ATF Evaluation Baseline Report

Baseline Report for the Active Travel Fund Tranche 2 evaluation

On behalf of the Department for Transport

transport for quality of life
UNIVERSITY OF WESTMINSTER
sustrans
UWE Bristol University of the West of England

Version number

Final [v8.0]

Issued July 2023

Citation

This document was produced by the University of Westminster with Sustrans and Transport for Quality of Life, for the Department for Transport.

The preferred citation is: Aldred, R., Furlong, J., Dennis, S., Goodman, A., Sloman, L.(2023) *Active Travel Fund Evaluation baseline report.* Report to Department for Transport.

Disclaimer

Acknowledgements

We would like to thank all those who have helped with this research, including local authority officers and councillors, and colleagues at Department for Transport.

Contents

Figures

Tables

Glossary of specialist terms and acronyms

Term	Definition
Active Travel England or ATE	Active Travel England is the government's executive agency responsible for making walking, wheeling and cycling the preferred choice for everyone to get around in England
Active Travel Fund or ATF	A funding stream through which local authorities in England have bid to support active travel infrastructure from 2020 onwards
Capability Fund	Supports English local authorities outside London to develop infrastructure plans and to carry out 'behaviour change' activities such as training and promotion
Capital Funding	Funding to create or purchase an asset, in this context referring to funding to build active travel infrastructure
Emergency Active Travel Fund or EATF	The first tranche of the Active Travel Fund, also referred to as ATF Tranche 1
ETRO or Experimental Traffic Regulation Order	A type of TRO used to trial new infrastructure, through a monitoring period of up to 18 months
Greenway	An active travel route that is away from motor traffic, for instance, along a river or through a park
Local Cycling and Walking Infrastructure Plan or LCWIP	A document produced by an English local authority incorporating a plan of the desired walking and cycling network and a programme of future improvements, over around a 10-year period
Local Transport Note 1/20 or LTN 1/20	England's national cycle infrastructure design guidance used to assess funding bids and review designs
Local Transport Plan or LTP	A forward-looking statutory plan usually produced every five years by English transport authorities for the Department for Transport
Low Traffic Neighbourhood or LTN (*see note below table)	A type of transport scheme seeking to remove or substantially reduce through motor traffic from an area or neighbourhood
Machine learning sensors	Cameras that continuously count different users/vehicles passing a countline (e.g. pedestrians, cyclists, cars, motorcycles) through in-camera machine learning algorithms. Data is analysed in-situ meaning that no personal data needs to be stored
Protected characteristics	Nine characteristics (e.g. race) protected by the Equality Act. It is illegal to discriminate against people with these characteristics, and the Act creates duties on public bodies to advance equality relating to the characteristics
Protected cycle track	A cycle track physically separated from motor traffic and from pedestrians, e.g. by a kerb
Revenue funding	Funding provided for activities such as training and day-to-day running costs, rather than capital items. In

	the context of active travel promotion this may include employing public engagement officers
Route User Intercept Survey	A survey of users of a particular route or piece of infrastructure, which often asks about the mode that active travel is replacing for the journey being undertaken in order to estimate change in usage associated with the scheme
School Street	A scheme restricting most motor traffic from the area immediately surrounding a school, at school opening and closing times, during term time
TRO or Traffic Regulation Order	A legal mechanism by which local authorities can make changes to how roads are designed and operated

*A note on terminology: In ATF tranche 2, traffic reduction schemes were often referred to as LTNs and this terminology continues to be used in some contexts, e.g. some London boroughs. In the current ATF tranche 4 scheme typologies, this term is not used. In ATF tranche 4, LTNs are termed a type of ‘area-wide traffic management scheme’ (the new terminology used by Active Travel England) which involve area-wide through traffic filtering at neighbourhood level, high street or urban centre. However, the schemes that are being discussed in this baseline report predate this new terminology. They are locally referred to by different names, such as LTNs or active neighbourhoods.

Executive summary

About the Report

This is the baseline report produced by the LTRA (Local Transport and Regional Analysis) consortium which was funded to conduct the Active Travel Fund (ATF) evaluation, looking at ATF Tranche 2 and elements of the Emergency ATF (Tranche 1). The LTRA consortium consists of University of the West of England, University of Westminster, Transport for Quality of Life, and Sustrans, and conducts a portfolio of projects. Within that, this project is led by University of Westminster.

The evaluation focuses on a sub-set of schemes taking a thematic approach, rather than covering everything. The main themes are cycle tracks and area wide traffic reduction schemes, with a lighter touch look at School Streets. The evaluation uses mixed methods, with quantitative analysis of secondary data and new data collected by authorities, and a qualitative focus on processes of planning and implementation (reported in separate process evaluation reports).

The quantitative approach includes use of quasi-experimental methods to compare intervention and control areas, so that changes due to an intervention can be separated from background changes such as increased cycling due to better weather. Combining count data (from sensors or more traditional counters) with user surveys will allow the estimation of completely new uptake due to the interventions (as opposed to people changing their route to take advantage of better infrastructure). New uptake can then be used to estimate health and carbon impacts of that type of infrastructure. Other quantitative analysis conducted will use secondary datasets such as road injury data and car ownership data, and data from Google API providing journey speed and time data.

Key Messages

Cycle tracks scheme data and analysis

The research team has identified 10 cycle track schemes and worked with partner authorities to identify control and intervention counter locations. There remains some uncertainty about changes to the nature and implementation date for one scheme, and delays in data collection and provision related to delays in scheme construction. However, the team is confident overall of being able to collect sufficient data to answer research questions for this theme, which are on impacts on cycling flows, mode shift/diversion of trips, and related health economic impacts. These schemes are all in England outside London providing useful data outside the generally more-often studied capital.

LTN scheme data and analysis

Despite problems linked to scheme delays, cancellations, and changes, there are at present 15 LTN schemes provisionally included in the evaluation. It is expected that only 10 will be included in the final report, due to some being cancelled or so delayed or changed that they cannot be included. There are generally well-matched control areas with good demographic similarity. Similarities between LTN and control areas give confidence in a robust comparison, so that when schemes are implemented, there should be sufficient good quality baseline data to evaluate impacts on walking and cycling, and hence, health economic impacts. Unfortunately, due to scheme delays and cancellations particularly affecting authorities outside London, this data is likely to be skewed to London schemes.

In addition to measuring changes in walking and cycling, the LTN theme analysis will use Google API data on journey speeds and times to explore impacts on boundary roads and potential disbenefits for car users. This makes use of Google's live traffic data that can be used to evaluate impacts of LTN schemes on car users and on roads around the boundary of the scheme, both immediately and in the short and longer term. Initial analysis of baseline data shows that the LTN and control sites are generally well-matched in terms of traffic speeds on boundary roads. An initial analysis of data from one LTN presented in this report provides an example of the type of analysis that can be undertaken with this data. The Google API data will, in future reporting, also be used to explore changes in car journey times to important local destinations. While the analysis will not seek to monetise these impacts, any changes in boundary road speeds or car journey times will be quantified for discussion alongside other impacts of LTNs.

This report explores the potential for analysing the impact of LTN schemes on injuries and car ownership using secondary data provided by DfT and DVLA. Initial analyses suggest that LTN and control areas are sufficiently well matched in prior trends to undertake such analysis. However, the data release timetables, and scheme delays and cancellations, mean there may be insufficient post-opening data and hence insufficient statistical power to identify modest changes in these variables during this evaluation.

School Streets data and analysis

The team has obtained data on School Streets already implemented in London, and provisionally on School Streets implemented outside London (pending confirmation that schemes were introduced as planned). The distribution of existing or planned schemes shows an unequal spatial distribution, with most authorities introducing few or no School Streets, and others introducing them for a substantial proportion of schools. The final report will present analysis of the implementation of School Streets relative to the proportion of pupils receiving Free School Meals at the school (as a proxy measure of deprivation) and compare patterns in London and outside London. The team will also seek to conduct an injury analysis through the same methods used to study impacts of LTNs on road injuries, but in this case using a buffer around the school in question.

Process evaluation data and analysis

The team has successfully collected, analysed, and written up data from the first stage process evaluation (ATF Evaluation: Process Evaluation Report Stage 1, 2023). Data from the second stage process evaluation is being collected, analysed, and written up during 2023. Conclusions from both process evaluations will be used to contextualise and deepen the understanding of the results of quantitative analysis to be described in final reporting.

Quantifying costs and benefits of cycle track and LTN schemes

The team has established the processes to estimate changes in levels of active travel, and hence the estimation of cycle track and LTN scheme health economic impacts (using DfT's Active Mode Appraisal Tool). The estimation process will use count and sensor data and estimates of mode replacement from Route User Intercept Surveys. Based on other literature (e.g. the systematic review of health impacts by Mueller et al[1]), the team hypothesises potentially large physical activity benefits. Where other impacts look likely to be significant and can be monetised based on available data, the team will seek to incorporate these within the assessment. They will also estimate typical costs of cycle track and LTN schemes, which can then be compared with the benefits.

[1] https://www.sciencedirect.com/science/article/pii/S0091743515001164

1. Introduction

This chapter draws on the ATF Evaluation framework to:

- Outline the structure of the report.
- Explain what the Active Travel Fund is and what is being evaluated.
- Describe the thematic approach to the evaluation.
- Outline the 4 themes covered in the evaluation.
- List the 9 research questions.

1.1. Structure of the Report

This **Chapter (1)** contains an introduction, explaining what the ATF is and what the evaluation covers. **Chapter 2** explains what is provided in this report and what will be provided in the final report in 2024. It gives some detail on research methods, although more is provided in individual chapters. **Chapter 3** explains the cycle track schemes studied, including brief description of the context and cases, methods, and some baseline data analysis. **Chapter 4** covers the area-wide traffic reduction schemes or Low Traffic Neighbourhoods (LTNs) studied, including some analysis of baseline count data. It additionally conducts some baseline and pre-post analysis of data on traffic speeds on LTN boundary roads, including an exploratory case study where some 'post' data already exists. Chapter 5 also provides some baseline analysis of secondary datasets on injury and car ownership related to LTN and control areas. **Chapter 5** provides some information on School Streets introduction in and outside London, including a map of London schemes, and provides information on the analysis to be conducted in the final report. **Chapter 6** summarises key points from the baseline report and outlines the next steps to be taken between the finalisation of this report and the production of the final report. An **Appendix** split into two sections provides more methodological detail, more detailed information about the cycle track and LTN case study sites, and more results tables.

1.2. What is the Active Travel Fund?

The Active Travel Fund (ATF) is a funding programme to which English local authorities could bid for cycling and walking infrastructure and associated projects. It was initially announced by the Secretary of State for Transport on 23 May 2020 as part of work to help deal with some effects of the COVID-19 pandemic: https://www.gov.uk/government/publications/emergency-active-travel-fund-local-transport-authority-allocations

At the time of developing the ATF evaluation framework (August 2021), two tranches had been allocated:

- Tranche 1 (the emergency ATF) supported the installation of temporary projects during the height of the COVID-19 pandemic, including footway widening, temporary pedestrianisation or removal of through motor traffic, and pop-up cycle tracks.

- Tranche 2 was described as supporting the creation of longer-term projects, with bids submitted by August 2020 with the aim of implementing schemes during the financial year 2021-22.

Allocations under ATF Tranches 3 and 4 were announced in Autumn 2021 and May 2023 and are being separately evaluated by another consortium for DfT/ATE alongside other parts of the active travel portfolio. In total, funding was just over £40 million in Tranche 1 and just over £175 million in Tranche 2. Funding was allocated to combined and district/unitary authorities.

1.3. Schemes included in the ATF 1 and 2

The Emergency ATF (EATF) – Tranche 1 – focused heavily on temporary and experimental schemes, often using low-cost materials (such as wands for cycle lanes and cones to mark out wider footways). The ATF Tranche 2 contains a wider mix of schemes, although as with the EATF, some schemes are being introduced under experimental traffic orders. Table 1 below provides a general indication of initial local authority plans, sourced from the first DfT monitoring survey conducted in March 2021.The nature and extent of a scheme is defined by the local authorities, so comparisons between types of measure need to be made with care. An additional caveat is that some schemes have since been delayed, changed, or cancelled. Note that authorities defined schemes in different ways: for instance, a ‘Town Centre’ scheme might cover a range of measures and neighbourhoods.

Table 1: Measures reported in first Pulse Survey of local authority plans for ATF Tranche 2

	Number of schemes involving this type of intervention
New segregated cycle track (permanent)	94
Upgrades to existing facilities (e.g. surfacing, signage, signals)	79
New road crossings	60
Low Traffic Neighbourhood / selective road closures	57
New shared use facilities	50
Traffic calming (e.g. lane closures, reducing speed limits)	50
Provision of secure cycle parking facilities	42
Installing segregation to make an existing cycle route safer	39
Restriction or reduction of parking availability	37
Widening existing footway	35
School streets	24
New permanent footway	20
Bus priority measures at single locations (e.g. bus gates)	12
New segregated cycle track (temporary)	9
E-scooter trial and/or e-scooter facilities	7
New temporary footway	5
Park and cycle/stride facilities	5
Bus priority corridor measures (e.g. bus lanes, bus only streets)	4

Note that Active Travel England is now using a different taxonomy for later versions of the Active Travel Fund; however, Table 1 reflects the taxonomy used to classify and monitor ATF2 schemes.

1.4. A Thematic Approach to the National Evaluation

This National Evaluation offers an opportunity to go beyond individual schemes or authorities and draw wider conclusions about types of intervention. Drawing such conclusions necessitates the use of standardised data, which may not otherwise be gathered by authorities in a format allowing easy comparison.

