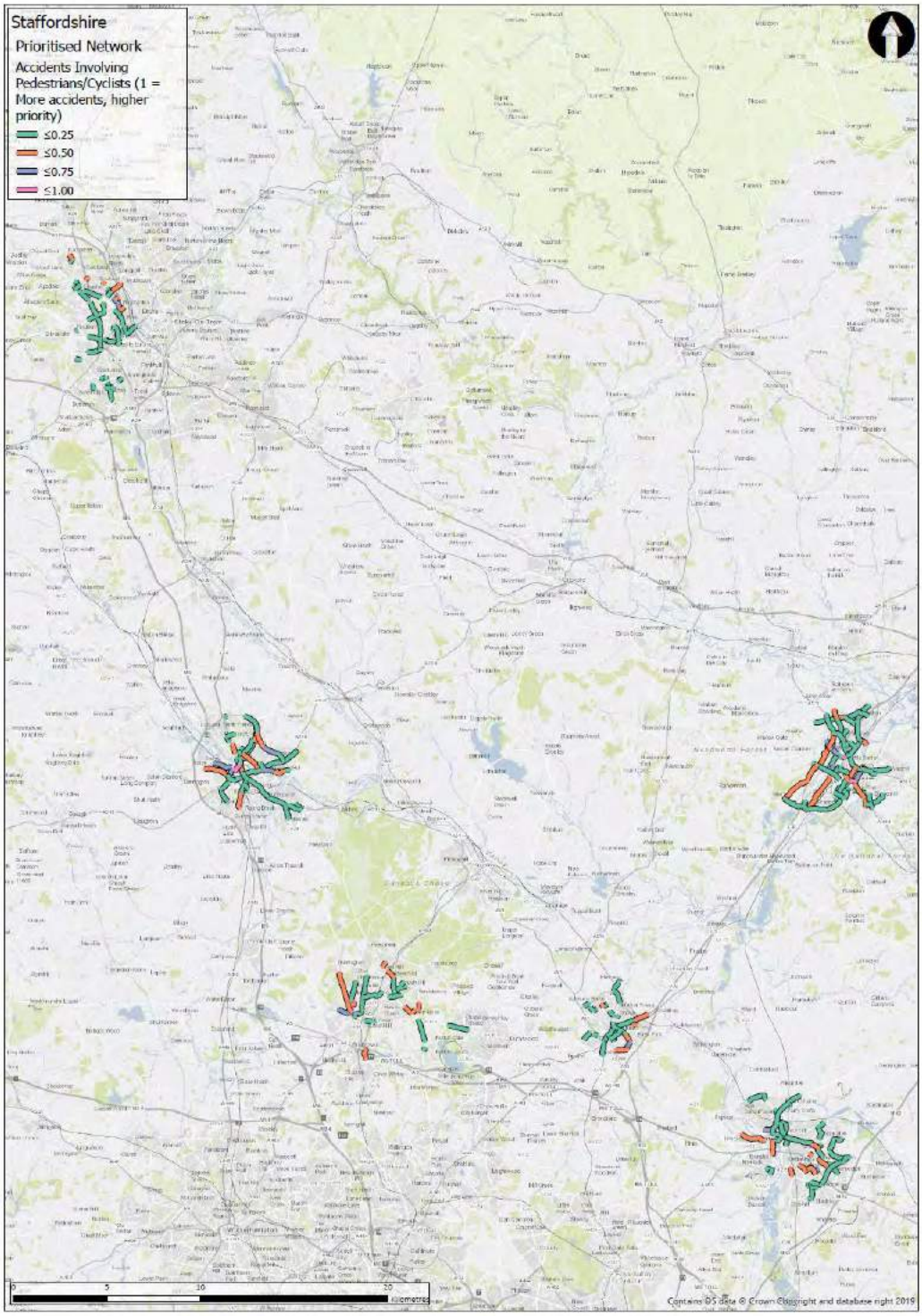
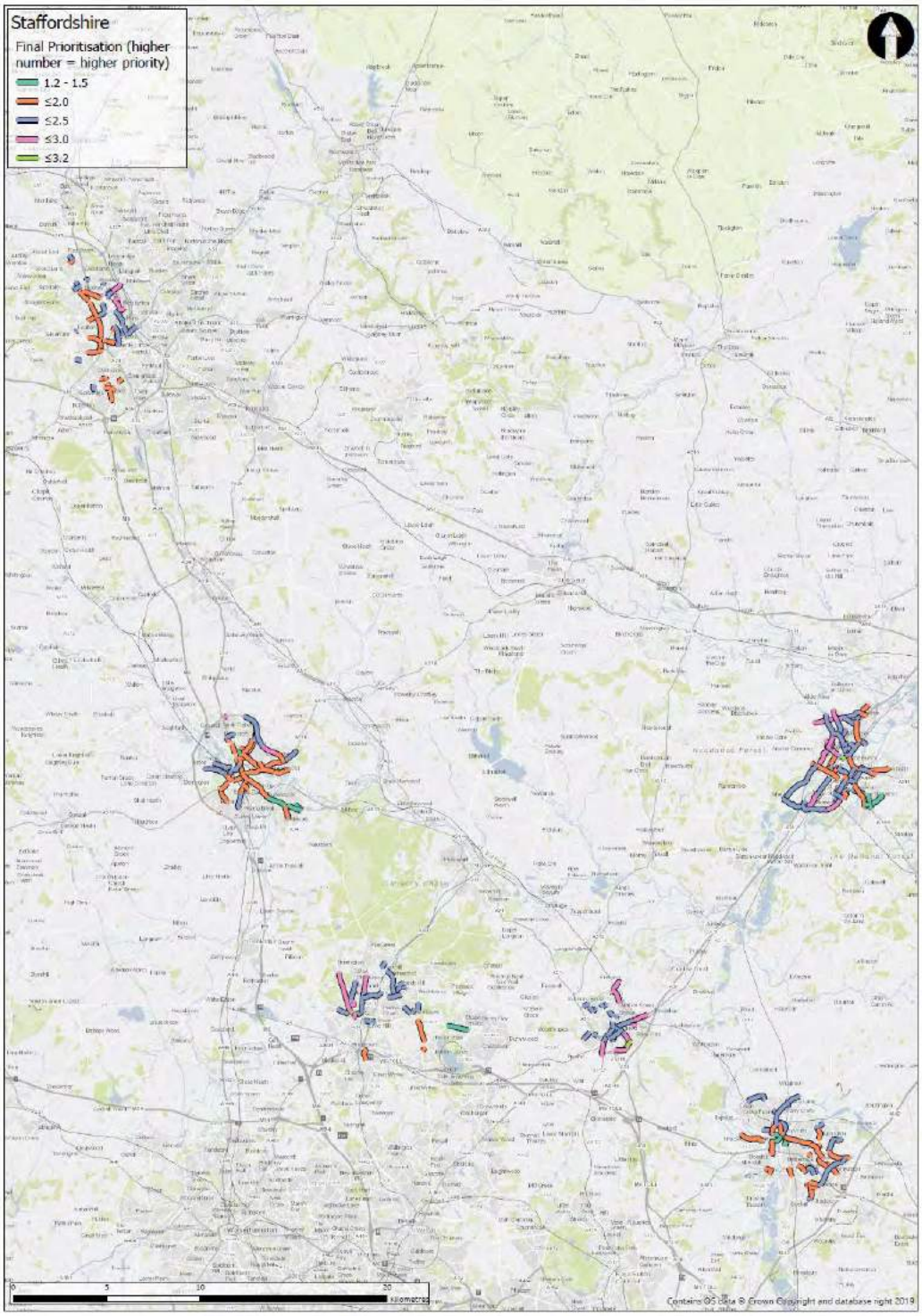
Staffordshire - Cycle Rail (prioritised)



Staffordshire – Network Density



Staffordshire - Personal Injury Accidents (prioritised)



Staffordshire – Final Prioritisation