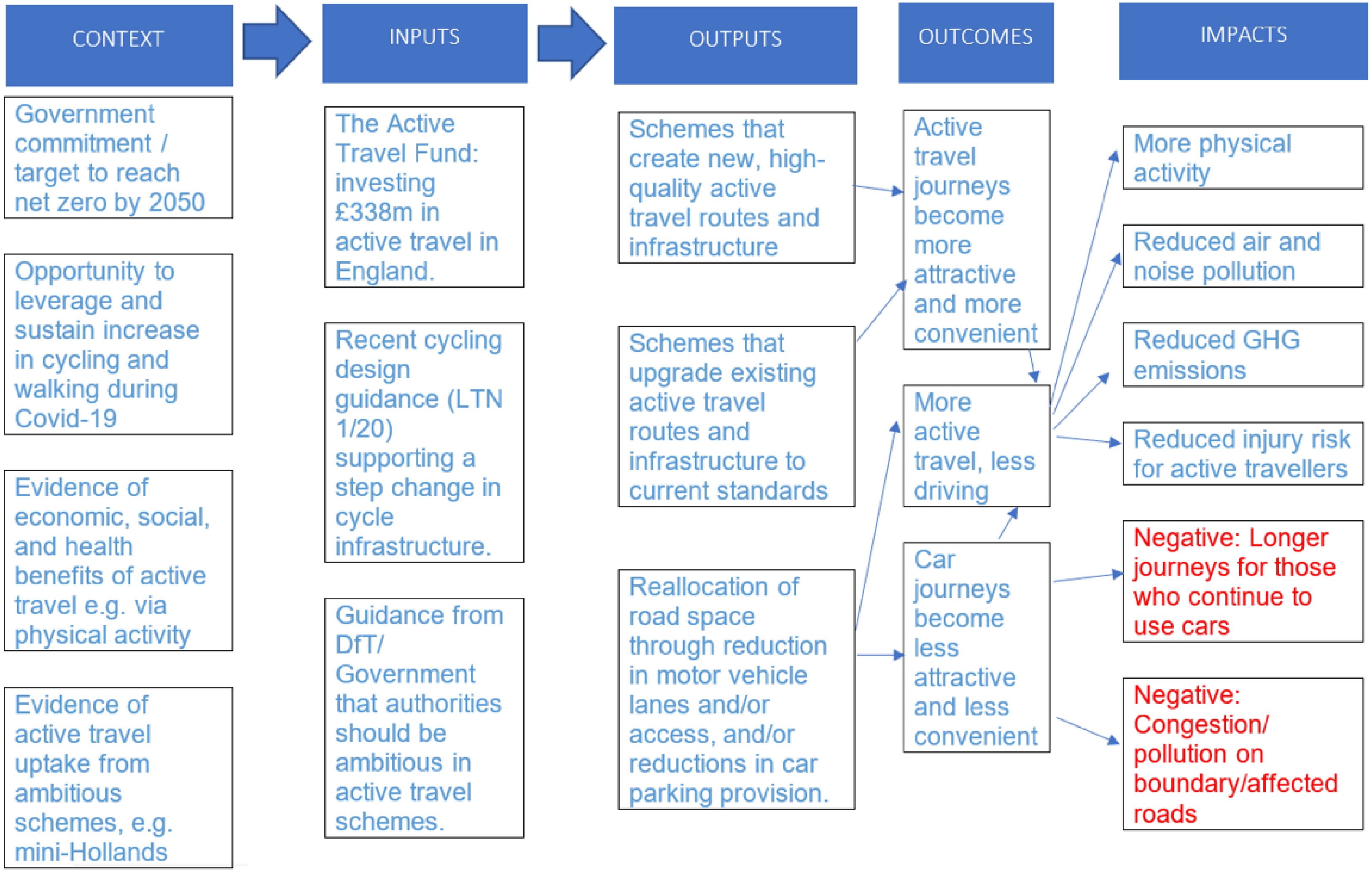
The National Evaluation includes three major and one light-touch theme. Of four themes, two are intervention-based (cycle tracks, area-wide traffic reduction, plus a light-touch investigation of School Streets), while the other is cross-cutting (implementation of interventions, or a process evaluation[2]). An intervention-based approach involved identifying the characteristics of the most potentially transformative types of interventions. However, the approach needs supplementing because it cannot answer qualitative questions about the implementation of the intervention relating to planning, consultation, engagement, design and/or delivery. Hence the need for the process evaluation.

Tranche 1 measures were temporary, intended to be put in place at speed and trialled while in-situ. For Tranche 2, authorities had more time to design proposed interventions which were intended to be permanent schemes. They were required to consult, or confirm they had already consulted, local stakeholders as a condition of receiving funding, and adapt their plans to account for responses to this consultation. The process evaluation (see ATF Evaluation: Process Evaluation Report Stage 1, 2023) seeks to understand the design, consultation, and delivery process to learn lessons about good practice and barriers to and enablers of delivery.

Figure 1 provides a logic map which charts the linkages from the context of the interventions through the inputs to the outputs, outcomes and impacts of the interventions. It also shows potential negative consequences.

[2] Public Health England, https://www.gov.uk/government/publications/evaluation-in-health-and-well-being-overview/process-evaluation, (2018)

Figure 1: Outline Logic Map, showing pathways to positive impacts and potential unintended or negative consequences



Theme 1: LTN/Area-Wide Traffic Reduction Theme

The first theme to be covered within the National Evaluation is that of Area-Wide Traffic Reduction schemes, often called low-traffic neighbourhoods or LTNs. For clarity, this acronym will be used here, although local authorities use different brand names to refer to these types of schemes, for instance 'active neighbourhood', and as noted earlier, newer traffic reduction schemes may not now be called LTNs at all.

LTNs are transport interventions that remove or substantially reduce through motor traffic from residential streets. LTNs restrict motor vehicles by using 'modal filters' (i.e. 'filtering out' some but not all types of traffic), which may be physical barriers (e.g. planters) or camera-enforced no entry points (e.g. to accommodate bus routes). All homes, shops and other destinations can be reached by car, but people cannot drive through the area from one main road to another.

Area-wide traffic reduction schemes are being implemented across the country, with 4% of London's population covered by LTNs introduced between March and September 2020[3], with other parts of London and the UK later introducing some such schemes. These schemes have design precedents in, for instance, 'garden city' planning and the planning of post-war public and private estate housing in the UK and many other countries, as well as typical town planning approaches in the Netherlands.

Emerging evidence from London indicates the potential for these schemes to bring benefits, but this evidence base is limited by these types of interventions being relatively novel where they are retrofitted to existing streets, rather than being a wider town planning principle implemented from the start. There is a need to extend the evidence base regarding the impacts of LTNs, to provide national and local policymakers and practitioners with robust evidence to inform their decision making.

[3] Aldred et al., https://www.sciencedirect.com/science/article/pii/S0966692321002477 (2021)

Theme 2: Cycle Track Theme

Public desire for safer cycling infrastructure has been demonstrated by the National Travel Attitudes Study (NTAS) Wave 5[4] which asked respondents what might encourage them to cycle more. Off-road and physically separated cycle-paths (55%) and safer roads (53%) were both mentioned by more than half of the sample.

The Cycle City Ambition (CCA)[5] programme provided 8 major cities with DfT funding between 2013 and 2018 to provide cycling infrastructure improvements. Of the 12 schemes that were monitored 8 showed marked increases in cycling flows that were highly likely or likely attributable to the CCA programme. The schemes of highest quality had the highest impact and schemes which were less ambitious showed less impact. 'Light' protection from motor traffic for example was less effective than 'full' protection for encouraging cycling uplift.

The Government's first Cycling and Walking Investment Strategy (CWIS1) 2017[6] outlined the ambition to double cycling stages by 2025 by making walking and cycling the natural choice for short journeys, with the further objective to make walking and cycling accessible to all by 2040. The strategy places a strong emphasis on making roads and active travel infrastructure safe enough for this to be possible. Many local authorities began creating Local Cycling and Walking Infrastructure Plans[7] (LCWIP) which focus on identifying and mapping cycling networks and core walking zones prioritised for enhancement.

Most of those authorities involved in the Cycle Track element of the evaluation have identified an LCWIP as their starting point for considering schemes to put forward for the bid. The DfT's 'Gear Change: a bold vision for cycling and walking' and 'Cycle Infrastructure Design: Local Transport Note 1/20 (LTN 1/20)[8] guidelines were published in July 2020, a few months into the Covid-19 pandemic. Early evidence of travel behaviour change as a result of Covid-19 was reported in Gear Change and showed that, despite fewer people travelling during the pandemic, cycling increased by as much as 100% on weekdays and 200% at the weekend when initial restrictions had been lifted.

Studying the impact of ATF cycle track schemes presents an opportunity to ensure policy supports longer term change in travel behaviours, post pandemic, by providing routes to facilitate safe, every day, habitual use of active travel. Compared to previous active travel funding programmes, the ATF is supporting a broader

---

[4] Department for Transport, 'National Travel Attitudes Study: Wave 5' (2021)

[5] Department for Transport, 'Summary and Synthesis of Evidence: Cycle City Ambition Programme 2013-2018', (2021).

[6] Department for Transport, Cycling and Walking Investment Strategy, (2017)

[7] Department for Transport, Local Cycling and Walking Infrastructure Plans, (2017)

[8] Department for Transport, Gear Change: a bold vision for cycling and walking, and Cycle Infrastructure Design: Local Transport Note 1/20 (LTN 1/20), (2020)

spectrum of local authorities and more varied types of scheme. This includes, for example, more rural schemes linking small towns to each other and to employment sites. In some areas, new cycle infrastructure is being installed and in other areas schemes are focused on improvements to existing infrastructure (typically, increased physical separation from motor traffic) to make routes safer and more attractive to users. This evaluation will assess how different types of ATF intervention perform and draw on evidence from previous studies like the CCA evaluation to contextualise and interpret the results[9].

The ATF-funded cycle track schemes considered for evaluation contain different types of cycle infrastructure along their length including the following: greenways; on- and off-road fully separated cycle tracks; on-road cycle lanes; light or temporary segregation methods such as plastic kerbs or wands; and in some restricted spaces short lengths of shared route. Many of the schemes also implement methods of controlling motor traffic such as junction improvements; speed-limit reductions; closure of side streets to traffic; bus gates; bus stop by-passes; and the removal of parking bays. The evaluation will seek to gauge the impact of the best or highest quality type of intervention which in most cases is likely to be sections of physically separated cycle track on or adjacent to highway interventions as laid out in section 6.2 of LTN 1/20, as suggested by results from the Cycle City Ambition report. The evaluation will explore whether these types of intervention will create increases in people cycling, and choosing the mode over car use.

[9] DfT, Cycle City Ambition programme: 2013 to 2018 evaluation, (2021)

Theme 3: Implementing interventions

Themes 1 and 2 are particularly important and suitable to be studied as interventions. The alternative would be to monitor change at a district level. However, there are many primarily qualitative questions about implementation processes that will not be captured by measurements such as controlled before-and-after changes in walking. At the heart of the issue lie the challenges related to delivering schemes that create a significant change for active travel. The challenge is creating additional space and/or priority, which may affect another mode[10]. This challenge may lead to the shelving or abandonment of more ambitious measures, particularly where there is a perceived lack of evidence for introducing potentially more controversial schemes[11].

Given the above, the third theme of this evaluation is being addressed through a two-stage process evaluation that will explore implementation processes over the life of schemes. Process evaluations can be used to inform programme design and delivery, and/or to establish the extent to which an intervention was implemented as planned and reached the intended recipients[12]. Frequently, qualitative methods such as interviews and focus groups with stakeholders are used to explore different experiences, facilitators, and barriers at different stages of the process. Data from a process evaluation explains why schemes and programmes might succeed or fail, and how they might be made more implementable, more impactful, and/or more equitable, and how they may potentially deliver better value for money. The results of the two process evaluations will be published in two reports.

[10] Thaller et al., https://www.sciencedirect.com/science/article/pii/S1361920921000201, (2021)

[11] White, Bloyce & Thurston, https://journals.open.tudelft.nl/ejtir/article/view/4364, (2020)

[12] Saunders, Evans & Joshi, https://journals.sagepub.com/doi/pdf/10.1177/1524839904273387, (2005)

Theme 4: School Streets (light-touch theme)

School Streets are interventions which restrict most motor traffic from using one or more streets (or sections of street) during the start and the end of the school day. The need to increase active travel to school and implement further School Streets specifically are referenced in the Cycling and Walking Investment Strategy Commitments and Gear Change.

In England until recently only London could enforce School Streets using CCTV, but 12 authorities outside London received powers in June 2022. An air quality monitoring study for the Greater London Authority found School Streets reduced nitric oxide (NO) by 34% during the morning intervention period (equivalent to 5% across the school day) and nitrogen dioxide (NO_2) by 23% (2% across the school day).[13] Evidence gathered as part of the CWIS Active Travel Investment Model design process suggested that School Streets are cost-effective interventions because of their the relatively low cost and effect on reducing driving and/or increasing active travel, although data was limited[14].

So far, school Streets have been a less common intervention funded by the ATF than LTNs and cycle tracks. However, there is scope for quick roll-out. Only a quarter of local authorities outside London had any School Streets, yet within London implementation had been rapid and there were, by 2021, 400 with 50 more being planned[15]. With non-London authorities having gained power to enforce with CCTV, the number of School Streets may increase elsewhere in England.

Evaluating the impact of School Streets on active travel is challenging because England lacks national data on mode of travel to school[16]. A review of 16 UK local authorities found 'medium strength' evidence School Streets increase active travel to school[17], although, due to the study design, it was not always clear that active travel increases were the result of the School Streets rather than other factors. Gathering

---

13 Gellatly & Marner, https://www.london.gov.uk/sites/default/files/school_streets_monitoring_study_march21.pdf, (2021)

14 Cairns et al., https://www.transportforqualityoflife.com/u/files/APPENDIX%205%20Compendium%20of%20interventions.pdf, (2019)

15 Hopkinson et al., https://www.wearepossible.org/latest-news/school-streets-reducing-childrens-exposure-to-toxic-air-and-road-danger, (2021)

16 Davis, https://www.napier.ac.uk/about-us/news/school-street-closures (2020)

17 Davis, https://www.napier.ac.uk/about-us/news/school-street-closures, (2020)

comparable and control data on change in school travel, without a national dataset, would require significant primary data collection.

This evaluation is hence not addressing mode switching. Other interesting questions remain, however, about the national and local distribution of School Streets. For instance, do they tend to benefit schools with relatively more or less advantaged students? Could one measure their impact on road injuries near schools at the start or end of the school day? This intervention will therefore use existing available data on pupil disadvantage and road injuries to explore distribution of these interventions and their impact on road safety.

1.5. Research Questions

Below are the eight research questions addressed by the evaluation, which were developed from the logic map and in discussion between the research team and DfT.

1. What level of change in the number of cyclists do separated cycle tracks induce, and how does the magnitude of any impact change over time?
2. What level of change in the number of pedestrians and cyclists do LTNs induce, and how does the magnitude of any impact change over time?
3. To what extent is there evidence of mode shift away from cars?
4. What impacts are there on traffic speeds on LTN boundary roads, and how does the magnitude of any impacts change over time? What impacts are there on local car journey times?
5. What other impacts of LTN schemes can be identified on road traffic casualties and car ownership?
6. What typically are the quantifiable benefits of these schemes, in terms primarily related to walking and cycling uplift, compared to their typical cost?
7. What do local authority stakeholder experiences say about challenges, opportunities, and learnings from planning and delivery of such schemes?
8. What types of school are gaining School Streets? And what scope is there for assessing their impact on road traffic injuries in the vicinity of a school?

2. Summary of Methods

This chapter outlines the methods used in answering each research question, described in more detail in specific chapters.

RQ1. What level of change in the number of cyclists do separated cycle tracks induce, and how does the magnitude of any impact change over time?

This question will be answered by measuring and analysing the number of cyclists on the cycle tracks using data from automatic cycle counters taken before and after the schemes are implemented. The before and after changes seen on the schemes will be compared to those also observed on control routes which have not seen ATF or any other investment. Difference-in-Differences analysis will be used which will also account for other factors which might impact on changes in cycling flows. The seasonality of counts collected and changing Covid-19 restrictions will also be explored. Changes in cycling flows will be explored at the scheme-level and the theme-level through the aggregation of count data across all cycle track schemes being evaluated. Analysis will also consider whether the data enables the assessment of differences in impacts on usage according to cycle scheme type.

RQ2. What level of change in the number of pedestrians and cyclists do low-traffic neighbourhoods induce, and how does the magnitude of any impact change over time?

The data collected to answer this question is either in the form of continuous data from machine learning sensors or (in two cases) from one-off data collection, this being manual counts or video recording. Continuous data collection is the preferred option because it provides more data, and random fluctuations are less of a problem than for short period counts. Ideally, analysis will compare changes in intervention and control areas between October months (2021 and/or 2022 as 'before', 2022 and/or 2023 as 'after'). Comparisons will be made pre- to post-intervention to assess, across all schemes, whether there has been an overall change in the numbers of pedestrians, cyclists, and motor vehicles inside the LTN. Changes within the LTN areas will be compared with changes in the control areas to understand whether, for instance, there has been a greater uplift in active travel associated with LTN installation compared to that seen in other areas with similar socio-demographic and travel characteristics.

RQ3. To what extent is there evidence of mode shift away from cars?

For both LTNs and cycle tracks, the analysis will examine the extent to which any increase in walking and/or cycling is associated with a shift away from car use. Travel behaviour change is complex and iterative. However, immediate impacts can be estimated by using Route User Intercept Surveys (RUIS), and specifically through a question about whether, and if so how, a particular journey being made has changed. RUIS is a method used by Sustrans and academic researchers and is recommended by DfT.

All participating authorities will be asked to conduct RUIS during Autumn 2023. The research team will ensure that the mode replacement question used is the same across all schemes, with authorities encouraged to standardise other aspects as far as possible (e.g. demographic data collection). Data from RUIS will be used in tandem with estimates of changes in walking and/or cycling (based on before and after control data) to estimate where new active travel comes from (i.e. which mode, if a replacement, or whether people are making an entirely new trip)[18]. Using the combination of count and sensor data and intercept surveys, the analysis will estimate the level of mode shift from cars to cycling (cycle track schemes) and from cars to walking or cycling (LTN schemes).

RQ4. What impacts are there on traffic speeds on LTN boundary roads and how does the magnitude of any impacts change over time? What impacts are there on changes to local car journey times?

Traffic speeds

Analysis will use Google API data to measure changes in journey times and journey variability for travel by car on segments of identified boundary roads, as a measure of changes in congestion. This will assess a potential unintended consequence of introducing an LTN including, crucially, investigating timelines for shifting from disruption to a new stability. To collect this data, the research team has mapped boundary roads that immediately surround the LTN roads and to where it is plausible that some traffic could be displaced. These LTN boundary roads were divided into segments between junctions using Google API to route each of these journeys by car 30 times each week on Tuesdays and Saturdays, including morning peak, evening peak, and off-peak times. For each journey, Google estimates the duration in seconds given live traffic conditions. Changes in mean and median average

[18] For an example, see Aldred & Croft, https://www.sciencedirect.com/science/article/abs/pii/S2214140518304006, (2019)

speeds and their variability will be used as a proxy for congestion on the boundary roads.

Delays to car users

Analysis will also use Google API to quantify the extent to which local car drivers face increased journey times. This may be expected if short car trips become slightly less convenient, which in turn may encourage mode shift to active travel. However, if any such journey time increases are large, this may impact disabled people who depend on private cars to access destinations. Data collection will involve deriving the average and standard deviation of journey times for routes from or near each LTN and control area to a set of very local and additional destinations (e.g. doctors' surgeries, supermarkets).

RQ5. What other impacts of LTN schemes are there on road traffic casualties and car ownership using secondary datasets?

Analysis will assess impacts on road traffic casualties and car ownership using methods previously developed and deployed for Waltham Forest[19], and for 2020 London LTNs (for road traffic casualties only).[20]

Analysis of road traffic casualties will use police recorded STATS19 injury data. The primary outcome will be number of injuries of any severity, both in total and by mode of travel. Analysis will separate injuries into those taking place on LTN boundary roads, inside the LTN, and all injuries elsewhere in the local authority, matched by urban/rural status (the comparison group). Following an assessment of changes in absolute injury numbers, analysis will assess likely changes in injury risk per mode user, based on data about changes in walking, cycling, and driving.

Analysis of car ownership will use data from the Driver and Vehicle Licensing Agency (DVLA), which maintains the registration and licensing of motor vehicles in Britain, including the address of the person responsible for vehicle taxation. This data can be provided by the DVLA for each quarter at the level of the Lower Super Output Area (LSOA). Analysis will compare change in cars per capita across the years 2017 to 2023, again using a control group to ensure that any changes can be attributed to the scheme with reasonable confidence rather than, for instance, being

[19] Laverty, Aldred & Goodman, https://findingspress.org/article/18330-the-impact-of-introducing-low-traffic-neighbourhoods-on-road-traffic-injuries, (2021) and Goodman, Urban & Aldred, https://findingspress.org/article/18200-the-impact-of-low-traffic-neighbourhoods-and-other-active-travel-interventions-on-vehicle-ownership-findings-from-the-outer-london-mini-holland-progr, (2020)

[20] Goodman et al., https://findingspress.org/article/25633-impacts-of-2020-low-traffic-neighbourhoods-in-london-on-road-traffic-injuries, (2021)

caused by longer-term secular changes in car ownership. Any effects on car ownership may well initially be small, but the previous research shows some effects may start to be detectable in data from 18 months post-implementation[21].

RQ6: What typically are the quantifiable benefits of these schemes, in terms primarily related to walking and cycling uplift, compared to their typical cost?

As explained in RQ1 and RQ2 above, for the two major themes there will be before-and-after data from control and intervention sites on walking and/or cycling from approximately 10 schemes per theme. Having estimated the proportion of 'new' walking and cycling trips rather than route changes (from the RUIS), health economic analysis will estimate the benefit from any increases in physical activity using DfT appraisal guidance. The output from RQ6 will be separate estimates of costs and quantifiable benefits from the two scheme types, which can feed into a) guidance on likely value for money on different types of intervention; b) future appraisal methods. These costs and impact ratios will be compared against those recently published as part of the DfT's guidance.

RQ7. What do local authority stakeholder experiences tell us about challenges, opportunities, and learnings from the planning and delivery of such schemes?

This RQ is being answered by a process evaluation exploring stakeholder perceptions and experiences of planning and implementing schemes, the stakeholders in this case being primarily local authority officers charged with different aspects of planning and implementation. To examine different life stages of an intervention, there will be two stages, both including online focus groups. Stage 1 has already been completed (published, 2023, as ATF Evaluation: Process Evaluation Report Stage 1) and fieldwork for Stage 2 is taking place during 2023, with a greater focus on post-implementation experiences. These results will contribute to the contextualisation of the quantitative research which will draw conclusions about the wider impact of interventions on key objectives.

---

[21] Goodman, Urban & Aldred, https://findingspress.org/article/18200-the-impact-of-low-traffic-neighbourhoods-and-other-active-travel-interventions-on-vehicle-ownership-findings-from-the-outer-london-mini-holland-progr, (2020)

RQ8: What types of school are gaining School Streets? And what scope is there for assessing their impact on road traffic injuries in the vicinity of a school?

This question aims to understand the characteristics of schools that are implementing School Streets (here primarily measured through percentage of pupils entitled to free school meals, as a proxy for deprivation) and the potential that they have for reducing road traffic injuries in their vicinity. The research team has gathered their own data for London and used DfT monitoring survey data to acquire data on which non-London schools currently have, or are implementing, School Streets. To assess the relative equity of the implementation of School Streets, analysis will compare the overall proportion of children receiving free school meals at schools with School Streets compared to all schools and specifically schools without School Streets. In 2024 the research team will assess whether there is sufficient statistical power to assess the impact on road traffic injuries (this is currently unclear). If so, they will conduct an analysis similar to that previously conducted for LTNs in London.[22]

[22] Goodman et al., https://findingspress.org/article/25633-impacts-of-2020-low-traffic-neighbourhoods-in-london-on-road-traffic-injuries, (2021)

3. Cycle Track Schemes

This chapter:

- Briefly outlines the context and the selected cases for the cycle track theme evaluation.
- Explains the methods being used to calculate increases in cycling at scheme and theme level, including dealing with missing or anomalous data.
- Present the baseline data that is currently available.

3.1. Context and Cases

This part of the evaluation focuses on 'protected' cycle track interventions delivered by local authorities who received EATF and/or ATF2 funding. 'Protected' cycle tracks refers to any cycle track which has physical separation from motor traffic. Whilst other interventions have often been delivered with cycle tracks using ATF funding, the role and impact of these other interventions is not covered in this report.

Given limited evaluation resources, it has not been possible to cover all local authorities delivering cycle track interventions with ATF funding. It was agreed with the Department of Transport (DfT) that the evaluation would add most value if it covered 10 'transformative' protected cycle track interventions. Table 2 below summarises the selected schemes and more detail is provided in Appendix 1.1. Table 3 outlines the shortlisting criteria, and how well each criterion was met.

After selection, one of the ten schemes returned to the stakeholder consultation phase so that more options could be considered. This scheme therefore cannot be included in this baseline evaluation report; however, it is hoped it will be possible to cover it in the final evaluation.

In some local authorities, multiple funding sources are being used to deliver the cycle track interventions. Unless stated, the evaluation of the schemes in each local authority will focus on the *entirety* of the scheme being delivered, rather than focusing solely on the ATF funded element of that scheme. This will ensure that all schemes being evaluated are fully (rather than partially) assessed. The scheme descriptions, lengths and costs described relate to the entirety of the schemes.

Table 2 Schemes being evaluated in each local authority, their lengths and their estimated costs

Local Authority	Scheme name[23]	Cycle track intervention type	Other interventions	Length (miles)	Estimated cost
Bolton (Greater Manchester)	South Bolton to Farnworth (GM01)	Road space reallocation for light segregation	Links to other active travel infrastructure, including a CYCLOPS junctions funded through the Transforming Cities Fund	1.55	£1,217,700
Essex	Transforming Colchester (ES01)	Permanent separated cycle track	4-way signalised junction, school streets, 20mph limits	3.40	£4,015,000
Gloucestershire	B4063 Gloucester to Cheltenham (GL01)	Permanent separated cycle track		7.50	£12,000,000
Kent	TBC[24] (KE01)	TBC	TBC	TBC	TBC

[23] Where appropriate, the abbreviated scheme names (e.g. GM01, ES01) will be used throughout the report to refer to the schemes in each local authority.

[24] Kent's plans for an interurban cycling route between Birchington-on-Sea and Margate were originally included in the evaluation shortlist, however it has not been possible to include in this baseline report due to the exploration of alternative routing options following recent stakeholder consultation. Whether it will be possible to evaluate Kent's scheme will be reconsidered when its nature is clearer and, if so, will be covered in final reporting.

Liverpool	Wirral – Leasowe Road (LP01)	Permanent separated cycle track	Kerb lines, junction redesigns, alterations to bus stops and pedestrian crossing	0.80	£600,000
	Runcorn Busway (LP02)	Permanent separated cycle track (alongside a busway)		3.30	£2,040,000
Newcastle	Queen Victoria Road (NE01)	Permanent separated cycle track	Junction improvements, reduction of vehicle parking and crossing upgrade	0.47	£2,950,000
Sheffield	Sheaf Valley Active Travel Lane (SH01)	Permanent separated cycle track	Improved crossings, the removal of parking bays and carriageway space, road closures, and improved on-road sections	2.23	£2,400,000
Surrey	Guildford to Burpham (SU01)	Permanent separated cycle track	Junction redesigns and crossing upgrades	1.15	£2,000,000
	Woking to West Byfleet (SU02)	Permanent separated cycle track	Toucan crossings, point closures, side road priority and 20mph speed treatments	2.78	£1,998,452

Table 3: The criteria used to shortlist the schemes being evaluated and how well each criterion was met

Criteria	Outcome
Including only schemes which were expected to start and complete within the planned timeline for the evaluation.	Every effort has been made to ensure all construction start and end dates fall within the planned evaluation timeline; however construction dates are subject to constant revision (beyond the control of the evaluation team) and may change during the course of this study. If baseline construction dates mean insufficient data is available for analysis for any scheme, different methodological assumptions can be possible (these are outlined later in this report). For all schemes where estimated construction completion dates have been provided, at least one analysis approach will be possible (these are outlined later in the report). For other schemes where construction completion dates have not yet been confirmed, their analysis approach will be determined at the time of the final evaluation report.
Excluding cycle schemes which were being delivered *as part* of a low traffic neighbourhood (as LTNs are being shortlisted and evaluated separately).	No cycle track schemes included in this evaluation are being delivered as part of a low traffic neighbourhood.
Considering all schemes which were estimated to cost over £2 million (some schemes costing over £2 million were excluded due to being deemed unsuitable for this report's evaluation requirements).	All schemes, except GM01 and LP01, are estimated to cost around or over £2 million when contributions from other funding sources are taken into account. The schemes range in cost from £600,000 to £12 million.

For those schemes costing less than £2 million, identifying those which were:	More than a mile in length.	Schemes GM01 and LP01 are estimated at 1.55 and 0.8 miles respectively.
	Planned to be the best quality (in terms of infrastructure type, permanence, spend, and LTN1/20 compliance).	Schemes GM01 and LP01 are both expected to offer improved and permanent cycling infrastructure.
	More than minor upgrades.	Schemes GM01 and LP01 are both considered to be more than minor upgrades GM01 involves considerable road-space reallocation for light separation of cycling from road traffic, whilst LP01 involves the introduction of a permanent segregated cycle track.
	Expected to be transformative (based on their location, inclusion in Local Cycling and Walking Index Plans (LCWIP), propensity to cycle tool values, and/or whether they connected to key areas of employment, housing and/or schools).	Schemes GM01 and LP01 are both expected to be transformative. GM01 will connect Bolton with Farnworth (connecting two key university campuses) and create a link to other key cycle infrastructure in the area. The University of Bolton has also invested in 1000 bicycles to encourage students to travel actively between the towns. LP01 will add cycling infrastructure to a route where there is none at present and will connect a leisure/residential district with employment areas and existing cycle routes.

To ensure the schemes selected included as many regions as possible.	Coverage was achieved in the north-east, north-west, east, south-west and southern regions (5 schemes are in the north and 4 in the south). Unfortunately cover in the Midlands and London was not possible.
To ensure the schemes selected were in a mix of large and small urban areas.	All the schemes are located within small or large urban areas.

3.2. Methods

The impact of each of the cycle track interventions will primarily be evaluated by answering research questions 1 and 3:

- RQ1. What level of change in the number of cyclists do separated cycle tracks induce, and how does the magnitude of any impact change over time?

- RQ3. To what extent is there evidence of mode shift away from cars?

Section 3.2 briefly outlined the methodology that will be used to answer each research question.

In this baseline report, data on the cycling flows and trends on each scheme prior to construction (relevant to RQ1) is presented. In the final evaluation report for the cycle track theme, scheme and theme level changes in both cycling flows and trends (RQ1) and mode shift away from car use (RQ2) will be reported.

Changes in cycling flows

Identifying the counters

To answer RQ1 and conduct the Difference-in-Differences methodology for each scheme (as outlined in section 3), the following was required:

- At least one automatic cycle counter located on the intervention route itself, situated where increases in cycle flows are expected to be observed as a result of the intervention.
- At least one automatic cycle counter located on a control route which will not be affected by any ATF scheme or other intervention.

It is crucial that the cycle counters can provide as much data as possible. Existing counters were therefore always preferred as they were likely to provide historic data. However, in some cases new counters had to be installed specifically to provide data for this evaluation. This was more likely to be the case for the intervention routes than it was for the control routes.

Local authorities were asked to identify control counters in a location which, regardless of funding source, had not benefitted from any upgrades for the 2-year period before cycling was expected to increase, and was not expected to benefit from improvements during the study. This was to help ensure that the data was representative of the 'background change' in cycling flows rather than being affected by recent improvements.

Appendix 1.2 details the full criteria given to local authorities to help select their intervention and control counters. These criteria were important to consider as they help minimise the impact of possible confounding factors. For instance, cycling schemes located closer to city centres may have cycling flows impacted by factors which more rural locations may not be, such as increases in housing supply. If an intervention was to therefore take place on a city centre scheme, but the control counter located away from the city, the impact of the intervention on increasing cycling flows may be overestimated due to the impact of the increased housing supply nearby. Of five local authorities with baseline data currently available for both control and intervention counters, one (SU1) matched within +/-15% of each other (as shown in the baseline data for each counter in Table 7). The other four differed by more than 15% and instead were matched on at least one of the other criteria. In most cases a single intervention and single control counter was sufficient, however, in Newcastle and Manchester the width of roads involved meant that more than one counter was needed to capture all movements at the given site, and data from these was then combined.

A suitable control counter for the Liverpool LP02 intervention could not be identified. The route has historically only been open to bus traffic (although an experimental traffic regulation order allowed cycle access during daylight hours from the end of August 2020 for a maximum period of 18 months) and so no comparable control route could be identified. For the ATF scheme, the evaluation will instead compare what is observed on the intervention route to what is happening across the Liverpool city region more broadly. The methodology to be adopted will be outlined in the final evaluation report. This report presents baseline data only for the intervention route.

Available data

From April 2022, each local authority was contacted and asked to supply data from their recommended intervention and control automatic cycle counters. Where a counter had been newly installed, all data available for the counter was requested. Where a counter was already in place, all data since 2018 was requested. The data cleaning methods used are set out in detail in Appendix 1.2.

Analysis Methodology

The analysis methodology involves the calculation of four metrics for each individual counter:

- **Pre-intervention Average Daily Total (ADT):** the mean average daily count of cycles at each counter prior to the start of the scheme construction.

- **Post-intervention Average Daily Totals (ADT):** the mean average daily count of cycles at each counter after the ATF scheme has been implemented.

- **Pre-intervention trend:** the annual percentage change in cycling volumes before the intervention.

- **Post-intervention trend:** the annual percentage change in cycling volumes after the intervention.

The methodologies to calculate each of these metrics are described in more detail in Appendix 1.2.

Cycle flows have been very volatile over the last few years due to the various impacts of Covid-19. Pre-intervention travel behaviour before scheme construction may have not been 'normal' and travel behaviour after the intervention may also be impacted by Covid-19. A Difference-in-Differences approach will be used where possible. Given that both the intervention and control counters will have been impacted by external factors like Covid-19, this methodology focuses on the differences in cycling flow change seen between the two counter types as the primary indicator of impact. With the control counter providing an estimate of background changes in cycling flows (including its impact by Covid-19), the difference between this change and that seen at the intervention counter can be considered attributable to the impact of the intervention itself.

The effect of the intervention will therefore be estimated in two ways, explored at both a scheme and theme-level:

- The effect on cycle flow of the intervention, referred to as the cycling 'flow change' – the difference in the percentage change in ADT pre- to post-intervention between the paired control and intervention counters.

- The effect on the trend in cycle flow of the intervention, referred to as the cycling 'rate change' – the difference in the deviation in annual trend pre- to post-intervention between the paired control and intervention counters.

The following assumptions will be made if there is insufficient data to calculate any of the metrics required above:

- Where there are insufficient pre-intervention data from the intervention site to calculate the pre-intervention trend, it will be assumed that the pre-intervention trend observed in the control data represents the pre-intervention trend that would have been observed at the intervention site.

- Where there are insufficient pre-intervention data to calculate the pre-intervention trend for both the control and intervention counters, it will be assumed that the post-intervention trend at the control site represents the pre-intervention trend that would have been observed at both the control and intervention sites.

- Where there are insufficient pre- and post-intervention data to observe any trend over time at either site, the effect of the intervention will be estimated for the change in flow only, using just the difference in a comparable post-intervention ADT between the control and intervention counter.

Scheme-level impact analysis

Table 4 below shows a simulated example of what the Difference-in-Differences cycling ‘flow change’ and ‘rate change’ analyses will look like for one scheme.

Table 4 A model example of what the cycling ‘level change’ and ‘rate change’ analysis will look like in the final evaluation report for one scheme

	Average (mean) daily cycling total				Annual cycling trend (% change per annum)			
Counter	**Pre-intervention**	**Post-intervention**	**Flow-change (%)**	**Difference (percentage points)**	**Pre-intervention**	**Post-intervention**	**Rate change (percentage points)**	**Difference (percentage points)**
Control	145	148	2%	+17	+2.3%	+2.8%	+0.5	+4.4
Intervention	130	155	19%		+4.5%	+9.4%	+4.9	

The conclusion in this example would be that there was a 19% increase in cycling flows at the intervention, of which 17 percentage points can be attributed to the impact of the intervention itself. There was also a 4.9 percentage point increase in the annual cycling trend year on year at the intervention scheme, of which 4.4 percentage points can be attributed to the impact of the intervention.

Any assumptions made will be identified in the final evaluation report. In all cases, the primary analysis will be a Difference-in-Differences comparison between the data from the control and intervention counters pre/post-intervention. Actual values will also be presented to provide additional information for counter pairs.

Theme-level impact analysis

For the theme-level analysis, data from all the cycle track counter pairs being evaluated will be aggregated to show how the wider ATF investment has affected cycling, as illustrated in Table 5. Statistical significance will be tested using an independent t-test, subject to confirmation that the distribution of values is appropriate[25].

Table 5 A hypothetical example of what the theme-level evaluation may look like in the final evaluation report

Number of counter pairs	Mean / median difference in average daily cycling total change (percentage points)	Mean / median difference in annual cycling trend change (percentage points)
10	+6.4 / +6.0	+2.5 / +2.1

Strengths and limitations

The strengths of the approach are:

- Use of control counters paired with the intervention counters means it will be possible to better isolate the impact of the ATF funding on cycling flows from local (as opposed to national) background trends in cycling flows.

- Reasonable assumptions can be made if there is missing pre- or post-intervention data which allow for use of the same analysis methodology, and this maintains the ability to compare local authorities and aggregate results for a theme-level analysis.

- User surveys will be completed on each of the schemes once they are completed. This data can be considered alongside the count data from the counters to help estimate levels of mode shift away from car trips, as well as the health benefits from entirely new cycling trips being made.

A limitation of the approach is that some ATF routes will have also seen investment from other funding sources too, so it is difficult to disentangle the impact of the ATF funding from that made by the other funding sources. The final evaluation report will

[25] This testing will only be done on theme-level results, rather than scheme-level results, as any impact from the imprecision in the matching of intervention counters to control counters will be lessened when considered at a theme-level.

note whether multiple funding sources have contributed to the delivery of an intervention. Another limitation is the use of automatic counters which only count cyclists and not pedestrians, hence pedestrian use. No changes in walking flows uptake will therefore be captured, although such schemes may mainly impact cycling.

3.3. Baseline Data Analysis

For this baseline report, only counter data that covers the baseline period has been analysed. This period is determined by the earliest date for which counter data is available for a scheme and the date that construction started. In many cases, the baseline data period includes a period when Covid-19 travel restrictions were in place. As a result, baseline cycling flows and trends may have been impacted by these restrictions and may not represent ‘normal’ travel behaviour.

It has only been possible to complete limited baseline data analysis for this report:

- For many local authorities, construction start dates have not been confirmed and so estimated dates of construction have been used. These estimates have been based on conversations that have taken place with the local authorities or through information about scheme progress online.

- Limited counter data was in some instances available at the time of this report – this may be due to delays in counter installation, or new counters having been installed only shortly before scheme construction started, meaning limited baseline data has been collected.

For the final evaluation report (when schemes will have been completed and re-opened fully for use), these construction dates and associated baseline counter data will be updated, if necessary. Hence, baseline data presented in this report is subject to change.

Scheme-level analysis

Scheme-by-scheme baseline analysis results are presented in Table 7, along with a summary of the current data availability. Table 6 provides the key used to describe the data availability for each counter in Table 7.

Table 6: A key to support the information in Table 7

Symbol	Detail
‡†	Estimated construction start date (subject to revision for the final evaluation report)
†	Counter installed but limited data available – calculation of baseline ADT or trend not possible
§	Counter installed and ADTs calculated from non-overlapping time periods
*	Counter not yet installed, but pre-intervention data expected
^	Insufficient data to calculate pre-intervention trend, will be assumed to match its post-intervention trend
~	Insufficient data to calculate pre-intervention trend, will be assumed to match the pre-intervention trend from the control counter

Table 7: Baseline counter analysis results for each local authority scheme

LA intervention	Counter	Construction start dates	Average daily cycling total	Annual cycling trend (% change per annum)
			Pre-intervention	Pre-intervention
GM01	Control	Apr-22	N/A†	^
	Intervention		N/A†	~
ES01	Control	Oct 2022‡†	167	^
	Intervention		249	~
GL01	Control	Oct 2021‡†	110	-0.06
	Intervention		N/A†	~
KE01[26]	Control	TBC	TBC	TBC
	Intervention		TBC	TBC
LP01	Control	May-23	50	^
	Intervention		144	~
LP02	Control[27]	Oct-21	N/A	N/A
	Intervention		35[28]	N/A†
NE01	Control	Nov-22	704§	-0.06
	Intervention		210§	~
SH01	Control	May-22	77	^
	Intervention		207	-0.12
SU01	Control	Oct-22	84	-0.01
	Intervention		92	-0.04
SU02	Control[29]	TBC	TBC	TBC
	Intervention		*	*

[26] Kent's plans have returned to stakeholder consultation and could not be evaluated for this report. It is hoped Kent's scheme can be evaluated in the final report.

[27] No single control counter could be identified for LP02. For the final evaluation report, changes in cycling levels on the busway will be compared to changes observed across the Liverpool city region more broadly.

[28] The baseline ADT for LP02 reflects counts collected during a period when the busway temporarily permitted cycle access (during daylight hours only).

[29] For SU02, 4 control counters have been suggested for evaluation (3 have been installed and are collecting data, and one waiting to be installed). Given that the intervention counters for Surrey have not yet been installed, there is no intervention data currently available which can be used to test for the suitability of which control counter to be paired with the intervention counter(s). The final decision on which control counter(s) to use for the SU02 intervention will therefore be made for the final evaluation report.

A summary of the expected analyses possible for each scheme are detailed below.

- GM01 - pre and post rate-change analysis of both counters
- ES01 - pre and post flow-change and rate-change analysis of both counters
- GL01 – analysis approach to be confirmed once construction completion dates are known
- KE01 - analysis approach to be confirmed once details of the scheme are confirmed
- LP01 - pre and post flow-change and rate-change analysis of both counters
- LP02 - pre and post flow-change analysis of the intervention counter only
- NE01 - pre and post flow-change and rate-change analysis of both counters
- SH01 - pre and post flow-change and rate-change analysis of both counters
- SU01 - pre and post flow-change and rate-change analysis of both counters
- SU02 - analysis approach to be confirmed once all counters are installed

It is hoped that Kent's ATF scheme (KE1) can also be included in the final evaluation report.

Beside the Difference-in-Differences flow and trend changes analysis, the final report will present the following:

- Theme-level data on cycling flow and trend change.

- Qualitative comment on any changes in cycling flows and trends between schemes.

- Analysis of the replacement of car trips by active travel, incorporating analyses of the Route User Intercept Surveys conducted by the local authorities on their intervention routes.

The confidence in the findings we will be able to conclude on each scheme are expected to be strong. The use of control counters alongside intervention counters will help us to isolate the impact of the cycle track interventions from local background changes in cycling flows; and the application of two analysis approaches will ensure that both elements of RQ1 can be answered:

'What level of change in the number of cyclists do separated cycle ways induce, and how does the magnitude of any impact change over time?'

However the number of schemes which will have data available to answer each part of this question is expected to be varied and dependent on levels of data availability implicated by any possible changes in construction dates.

The delivery of user surveys on schemes once they are complete can then be used to effectively answer RQ3:

To what extent is there evidence of mode shift away from cars?

It is expected that this will be possible on all schemes, provided construction is completed in sufficient time to allow for their delivery in time for the final evaluation report. This data can be used in conjunction with the counter data to confidently understand the extent and possible levels of mode shift away from car use, resulting from the interventions delivered.

4. Area-wide Traffic Reduction Schemes (LTNs)

This chapter:

- Describes the context and the cases for the LTN theme evaluation.
- Explains the methods used to collect data on pedestrian, cycle, and motor vehicle flow, to clean it, to prepare it for analysis; and briefly outline that analysis.
- Analyses baseline count data by scheme, by London versus non-London, and across the theme. This generally shows moderate to high similarity of flows, increasing confidence in the ability to detect changes with ‘post’ data.
- Presents baseline traffic speed data (from Google API) for LTN boundary roads by scheme, by London versus non-London, and across the theme. Again, this shows a good degree of similarity. The report also presents initial analysis for one scheme, Camden Square, provisionally showing a small reduction in traffic speed post-implementation.
- Examines baseline data for injuries and car ownership. The analysis has not found evidence of differences between intervention and control areas. However, numbers are small. Looking to the final analysis, there are delays in scheme implementation, and STATS19 and DVLA datasets emerge up to around nine months after the year to which they relate. The combined effect of delays and potentially only small changes in low numbers suggest there may be insufficient statistical power to provide definitive conclusions using data available at the time of analysis in 2024.

4.1. The context and selected cases

This section provides information and baseline data on area-wide traffic reduction schemes (referred to here as LTNs, though they may not be called that in their areas). To fit the evaluation’s inclusion criteria, LTN-type schemes selected for evaluation needed to be genuinely area-level. Through motor traffic needed to be removed or substantially reduced from at least two streets such that authorities could install two sensors to monitor changes in travel behaviour within the area. Each intervention area needed a control area with no LTN-type schemes planned in the coming years, with as far as possible similar characteristics to the LTN-type area in population, size, road network structure, destinations, and travel behaviour. This process was challenging as frequently authorities did not have information on many such factors (in particular, walking and cycling). It also meant that some potential schemes could not easily be included as they had unique features that could not be matched within the authority.

Two further challenges included firstly the need for authorities to collect baseline and follow-up data in intervention and control areas. Ideally, this would involve using machine learning sensors, which can gather accurate 24/7 data on all modes by in-situ detection and classification of different road users. However, many authorities are not used to procuring these items, which have a longer lead time and are more expensive than traditional ATC based methods (Automatic Traffic Counts), although ATCs are not good as recording cyclists and do not count pedestrians at all. Two authorities included in this report (Oxford and Birmingham) procured one-off counts; both ATC counts for vehicles and manual (video) counts for cyclists and pedestrians. This was less ideal as it provides only a short window of data and needs to be re-procured at follow-up (increasing risk); however, both are authorities implementing interesting and substantial schemes, and the count data was collected correctly.

The larger challenge relates to failure to implement schemes, which is likely further to reduce the sample size and increase London bias, despite substantial attempts to mitigate this. While ATF2 schemes were ideally meant to be implemented by March 2022, this only happened in two shortlisted authorities (both in London) and most schemes included on an initial non-London shortlist were not implemented as of February 2023. Some authorities launched additional engagement, postponing schemes, and reducing their likelihood of implementation. Some schemes were only partially implemented or in some cases, experienced persistent vandalism affecting their functioning.

From an initial shortlist of 25 authorities potentially planning to implement LTN-type ATF schemes, 15 were outside London. This would have sufficiently mitigated against dropout if all 15 proceeded to baseline data collection. However, 5 of those 15 dropped out before data collection due to scheme cancellation or delays. Hence, only 10 non-London schemes were collecting baseline data, with some of these at high risk of cancellation, delay, or scaling-down. Therefore, a further 8 schemes were added in from a London-based, National Institute for Health and Care Research (NIHR) funded project, giving a total of 18 schemes where baseline data has been collected.

Many of these 18 schemes have been substantially delayed, almost all have experienced at least some delay, with at least two no longer meeting the original criteria due to scheme changes. Table 8 provides the names of the schemes along with their status; also showing the additional non-London schemes removed from the study due to non-implementation.

Table 8: Summary of LTN schemes included and excluded, as of February 2023

Scheme Name	Authority	Category	Implementation Date	Status
Stoke Newington	London Borough of Hackney	London	Implemented Autumn 2021	In place
Camden Square	London Borough of Camden	London	Implemented Winter 2021	In place
East Oxford	Oxfordshire CC	non-London	Implemented May 2022	In place
Crookes	Sheffield/SCR	non-London	Partially implemented May-June 2022	(Partially) in place
St Ann's	London Borough of Haringey	London	Implemented August 2022	In place
Areas 5 and 6 (Woodgrange and Capel)	London Borough of Newham	London	Now due Spring-Summer 2023	Planned
Brixton Hill	London Borough of Lambeth	London	Now due Spring-Summer 2023.	Planned
Streatham Wells	London Borough of Lambeth	London	Now due Spring-Summer 2023.	Planned
Kings Heath LTN	Birmingham City/WMCA	non-London	Now due Spring-Summer 2023.	Planned
Frizinghall	Bradford/WYCA	non-London	Delayed, no date given.	Possible
Cumberland and Holborn	London Borough of Newham	London	Delayed, no date given.	Possible
The Cally	London Borough of Islington	London	Delayed, no date given.	Possible
Fleetville LTN	Hertfordshire CC	non-London	Delayed, no date given.	Possible
Chapel Allerton	Leeds/WYCA	non-London	Delayed, no date given.	Possible

Edwards Lane Estate, Sherwood	Nottingham CC	non-London	Delayed, no date confirmed, and scheme may no longer meet criteria (TBC).	Possible
Worsley Mesnes Active / LTN	Wigan/GMCA	non-London	July 2022 but scheme substantially scaled back; no longer meets definition of an LTN.	Excluded
Fishpool and Pimhole Active Neighbourhood	Bury/GMCA	non-London	Delayed (and scaled back), no date given, and baseline data was incomplete.	Excluded
Southport Liveable Neighbourhood	Sefton/LCR	non-London	Delayed and scheme scaled back; no longer likely to contain new modal filters.	Excluded

Appendix 2 provides further details on each of these schemes and their progress as of February 2023.

4.2. Methods

The following section outlines the methodological approach used in relation to RQ2: "What level of change in the number of pedestrians and cyclists do low-traffic neighbourhoods induce, and how does the magnitude of any impact change over time?". The section outlines data collection in LTN and control areas, missing data, imputation methods, anomaly detection and treatment and analysis methods that will be used to answer RQ2.

Data collection

Identifying and selecting control areas

Matching each area-wide intervention area with a control area was important because areas with different characteristics (traffic or demographic) might see different patterns in active travel uptake. For instance, it is plausible that where active travel is growing, it might grow faster among people living in car-free households. Thus, if intervention areas contain a much higher proportion of car-free households than control areas, this might bias the study by increasing the apparent effect of the intervention. If the skew is the other way around, the intervention effect could be reduced. While one could adjust for these differences, it is better to have a well-matched control group in the first place.

Selecting a matched control area was iterative, involving geographical information software (GIS). Census 2011 data (https://www.nomisweb.co.uk/sources/census_2011) was used alongside expert and local knowledge, to identify control areas with similar size, traffic, road and demographic characteristics to the LTN. The process considered other important factors such as distinctive topography and presence of services that may affect traffic levels, such as schools, hospitals, parks and shops. The overall aim was to identify a control area that is in such terms broadly like the intervention area, but that is not the site of an area-wide traffic reduction intervention nor another major active travel / sustainable transport intervention. There should be no such interventions planned in the control area for the next 1-2 years.

Control areas were generally only considered if they had not already had through motor traffic removed. Nor should they be adjacent to the intervention area or another area undergoing a similar intervention, to avoid contamination effects. Control areas were, however, somewhere where such a scheme could hypothetically be implemented. Initially, several potential control areas were identified for each area-wide intervention included in the study. Following discussions with local authority staff with local knowledge, the characteristics of each potential control area were compared with the intervention area, including confirming that the control areas were indeed seen as potentially treatable, albeit not within the current or near future funding envelope.

The final report will re-run the demographic matching analysis with Census 2021 for the final set of schemes. Analysis using Census 2011 and English Indices of Multiple Deprivation data (https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019) showed that in most individual cases, and across schemes (London and non-London), schemes were generally a good match. For instance, Table 9 compares a set of shortlisted non-London schemes aggregated (Leeds, Southport, Nottingham, Sheffield, Oxford) showing very minor differences except for deprivation. Considering the constraints involved in choice of area, this represents an excellent match, especially for car ownership and commute method; similar results were achieved for other areas.

Table 9: Comparison of selected non-London control and intervention areas (Leeds, Southport, Nottingham, Sheffield, Oxford) - all data from Census 2011, except deprivation)

Area name		LTNs	Control	Difference
Population		3809	4335	-526
Percentage of population		100%	100%	0%
Age	0 to 4	6%	5%	0%
	5 to 17	11%	14%	-3%
	18 to 64	71%	69%	2%
	65+	13%	12%	0%
Ethnicity	White	83%	86%	-3%
	Black	4%	3%	1%
	Asian	8%	6%	2%
	Mixed or other	5%	5%	0%
Disability	Not disabled	84%	86%	-1%
	Limited a little	8%	8%	0%
	Limited a lot	7%	6%	1%
Household car ownership	None	33%	33%	1%
	1 car	45%	46%	-1%
	2 or more cars	22%	22%	0%
Household employment	Any employed adult	71%	71%	0%
	No employed adult	29%	29%	0%

Area deprivation	Fifth 1 (least deprived)	29%	37%	-8%
	Fifth 2	19%	13%	6%
	Fifth 3	18%	8%	10%
	Fifth 4	3%	17%	-14%
	Fifth 5 (most deprived)	32%	25%	6%
	Median deprivation percentile	45%	44%	1%
Usual, main commute method	Bicycle	10%	10%	-1%
	Walk	21%	21%	0%
	Car or motorbike	49%	48%	1%
	Public transport/other	20%	21%	0%

Identifying segments and sensor locations

The next step was to identify two sensor locations in each area – a three-step process that begins by identifying desire lines and road segments of interest in each area.

1. Identify desire lines for cars, cycling and walking: These are essentially logical ways of passing through the neighbourhood to get to different key points, services or areas outside of the boundaries. They should ideally be two-way roads for motor traffic used by more than simply residents of the street or area itself.

2. Identify two segments of interest within an area: these are sections of a road on which to consider placing a sensor/camera. Two segments were seen as most appropriate given the general size of these schemes (larger than a single street, generally a small contiguous set of neighbourhood streets). Selected segments were situated on the desire lines, generally not on the same road as each other and should represent separate desire lines, i.e. it should be reasonably unlikely that a road user would pass over both segments on a journey through the neighbourhood. The two segments in the LTN were intended to – at present - collectively carry a similar amount of motor traffic, cyclists and pedestrians as the two segments in the control neighbourhood. To help identify segments with likely similar traffic volumes

and modal shares, the research team consulted typical traffic speed data on Google Maps at a typical peak time – 8am on a Tuesday morning.

3. Identify sensor locations[30]: on each segment, a point was selected which represented a good observation site, with a suitable location to attach sensors or cameras if needed. It was important to choose a point with a clear view of the road and both pavements, unobstructed by trees and structures. The sensor location and direction were chosen to avoid bus stops, significant junctions, crossings, or major businesses or services likely to distort the data. The suitability of sensor locations and lamp columns was assessed on a site visit by the external company providing the sensors and by the local authority street lighting team.

In occasional cases sensor siting was problematic; for instance, in one non-London case the authority agreed to site one sensor on a relatively busy road that was planned to be filtered and hence internal; but later scheme changes meant the road was instead a boundary. Conversely, in one London scheme, the team did *not* site a sensor on a busy road suspecting it might become a boundary, but which as planned is now internal to the LTN. In the second case this simply means potentially having missed the best possible choice; however, in the first case, it means that there is only one sensor inside the (now much smaller than originally planned) LTN.

Engagement with local authorities

Given the importance of local authority participation in the project as well as the reliance on expert local knowledge to guide decision-making around control area/sensor locations, consistent engagement with local authorities was important. Throughout this process, regular meetings were held with local authorities to discuss progress and ensure receipt of adequate data. During the selection process each local authority was sent a document that described the selection process and the suggested control/sensor locations.

Processing sensor data

For all but two non-London schemes, the data comes from machine learning sensors attached to lamp columns at the agreed locations in the LTNs and control areas. These sensors run continuously using artificial intelligence to classify street users into detailed modes (e.g. pedestrian, bicycle, car, van etc.) and collect data on the speed and the paths of the different road users. The main interest is the counts of transport modes, which can be broken down into short time periods (15-minutes/1 hour) that allow detection of whether mode shares vary across different periods of the day, as well as days of the week, months of the year and seasons. Appendix 2 outlines the classification of road users from the sensor data used in this analysis and further details of data collection at each site.

[30] In two cases as described earlier, more traditional counting methods were used, but the same process was followed.

Data cleaning

Processes taken to clean the data and ensure data quality are outlined below. More detail on all of these is provided in Appendix 2.

Dealing with missing data

The first task after downloading the data for all time periods and noting the validation and start dates for the baseline, was to identify any periods of zero count data where the sensor is likely to have stopped recording data, and hence, we could be confident that the counts were incorrect. An automated script examined counts from each direction for each sensor and identified days when there were either a) zero counts across all modes b) very low counts (less than 3) across all modes. Sensor data has been removed from analysis on zero count or very low count days, or on buffers just before, after, or in between such days (because these data may also be unreliable).

In the baseline analysis, if one of the sensors in an LTN-control set is to be removed, data is removed for all four sensors affected (two in the LTN, two in the control area) at the same time period. This is to ensure that the comparison is precisely like-for-like. The same principle is applied to cases where anomalous data has been removed. Across all schemes, the total number of one-hour periods for which data has been removed is 60,464, or just under 0.8% of all one-hour time periods. The relatively low percentage of such removals indicate the relatively good performance of the sensors.

Night-time automated anomaly detection and imputation

The first stage of detecting anomalies uses time series decomposition methods, combining short and longer-term trends to identify anomalies in one-hour periods at night-time (10pm to 6am). Night-time counts are typically smaller and less variable than day-time counts, making the detection process easier. Night-time anomalies (often spuriously high counts, discussed further in the appendix) have been removed from the data and the values replaced with predicted values that account for seasonal and short-term trends in the data. Data has been imputed rather than removed because during the night, with a narrow classification of anomalies, the risk of replacing real values is low. This, in combination with the lower variation in night-time values across all modes means that the imputed values are likely to be good estimates for actual values. The total number of one-hour periods for which data has been imputed so far totals 1175, 0.36% of all night-time one-hour periods.

Day-time automated anomaly detection

After imputing the anomalous night-time count data, the same time series decomposition approach was used to detect anomalies during the daytime (6am-10pm), with two main modifications. Firstly, because of the greater variation in daytime count data, anomalies are not automatically replaced, as there is a higher risk that the observed data is real rather than the result of a sensor malfunction/miscounting. Instead, identified anomalies are manually reviewed (see below). Secondly, anomalies have been detected in the daytime at the day-level i.e., identifying anomalies for each mode for each day, rather than at the hourly level. Working with day-level data makes the subsequent manual process more manageable across a small team.

Manual review of anomalous data

The manual review aimed to identify whether pre-identified day-time anomalies should be excluded or included in the final, cleaned data for analysis and to identify any unusual longer-term trends (rather than short-term, daily anomalous points/fluctuations) and decide whether this data should be included or excluded. This manual task was completed by several members of the team. Each reviewer had access to the identified anomalies, the predicted values, weather and bank holiday data, additional data where available showing the tracks (pathways) followed by people and vehicles passing the sensor, day-time daily counts for each sensor (including anomalies) and a daytime count graph of pedestrians in the roadway (which could indicate the presence of works on the footway, for instance). Using a combination of this data, the reviewer decided whether each anomalous data point should be removed from the data or kept in, using the table and rules described further in Appendix 2.

Identifying unusual long-term trends

In some cases, where the pre- or post- period may be quite short, longer-term unusual trends driven by roadworks (in particular) might pose a threat to the data. It would not be appropriate, for instance, to make conclusions about changes from pre- to post- periods, for example, where there may have been roadworks for an extended period affecting one of these time periods. And while the time series decomposition approach used performs well in identifying single-day or single-hour anomalies, it is less effective for identifying longer time periods of unusual data points.

To address this, the research team has manually inspected the daily count graphs for each sensor and mode for the baseline period to identify unusual long-term trends. These have been flagged by the reviewer and subsequently assessed collaboratively in a meeting. As previously, if the data appears to be a malfunction, miscalculation or one-off event, it has normally been removed. If the unusual data is caused by something unknown or for instance school holidays (recurring), the data is retained. (While not included in the main analysis, data removed or imputed is kept for inclusion in sensitivity analysis.)

Forthcoming analysis

Interrupted time series and controlled interrupted time series (ITS and CITS) will be used as the primary analysis method. On the whole, CITS is regarded as a more powerful design that Difference in Differences. ITS and CITS allow for temporal trends in the before and after period, by comparing slopes of best-fit lines through multiply measured pre- and post-period outcomes separately to detect differences. Using these methods, it will be possible to test whether there is not only an immediate impact of the LTN intervention, but also to explore how this may change over time after implementation (bedding-in, hypothesised to take place after the introduction of LTNs but not immediately).

Once there is aggregated sensor data from pre- and post-intervention time periods to provide daily totals by mode for each sensor, the analysis will first conduct an interrupted time series (ITS) analysis separately for each LTN sensor only. This will allow examination of the heterogeneity in the effects associated with LTN interventions across different locations. These initial models will essentially allow for the assessment of the impact of LTN interventions by comparing counts in the pre-intervention period with counts in the post-intervention period for each LTN sensor. The pre-intervention period will act as the control in this model.

Using ITS to compare only pre- and post-intervention data, there is a risk that perceived intervention effects actually reflect underlying changes in the area more widely: for example, changes in weather patterns, to emission zones or petrol prices. To account for such confounding factors, the analysis will make use of the control area sensors. This will create three controlled interrupted time series models for each LTN-control pair where the outcome variable is a ratio of counts (daily LTN sensor count over daily control sensor count). The count data will be aggregated for each pair, taking the total counts from two LTN sensors as intervention counts and the total counts from two control sensors as control counts. The data will therefore have two observations per each day and will include a dummy variable to differentiate between the control (0) and treatment group (1).

4.3. Baseline walking, cycling, and motor vehicle flow data

It is important for this research that the LTN sites and control sites have similar characteristics, not only in terms of demographic composition, but also in traffic volume and modal shares. The following section presents a summary of ‘pre’ data (walking, cycling, and motor vehicle flows) from control and intervention sensors across schemes in London and outside of London where sensors have been installed. Note that in the final reporting the figures may vary from those reported here because some areas will be removed from analysis if schemes are not implemented.

All schemes

Table 10. Baseline counts by mode across all LTN schemes

Type	Pedestrian	Cyclist	Car	Bus	Motorbike	LGV	OGV
LTN	5,816,724	1,324,538	8,973,470	91,597	737,270	1,350,742	105,789
Control	6,119,097	1,171,056	11,578,778	117,713	726,811	1,493,401	118,682
Percentage difference (control-LTN)	5%	-13%	23%	22%	-1%	10%	11%

Table 11. Baseline counts by mode across all LTNs in London

Type	Pedestrian	Cyclist	Car	Bus	Motorbike	LGV	OGV
LTN	5,050,323	1,266,934	7,454,054	87,418	728,273	1,195,451	96,352
Control	5,182,500	1,104,049	8,244,691	86,343	712,847	1,185,891	100,344
Percentage difference (control-LTN)	3%	-15%	10%	-1%	-2%	-1%	4%

Table 12. Baseline counts by modes across all non-London LTNs

Type	Pedestrian	Cyclist	Car	Bus	Motorbike	LGV	OGV
LTN	766,401	57,604	1,519,416	4,179	8,997	155,291	9,437
Control	936,597	67,007	3,334,087	31,370	13,964	307,510	18,338
Percentage difference (control-LTN)	18%	14%	54%	87%	36%	50%	49%

Table 10 presents the baseline data counts aggregated across all LTN and control sensors. Overall, across all time periods, the LTN and control counts are generally very well matched on all modes, except for cars and buses. The number of pedestrians and motorcyclists are especially well matched, with cyclists, LGVs (light goods vehicles, typically vans), and OGVs (other goods vehicles, typically lorries) reasonably close (within 13%). Across LTN sensors there were 5.8 million pedestrians counted compared to 6.1 million across control area sensors. For cyclists, the respective totals are 1.3 million and 1.2 million. The research team sees these figures as reassuring, especially given change in walking is such a key outcome. For cars and for buses, the baseline counts were 23% and 22% lower in LTN than control areas. Changes in these modes are not headline outcome measures, although they do suggest minor aggregate contextual differences which can potentially be explored further during analysis.

Further information on differences by time period, and weekday versus weekend, alongside summary statistics on averages can be found in Appendix 2.

London vs. non-London schemes

Table 11 and Table 12 show that the difference in the overall car counts between LTN sensors and control sensors is largely a result of schemes outside of London. In the schemes across London, the total baseline car counts across LTN sensors totalled 7.5 million compared to 8.2 million across control area sensors. The counts across other mode types were similar across LTN and control areas in London. For pedestrians and cyclists, the counts in non-London schemes were fairly similar across LTN and control sensors (14-18% difference).

However, in contrast, for the schemes outside of London, there is a more significant difference between the car counts: only 1.5 million cars were counted at sensors within the LTNs compared to 3.3 million cars at sensors in the control areas. For other vehicular modes, the counts were also dissimilar. This is in part a reflection of how complicated the process was to determine sensor locations outside London and the research team's lower level of control over this process. Generally, the more similar the intervention (LTN) and control groups, the lower the likelihood of confounding factors affecting any conclusions related to intervention effects. As such, it will be important in the analysis to adequately control for confounding factors that could create biases in the analysis. The greater dropout among non-London schemes will reduce this bias overall, although at the cost of the schemes in the analysis being disproportionately London LTNs.

Oxford and Birmingham (one-off data collection)

For the schemes in Oxford and Birmingham, sensors have not been installed to continuously record counts by mode across the whole time period. Rather, one-off data collection methods have been used in which manual and Automatic Traffic Counts (ATCs) have collected data at baseline. In Oxford, baseline data has been collected for two weeks between 11 and 25 October 2021. In Birmingham, baseline data has been collected for 4 weeks between 1 and 28 October 2021. These counts are being repeated across the same time periods in 2022 and will be repeated in subsequent years.

In Oxford, because one of the roads in the control area is one-way, the overall control baseline counts are lower than in the LTN area. Rather than compare overall counts, Table 13 below therefore analyses the median daily counts. For each sensor, the median count value is calculated across the counts in both directions on the road; for the sensor with only one direction, this uses the median value from this direction only. Table 13 shows that, in Oxford, the median daily counts are somewhat higher for pedestrians, cars/LGVs and cyclists in the LTN compared to the control area.

Table 13. Median baseline daily counts for LTN and control locations in Oxford

Type	Car & LGV	OGV	Bus	Pedestrian	Cyclist
LTN	892	120	2	880	361
Control	662	104	3	548	146

In Birmingham, counts for each mode have been aggregated across the entire monthly period. As Table 14 shows, for most mode types except buses, there are only relatively small differences between the LTN counts and the control area counts. However, for cars specifically, there are some 398,358 counts in the LTN compared to 257,214 counts in the control area.

Table 14. Total baseline counts for LTN and control locations in Birmingham

Type	Bus	Car	Cyclist	LGV	Motorbike	OGV	Pedestrian
LTN	602	398,358	7,271	29,814	1,838	2,756	28,558
Control	5,473	257,214	2,044	18,435	1,512	2,002	23,348

Individual schemes

As well as comparing the aggregated pre-intervention count data across all of the London-based and non-London based LTN and control sensors, the research team has conducted analysis of each scheme independently. This involves comparing 1) the daily count data by mode per pair of LTN sensors with their respective pair of control sensors; 2) the mean, median and standard deviation of daily counts per mode across LTN and control sensors.

The focus here is predominantly on the median daily values associated with pedestrians, cyclists, and cars, with tables in Appendix 2 providing breakdowns for individual schemes.

Overall, for scheme-level counts of pedestrians and cyclists, the LTNs and control areas, both in London and outside of London, are generally well-matched, with some exceptions for pedestrians. This is important as, employing a quasi-experimental approach, the control trends, which will act as a comparator, should be unaffected by confounding factors that do not impact on the LTN areas.

The schemes are generally less well-matched by daily car counts, particularly outside of London. In part, this is likely a consequence of a) the greater variation in car counts across all sensors; b) very high levels of car traffic in some areas; c) the lack of control the research team had in determining some matched control areas and sensor locations in some non-London schemes. Given the uncertainty over completion of some non-London LTNs (including two schemes with particularly high variation for pedestrians), while there will be some inevitable variation across sites, this is unlikely to cause significant bias.

Strengths and limitations

The strengths of the approach are:

- Use of control and intervention areas means it is possible to better isolate the impact of the ATF funding on walking, cycling, and motor vehicle levels from local (as opposed to national) background trends.

- Sensor data provides continuous data on walking, cycling, and motor vehicle levels, to a high degree of accuracy (in all but two cases).

- Combining the count data with Route User Intercept Survey data allows for the estimation of the proportion of users who are making new walking or cycling trips, thereby allowing us to estimate health benefits from new physical activity and the extent to which trips have replaced car use (which bring additional benefits).

A limitation of the approach is that most of the evaluated schemes will be in London. Although most of the schemes initially shortlisted were non-London schemes, many were indefinitely delayed or cancelled, or changed to such an extent that they no longer resembled an LTN (which we defined as including at least two ‘modal filters’ and affecting more than one street). The introduction of most schemes later than planned has also reduced the length of ‘post-intervention’ data and extended the study timeline.

4.4. Baseline traffic speed data for LTN boundary roads

The research team has been collecting Google API real-time journey data to measure journey times by car on segments of identified boundary roads. Data is collected from segments of boundary roads surrounding LTNs and comparable control area boundary roads. The aim of this is to answer RQ4, which is:

What impacts are there on speed of traffic on LTN boundary roads and how does the magnitude of any impacts change over time? What impacts are there on changes to local car journey times?

At this stage, there is limited post-intervention traffic speed data across the schemes as implementation has been delayed. However, the analysis can be split into two parts:

1. A comparison of baseline (pre-intervention) data on LTN (intervention) and control boundary roads
2. A pre- and post-intervention analysis for Camden Square LTN, which was implemented in December 2021. This LTN, treated here as a pilot study, is included to demonstrate some of the analysis and outputs that will be produced across all schemes.

Later reporting will also analyse changes to local car journey times, using the methods outlined in Appendix 2.

Baseline data comparison: LTN and control boundary roads

Table 15 compares the mean, median and standard deviation of all pre-intervention journeys in schemes outside of London routed by Google API, separated into time periods and LTN or control boundary roads. While the standard deviation in the speeds of LTN and control segments are generally similar across these time periods, the mean and median speeds are a little faster on LTN boundary roads than on control roads. The median speed across all time periods on control boundaries is 20.5mph compared to 18.0mph on LTN boundary roads. This small difference in speeds is consistent across most time periods, though slightly greater on Tuesday early mornings and Saturday daytimes.

This is unlikely to cause problems for the statistical models, as relatively small baseline differences of this type suggests that the roads are relatively similar for standard assumptions to hold (for instance, parallel trends for Difference-in-Differences models). Appendix 2 provides a breakdown by speed by LTN scheme. Across most schemes, speed levels are similar on LTN and control boundary roads, except for Oxford (and to some extent Leeds) where the control boundary road speeds are higher.

Table 15. A summary of pre-intervention traffic speed data across LTN and control boundary roads for non-London schemes

	Number of journeys		Mean speed (mph)		Median speed (mph)		Speed standard deviation	
Time period	LTN	Control	LTN	Control	LTN	Control	LTN	Control
All time periods	373,491	327,806	17.8	20	18	20.5	6	5.8
Tuesday early morning	25,420	22,296	21.2	24.5	21.8	25.5	5.7	5
Tuesday morning peak	68,060	59,865	17.5	19.6	17.7	20.1	5.9	5.5
Tuesday inter-peak	76,255	66,881	17.5	19.6	17.6	20	5.7	5.4
Tuesday evening peak	76,256	66,887	16.4	18.3	16.2	18.8	5.9	5.7
Tuesday evening post-peak	50,840	44,587	19.2	21.7	20	22.3	5.8	5.3
Saturday daytime	76,660	67,290	17.6	19.7	17.6	20.6	5.9	6.2

Table 16 below presents the mean, median and standard deviation of speed for all pre-intervention journeys on LTN and boundary roads for LTN schemes in Greater London. Compared to the non-London boundary roads, mean or median average speeds outside of London are lower with a smaller variance in speeds. The LTN and control boundary road speeds for London schemes are closely matched: the median speed across all time periods was 13.0mph on LTN boundary roads compared to 12.2mph on control boundary roads. This small difference is consistent across all time periods. Appendix 2 contains the same table broken down by LTN scheme. There are no schemes where there are substantially higher or lower speeds on LTN boundary roads compared to the control boundary roads – all schemes are well matched in terms of boundary road speeds.

Table 16. A summary of pre-intervention traffic speed data across LTN and control boundary roads for London schemes

	Number of journeys		Mean speed (mph)		Median speed (mph)		Speed standard deviation	
Time period	LTN	Control	LTN	Control	LTN	Control	LTN	Control
All time periods	560,543	488,572	13.1	12.3	13	12.2	4.3	4
Tuesday early morning	37,180	32,392	17.3	16.2	17.7	16.4	4.2	4.4
Tuesday morning peak	111,528	97,172	12.6	12.1	12.6	12	4.3	3.9
Tuesday inter-peak	111,538	97,159	12.8	12.1	12.7	12.1	4	3.8
Tuesday evening peak	111,540	97,166	11.7	11.2	11.6	11.3	3.7	3.6
Tuesday evening post-peak	74,934	65,312	14.1	13.3	14.1	13.3	4	3.7
Saturday daytime	113,823	99,371	13	11.9	13.1	11.9	4.1	3.8

In the analysis that follows, speed from the Google API journey data is treated as a measure of congestion. A decrease in speed along a road segment is considered evidence of an increase in congestion; an increase in speed reflects a decrease in congestion. For this initial analysis, the focus is largely on average speeds, though this will be extended in later analysis to consider specific thresholds of congestion (e.g., proportion of journeys that fall below a given speed) or the lowest speeds.

A pre- and post-intervention analysis for Camden Square LTN

The section below describes exploratory work in Camden Square LTN, using mean and median average speeds across pre- and post-intervention periods. The pre-intervention period runs from 18 June 2021 to 22 December 2021. The post-intervention period data is taken from the scheme implementation date of 23 December 2021 up until 6 September 2022. Note that this is still a relatively short post-implementation period from which to make any conclusive judgment about any association between LTN implementation and traffic speed on boundary roads. Also, this is one scheme and is presented only as an initial example using data available due to the relatively early implementation of this LTN, compared to other schemes.

Table 17. A summary of pre- and post-intervention traffic speed data across LTN and control boundary roads for Camden Square LTN

		Number of journeys		Mean speed (mph)		Median speed (mph)		Speed standard deviation	
Time period	Area	Pre-intervention	Post-intervention	Pre	Post	Pre	Post	Pre	Post
All time periods	LTN	31,608	39,960	11.3	10.6	11.3	10.6	3.7	3.9
	Control	35,120	44,396	12.2	12.2	11.6	11.5	4	3.9
Tuesday early morning	LTN	2,088	2,664	15.3	14.7	15	14.2	4.9	5.2
	Control	2,320	2,960	15.4	14.9	15.9	15.2	4.2	4
Tuesday morning peak	LTN	6,264	7,992	10.5	9.7	10.1	9.6	3.8	3.8
	Control	6,960	8,880	12.1	11.9	11.6	11.3	3.8	3.8

Tuesday inter-peak	LTN	6,264	7,992	10.7	10	10.7	10.4	3.2	3.5
	Control	6,960	8,876	12	12.2	11.3	11.2	3.9	3.7
Tuesday evening peak	LTN	6,264	7,992	10.4	9.7	10.4	9.9	3.2	3.3
	Control	6,960	8,880	11.3	11.5	10.8	10.6	3.9	3.7
Tuesday evening post-peak	LTN	4,248	5,328	12.7	11.7	12.7	12.2	3.3	3.7
	Control	4,720	5,920	12.8	12.7	12.7	12.2	4	3.8
Saturday daytime	LTN	6,480	7,992	11.2	10.7	11.6	11.4	3.2	3.6
	Control	7,200	8,880	11.9	12.2	11	11.2	3.9	3.9

Table 17 above presents an overview of the mean, median and standard deviation of speeds across all LTN and control area road segments in Camden Square, broken down by pre- and post-intervention and time period. Assessing all time periods, the mean and median speeds in control area boundary road segments has remained consistent between the pre- and post-intervention periods. In contrast, on the LTN boundary road segments, there is a small decrease in mean (and median) speed from 11.3mph to 10.6mph following the implementation of the LTN. This is the equivalent of it taking 5 minutes and 40 seconds rather than 5 minutes and 19 seconds to travel a mile.

There is always a decrease in speed on the LTN boundary road segments that is not matched on control area boundary roads. There is no pattern to the time periods that have had more or less substantial falls in median speed compared to control areas. What is noticeable, however, is that the standard deviation in speeds has also increased very slightly on LTN boundary road segments compared to control boundary road segments. The implication is that there is, post-LTN, slightly higher variation in speeds across Camden Square LTN boundary roads than those in comparative control areas.

The splitting of the boundary roads data into intervention (LTN) and control groups allows us to use a quasi-experimental approach (Difference-in-Differences) to compare the changes in speeds across the pre- and post-intervention time periods for the LTN and control boundary roads. Further details of this method are in Appendix 2. Provisionally, in between the pre- and post-implementation periods, the results indicate that the LTN in Camden Square reduced speeds on the boundary roads by a mean 0.75mph. The accompanying model results can be found in Appendix 2.

It is worth reiterating that these results come from a short post-implementation time period, where this change might reflect an initial decrease in speeds before traffic 'settles' to a similar level as pre-implementation. This can be tested more thoroughly in forthcoming analysis with data across multiple schemes with longer post-implementation time periods. This will enable more conclusive findings and evidence of the extent of between-scheme variation that considers specific effects associated with peak times and non-peak times.

Strengths and limitations

The strengths of the approach are:

- Use of a novel dataset which provides objective data on predicted journey times based on live traffic information, involving many routed journeys.
- Use of the already created control areas makes it possible to separate other causes of changes in traffic speed from LTN implementation.

One limitation of the approach is again that most of the evaluated schemes will be in London. There are also potentially other factors affecting traffic speeds in both control and intervention areas, such as long-running roadworks, so comparisons between individual sites should be treated with care. Finally, the novel approach means that there are relatively few other examples of analysis using this dataset to answer such questions. The same comments apply to the analysis of changes in car journey times that will be conducted (see Appendix 2).

4.5. Analysis of 'before' trends using secondary data (car ownership, injuries)

Note that the following analysis includes both Bury and Wigan, which were recently removed from the analysis, hence that is why there is reference to '10 non-London schemes'. This analysis will be re-run for the final report, at which point some other schemes that have not proceeded will also likely be removed.

Analysis of secondary data on car ownership

Methods

The Driver and Vehicle Licensing Agency (DVLA) maintains the registration and licensing of motor vehicles in Britain, including the address of the person responsible for vehicle taxation. For simplicity this is referred to here as 'ownership', although it also covers some forms of leasing a vehicle. The DVLA data used consists of the number of cars and light goods vehicles ('vans') in each Lower Super Output Area (LSOA[31]) in England on 31st December for the years 2012-2020. This was obtained via Freedom of Information requests to the DfT Vehicle Stats team.

To examine how car and van ownership has been changing over time in the intervention and control areas, each LSOA was identified as lying 'inside' a) one of the forthcoming LTN intervention areas, b) one of the control areas. 'Inside' here means at least 70% of the LSOA's area inside the intervention / control area. Note that these figures may change slightly in the final report, e.g. if LTN boundaries change once schemes are implemented, or if some schemes are never implemented. Of 78 LSOAs intersecting the LTN and control areas, none were ever outliers for vehicle ownership (outlier status can reflect e.g. the presence of a car dealership).[32]

ONS mid-year population data was used to calculate vehicle ownership per capita. Annual vehicle ownership per capita is presented for LTN and control areas at the aggregate level, stratifying between the London versus non-London schemes. Population trends were very

---

[31] LSOAs are administrative areas containing around 1500 residents.

[32] Outliers were defined as ever being any of the following: >1000 cars per 1000 adults; >200 vans per 1000 adults; or in the top 0.2% for residual size in any of 3 regression models adjusting only for year and LSOA and predicting in turn to cars/vans, cars, or vans.

similar in the LTN and control areas, so the results were unchanged in sensitivity analyses that instead examined trends in absolute numbers of vehicles owned.

Findings

Car/van ownership per capita is presented in Table 18 for 8 London schemes, 10 non-London schemes, and the combined set of 18 schemes. There was no statistically significant evidence of a difference between the LTN versus control areas in how vehicle ownership changed over time (all $p \geq 0.1$). This similarity in pre-intervention trend is encouraging, as it enhances the confidence in interpreting any post-intervention differences between the areas as being caused by the LTN schemes.

One caveat is that the numbers of LSOAs covered by these areas is relatively modest (e.g. n=14 in non-London LTN areas). Given that DVLA data provides comprehensive information on vehicle registration, the relatively small number of LSOAs involved will not necessarily be a problem with sufficient follow-up: in Waltham Forest there was a highly statistically significant reduction in car/van ownership after 2 years based on a sample of only n=7 LSOAs.[33] This trend in Waltham Forest only started to emerge after schemes had been in place for at least 1 year, however, and became far more apparent after 2 or 3 years. The final analysis for this theme will be able to draw on data up to 2023-4, at which point some of these schemes will have been in place for less than a year. It is therefore proposed that the final report will present early results for these schemes, but there may not be a significant effect at this stage. The research team may conduct follow-up analysis separately in 2025, including vehicle ownership data up to the end of 2024. While not a formal ATF deliverable this would be published in an academic journal.

[33] https://findingspress.org/article/18200-the-impact-of-low-traffic-neighbourhoods-and-other-active-travel-interventions-on-vehicle-ownership-findings-from-the-outer-london-mini-holland-progr

Table 18: Can/van ownership inside the LTN and Control areas, for the 8 London schemes

	Year	LTN areas		Control areas		p-value for difference in trend
		No. LSOAs	**Mean cars/vans per 1000 adults**	**No. LSOAs**	**Mean cars/vans per 1000 adults**	
London (8 schemes)	2012-14	27	252	26	266	0.95
	2015-17	27	254	26	268	
	2018-20	27	252	26	266	
Non-London (N=10)	2012-14	14	523	11	435	0.10
	2015-17	14	541	11	453	
	2018-20	14	559	11	458	
England (N=18)	2012-14	41	345	37	316	0.24
	2015-17	41	352	37	323	
	2018-20	41	357	37	323	

LTN = low traffic neighbourhood. P-values for differences in trend calculated as the interaction between year and LTN status in multilevel linear regression models, with car/van ownership as the outcome and a random intercept by LSOA.

Strengths and limitations

The strength of the approach is that the use of objective data on car ownership incorporating a comparison with our control areas allows separation of LTN from other impacts on this. One limitation of the approach is again that most of the evaluated schemes will be in London. Due to delays in scheme implementation, it is possible that there will be insufficient power to detect a change in car ownership, which is likely to take longer than changes in travel behaviour.

Analysis of secondary data on road traffic injuries

Methods

STATS19 police injury data for the years 2012-2020 was used to provide information on the travel mode and injury severity of road traffic injuries, plus detailed geographical coordinates for the collision location.[34] The primary outcome was number of injuries of any severity, in total and stratified by mode of travel, with secondary analyses of killed or seriously injured (KSI), but these are much less well powered due to small sample sizes.[35]

To examine how numbers of injuries have been changing over time in intervention and control areas, the research team identified whether the point location of each injury lay inside a) one of the forthcoming LTN intervention areas, b) one of the control areas. 'Inside' was defined as being at least 15 metres inside the LTN / control area boundary. This internal buffer was used in recognition of the fact that there is some imprecision in injury mapping, and points near the boundary often in fact lie on a boundary road.

The analysis presents mean average injury numbers across time for LTN and control areas at the aggregate level, stratifying between the London versus non-London schemes. It uses chi-squared tests to examine whether there is statistically significant evidence of a difference between the LTN and control areas in injury numbers over time.

Findings

Numbers of traffic injuries are presented in Appendix 2 for London, non-London, and both types of schemes combined. There was no statistically significant evidence of a difference between LTN versus control areas in how injury numbers changed over time (all $p>0.05$). This should, however, be treated with caution given small sample sizes. For example, there was an average of only around 20-30 casualties per year for the London LTN areas and a further 20-30 per year for non-London Control areas. Numbers are lower when restricting to killed and seriously injured (KSI) injuries or when considering injuries stratified by mode.

Analysis will conclude during 2024. As only two schemes had been implemented by March 2022 (the target date for completing ATF2 schemes), there may not be sufficient 'post' data from these schemes available for the follow-up report, especially as Stats19 data is released annually in September; so the latest year of available data will be 2022. The final report will thus present early indicative results for these schemes, but firm conclusions may not be possible. The research team may conduct follow-up analysis later in 2025, using additional data available then. While not a formal ATF deliverable this would be published in an academic journal.

Strengths and limitations

The strength of the approach is that the use of policy road injury data incorporating a comparison with our control areas allows separation of LTN from other impacts on this.

---

[34] Available from https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data

[35] This incorporates the adjustment factors provided by Stats19 to account for changes over time in how police have distinguished 'serious' versus 'slight' injuries.

One limitation of the approach is again that most of the evaluated schemes will be in London. Due to delays in scheme implementation, it is possible that there will be insufficient power to detect a change in injuries during the project timeframe. While police recorded injury data is the best data available, there is known under-reporting, especially of single vehicle collisions involving cycles and slight injuries.

5. School Streets

This chapter:

- Presents information about the regional spread of School Streets (as far as is currently known).
- Comments on the methods to be used to analyse (i) the distribution of school streets (in terms of free school meal entitlements) and (ii) their potential for reducing road injuries, if possible.

5.1. Regional Distribution of School Streets

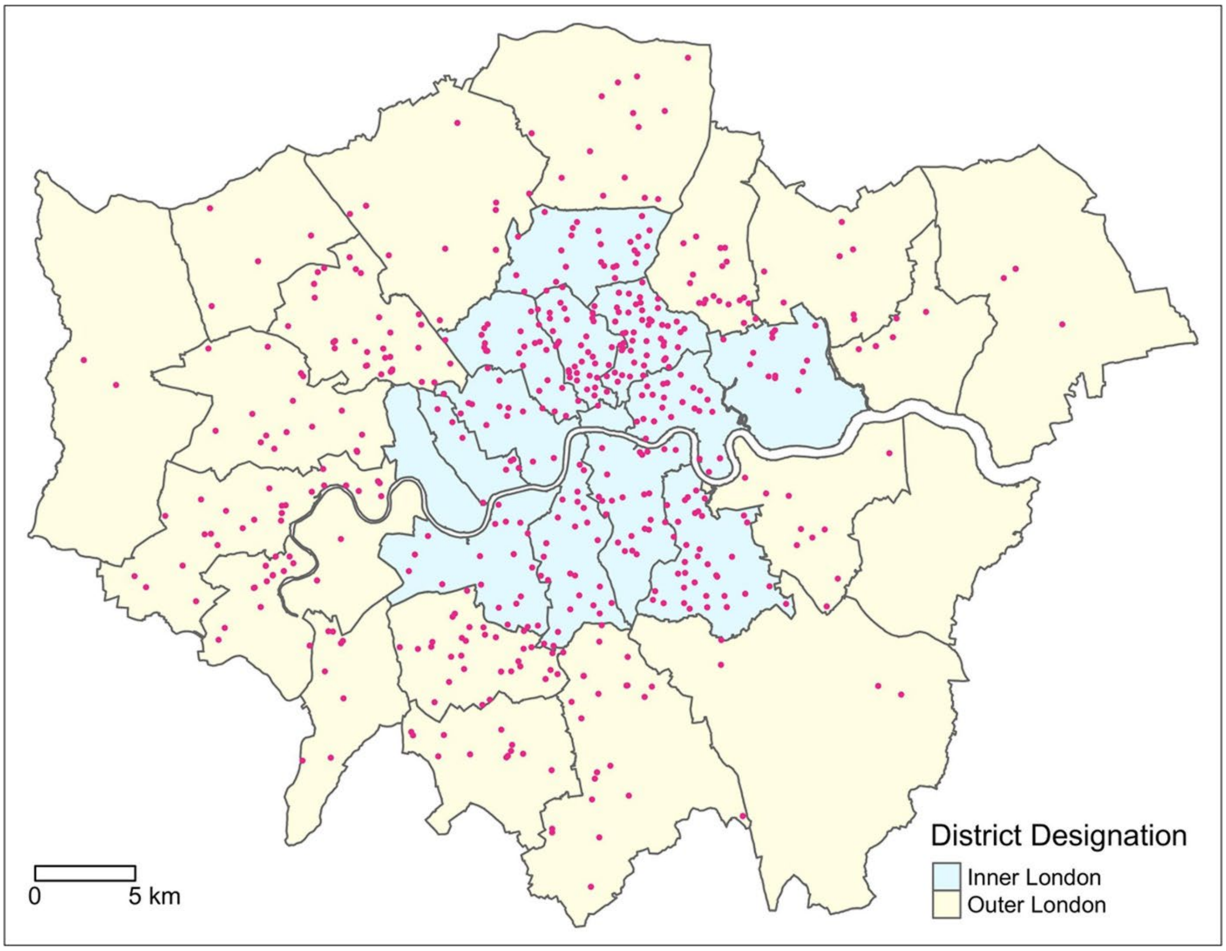


Figure 2: A map showing the location of state-funded primary schools with School Streets (implemented between March 2020 and April 2022) across Greater London (Thomas et al 2022)[36]

The research team has acquired data on which schools have implemented, or are implementing, School Streets. The majority (over three quarters) of School Streets reported to have been introduced since March 2020 are in London. Figure 2 above illustrates the pattern of School Streets implementation in London after March 2020, just considering state primary schools (the most commonly treated school type). Analysis published by Thomas et al (2022[37]) found that among 1813 state-funded primary schools in London, 446 (or just under 25%) had received a School Streets intervention between March 2020 and April 2022. This varied substantially by borough and area of London, however, with 34% of Inner London state primary school having a School Street, but only 18% of Outer London state primary schools having one.

[36] https://www.sciencedirect.com/science/article/pii/S1361920922002292

[37] Thomas et al 2022, https://www.sciencedirect.com/science/article/pii/S1361920922002292

The measure remains much less common in other parts of England. In March 2022, responses to a DfT ATF monitoring survey reported that 148 School Streets were to have been implemented by September 2022 in the rest of England, with 40 of those in a single authority area (West Yorkshire Combined Authority). Most authorities who were introducing the measure reported that they had implemented or were implementing only one or a handful at most of School Streets.

Table 19: School Streets to be implemented by September 2022, outside London, by authority

Authority Name	Number of School Streets in operation or to be implemented by September 2022 (reported in March 2022)
West Yorkshire CA	40
Brighton and Hove UA	14
Southampton UA	12
Essex	9
Oxfordshire	9
Nottingham UA	8
Northeast Joint Transport Committee	7
Bournemouth, Christchurch and Poole UA	6
Cumbria	5
Greater Manchester CA	5
Southend-on-Sea UA	4
West of England CA	4
Devon	3
Leicester UA	3
Hampshire	3
West Berkshire UA	2
Bedford UA	2
East Riding of Yorkshire UA	2
Slough UA	2

Kent	2
Liverpool City Region CA	1
Swindon UA	1
Northamptonshire	1
Dorset	1
Northamptonshire	1
Lancashire	1

5.2. Planned analysis of equity of implementation and impacts on road injuries

The final report will check whether schools included in the numbers given in Table 19 have had schemes implemented. Based on experience with LTN and cycle track schemes, not all implementations may have happened. It will then present the proportion of schools with School Streets by type and size of school, broken down by number of pupils, and whether the school is a primary or secondary, state-funded or independent school. This will extend previous analysis in London which has shown that primary schools and state-schools were more likely to have a School Street than secondary or independent schools.

To assess the relative equity of the implementation of School Streets, analysis will use gov.uk data on the proportion of children receiving free school meals. This will compare the overall proportion of children receiving free school meals at schools with School Streets compared to all schools and specifically schools without School Streets. The analysis will show whether there is an association between the proportion of students likely to be living in economic deprivation and the implementation of School Streets.

School Streets have been shown to be associated with improvements in air quality. The research team's analyses have previously found that LTNs are associated with a reduced injury risk, but there has yet to be any evidence on the effectiveness of School Streets in this regard. The lack of existing research is likely to be because School Streets are relatively new and there are still relatively few. The small sample size means that baseline (pre-implementation) injury numbers in the vicinity of schools with School Streets are likely to be low. It therefore becomes difficult to make any statistically robust conclusions around injury risk pre- and post-intervention from assessing the change in injuries. Hence it is unclear whether there will be scope to assess the impact of School Streets on road traffic injuries. Initially, police injury data (STATS19Stats19) will be used to generate baseline data of injuries to children within a 100 metre or 200 metre radius of a school pooled across the years 2015 to 2019. A power analysis will be conducted to assess the difference required to achieve a statistically significant result, comparing pre/post intervention trends at intervention schools with all other schools.

Based on an initial power calculation, it may not be possible to conduct a statistically robust analysis at present. However, this power calculation will be revisited in 2024, once 2020 and 2021 School Street locations are confirmed and baseline injury data and available follow-up data can be extracted for those schools. At this point either the analysis will be conducted or the research team will estimate when it can be expected that there will be sufficient power (e.g. '2 more years of follow-up data'). If it is possible to conduct this analysis, police injury data will be used to make pre/post-intervention comparisons of injury numbers in the vicinity of a) schools with School Streets; b) all other schools. Fisher’s exact chi-squared tests will be used to understand whether the distribution of injuries to children is related to a school being a School Street or not.

Strengths and limitations

The strengths of the approach are:

- Inclusion of School Streets across the country, not just London, unlike most research to date.
- Use of standard data, i.e. on free school meals and on injuries.

One limitation of the approach is that the analysis will not study the impact on method of journey to school, as unfortunately there is no secondary data available on this.

6. Discussion & Conclusion

This chapter:

- Briefly discusses the baseline data and issues arising.
- Outlines next steps in analysing follow-on data, and its collection where relevant.

It states that:

- Generally, the data are sufficient to answer the research questions.
- In the main analysis of changes in walking and cycling, there will be bias towards London in the LTN scheme data analysis, due to a lack of scheme progression outside London. To some extent this is balanced by the cycle track schemes included in the analysis all being based outside London.
- Use of secondary data is likely to provide only initial indications of trends, due to slower than planned implementation of schemes.

6.1. Cycle track scheme data and analysis

The research team has identified 10 cycle track schemes and worked with partner authorities to identify control and intervention counter locations. There remains some uncertainty about one scheme, and there have been some delays in data collection and provision related to scheme delays, necessitating extension in the study period. However, the team has overall confidence in being able to collect sufficient data (including the Route User Intercept Survey data, to be collected by authorities with the research team’s support and advice) to allow the research questions relating to this theme to be answered. These are specifically on impacts on cycling flows, the diversion of trips to walking and cycling, and related health economic impacts.

6.2 LTN scheme data and analysis

Despite problems linked to scheme delays, cancellations, and changes, particularly outside London, there are at present 15 LTN schemes provisionally included in the evaluation. It is expected that only 10 will be included in the final analysis and report, as some are likely still to be cancelled or so substantially delayed or changed that they cannot be a part of the analysis. There are generally well-matched control areas, with good demographic similarity (e.g. car ownership, commute mode), and the team are generally satisfied with sensor locations.

The report has presented a dataset for 15 LTN schemes and matched control areas of pedestrian, cycle, and motor vehicle flows mostly from continuously recording sensors. The similarities between LTN and control areas gives confidence that a robust comparison can be made, particularly for the London schemes which are especially well matched (although non-London schemes are generally well matched for pedestrian and cyclist flows, which is more important). Hence, when schemes are constructed, there should be sufficient good quality baseline data to evaluate their impact on walking and cycling. As with the cycle track schemes, the team will support local authorities to carry out Route User Intercept Surveys in Autumn 2023, allowing an estimate of the proportion of cycle and walking trips replacing car trips, and hence, health economic impacts.

The report comments on traffic speed data. This is a novel dataset that can be used to evaluate impacts of LTN schemes on boundary roads, both immediately, in the short and longer term. It shows that the LTN and control sites are generally well matched, but with differences between London and non-London site pairs. An exploratory analysis illustrates how the analysis may assess changes to mean and/or median speeds. Again, this is a good starting point to conduct the follow-on analysis, which will go further in calculating, for example, any impacts of LTNs on the proportion of trips that are undertaken in congested conditions at different times of the day and week. Regarding RQ4, the final report will also analyse a car journey time dataset to explore impacts on car journey times to and from LTNs, separate from any congestion impacts. The car journey time dataset also derives from Google API data, and involves routing to a set of key destinations in LTN and control areas, as described further in Appendix 2.

The report has explored the potential for analysing the impact of schemes on injuries and car ownership, using secondary data provided by DfT and DVLA. Initial analyses suggest that LTN and control areas are sufficiently well matched in prior trends. However, the data release timetables and the slower than planned progress with scheme implementation (and likely cancellation of some of the 15 remaining schemes) mean there may be insufficient 'post' data and hence insufficient statistical power to identify modest changes in these variables. The team will attempt the analysis and have planned separately to conduct analysis later involving their own dataset of all London schemes (not only those included here), but this is unlikely by 2024.

6.3 School Streets data and analysis

The team has obtained data on School Streets already implemented in London, and provisionally on School Streets implemented outside London (pending confirmation that schemes have been introduced as planned). The distribution of existing or planned schemes shows an unequal spatial distribution, with most authorities introducing few or no School Streets, and others introducing them in a substantial proportion of schools. The final report will analyse the implementation of School Streets in relation to the proportion of pupils receiving Free School Meals at the school, comparing patterns in London and outside London. This provides an understanding of the extent to which School Streets are benefiting schools with a more, or less, deprived pupil catchment. The team will also then seek to conduct an injury analysis through the same methods used to study impacts of

LTNs on road injuries to identify whether School Streets are associated with a reduced injury risk but in this case using a buffer around the school in question.

6.4 Process evaluation data and analysis

The team has successfully collected, analysed, and written up data from the first stage process evaluation (ATF Evaluation: Process Evaluation Report Stage 1, 2023). Data from the second stage process evaluation will be collected, analysed, and written up in 2023. Conclusions from both process evaluations will be used to contextualise and help explain the results of quantitative analysis described in the final report.

6.5 Quantifying costs and benefits of cycle track and LTN schemes

The team has established the processes to quantify the impacts of cycle track and LTN schemes through estimating changes in active travel uptake, and hence (via DfT's Active Mode Appraisal Tool) health economic impacts. This will draw on count and sensor data and estimates of mode replacement generated through Route User Intercept Surveys. The team anticipates potentially large physical activity benefits. Where other benefits look likely to be important, the team will seek to quantify these (e.g. related to positive impacts of reduced driving). They will also estimate typical costs of such schemes, which can be compared with the benefits.

Appendix 1. Cycle track theme

A1.1 Cases

In the following section the cycle track schemes being delivered in each local authority are described in more detail, as well as the location of their intervention and control counters. In most cases, information on each scheme has been obtained from the local authorities' submission to the DfT for Active Travel Fund tranche 2 funding and through discussions with local authority staff. Descriptions are accurate at the time of writing, but schemes may change in scope when they are delivered. Kent's proposal is unconfirmed and so no write-up is contained here.

Bolton (Greater Manchester) - South Bolton to Farnworth (GM01)

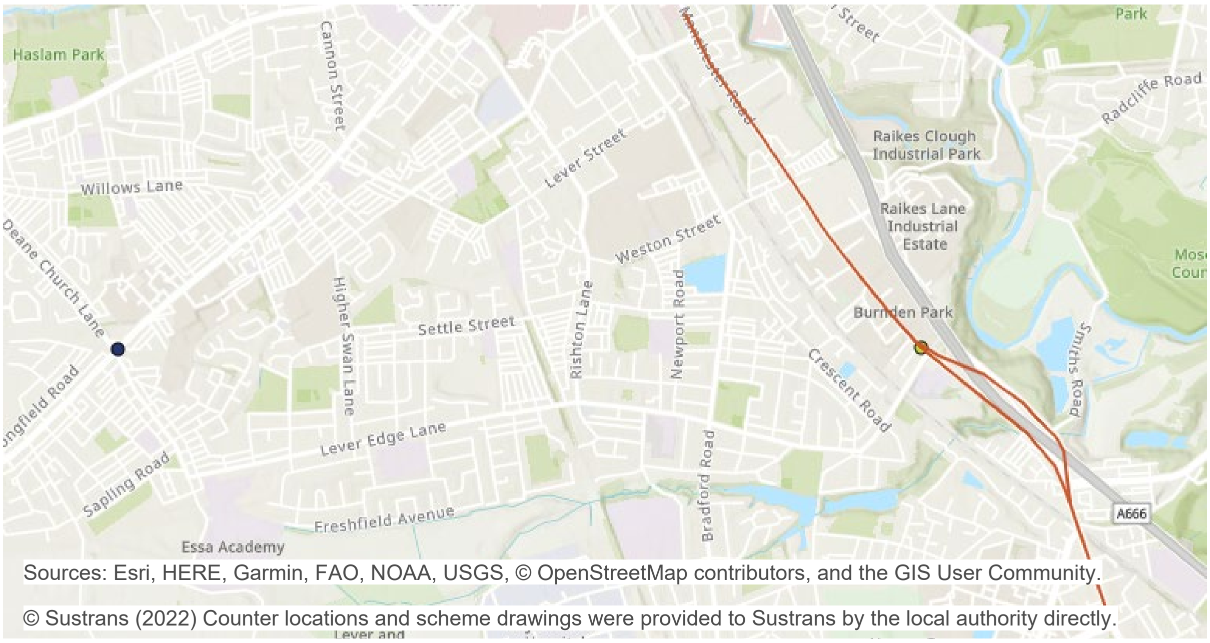
Manchester Road, which runs parallel to the A666 (a major dual carriageway), connects Bolton town centre with Farnworth. This route currently only offers painted, narrow cycle lanes along much of its length.

The Active Travel Fund tranche 2 proposal will improve the cycling provision along Manchester Road by formalising the cycle lanes through road space reallocation and 'light' segregation. It will involve the creation of links to other active travel infrastructure, including a CYCLOPS junction at Trinity Street, Bradshawgate, Manchester Road and Bridgman-Lower Bridgman Street funded through the Transforming Cities Fund. The University of Bolton has also invested in 1,000 bicycles for students to support students travelling between the Bolton town centre Deane Road campus and the Farnworth campus.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counters are located (green dots) and where the control counters are (black dots).

Figure 3 Bolton’s scheme (red line), intervention counters (green dots) and control counters (black dots)



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.

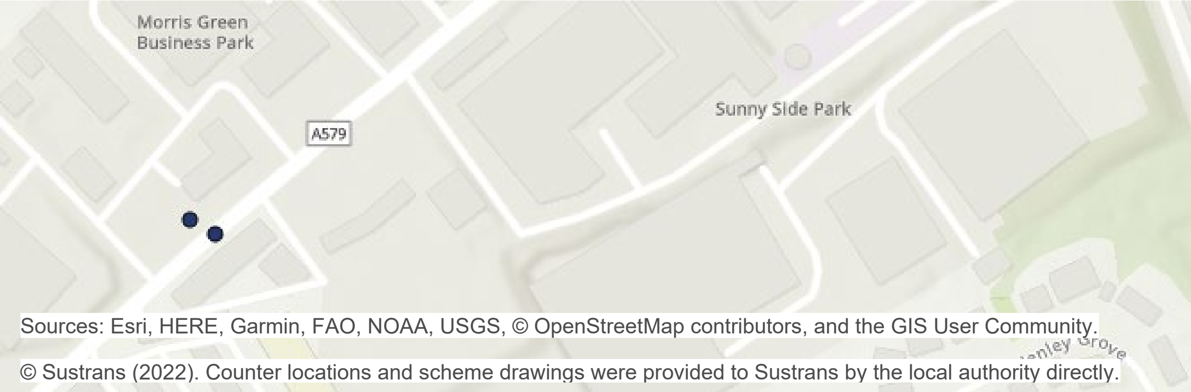
© Sustrans (2022) Counter locations and scheme drawings were provided to Sustrans by the local authority directly.

Figure 4 Bolton’s scheme (red line) and the two intervention counters (green dots) where Manchester Road splits

Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.

© Sustrans (2022). Counter locations and scheme drawings were provided to Sustrans by the local authority directly.

Figure 5 Bolton’s two control counters (black dots) on St. Helen’s Road



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.

© Sustrans (2022). Counter locations and scheme drawings were provided to Sustrans by the local authority directly.

The two intervention (video) counters are located on parallel sections of Manchester Road, which connect the south of Bolton with the city centre. One counter is located on a road where no cycling provision currently exists (counting movements both on the road and the pavement), and the other on a road with painted cycle lane provision (counting movements here as well as on the road and pavement). Both routes are likely used largely for utility purposes.

Both control counters, also videos, are situated on St. Helen’s Road, south-west of the city centre. No cycling provision currently exists on the road, with both counters counting movements on the road and pavement. Like the intervention route, use is largely for utility purposes.

Figure 6 Looking north-west along the scheme route (Manchester Road) with its current painted cycle lane provision on either side of the road

Source: [Google Maps]

Essex - Transforming Colchester (ES01)

The Active Travel Fund proposals focus on two routes heading east-west and north-south in Colchester. Some scheme information has been obtained from: [https://www.essexhighways.org/uploads/sgh/atf-colchester-summary-of-proposals-may-2021.pdf).](https://www.essexhighways.org/uploads/sgh/atf-colchester-summary-of-proposals-may-2021.pdf)

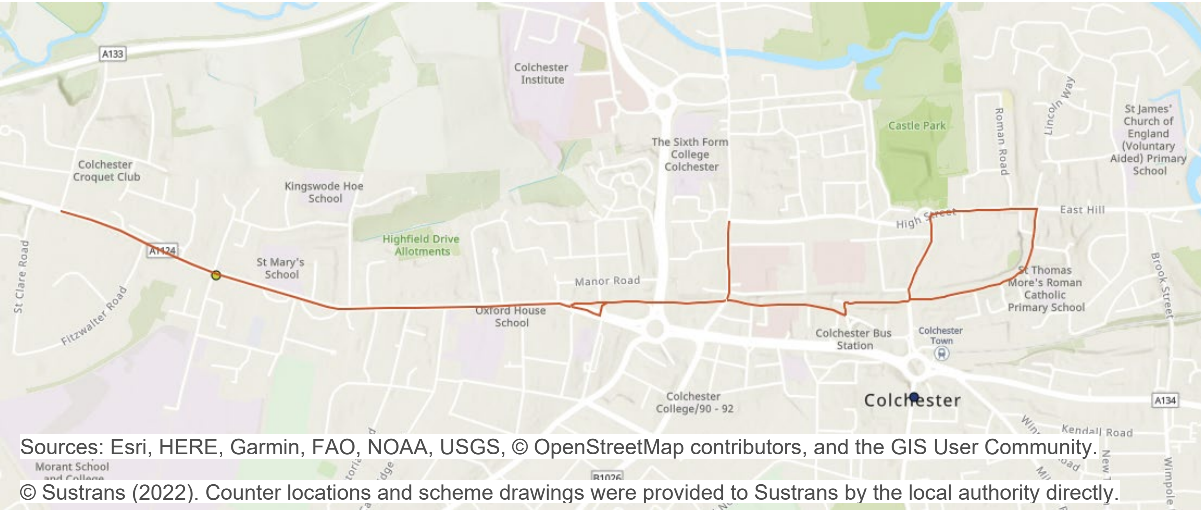
Running east-west, a new permanent separated cycle track along the length of Lexden Road and Crouch Street is proposed, running from the junction with Glen Avenue in the west to East Hill in the east. The new cycle track will support local journeys and provide safer access to schools. Floating bus stops, raised tables, improved crossings, increased public realm space, school streets and 20mph limits are all also planned.

A 4-way signalised junction will also be introduced at the junction of Crouch Street with Head Street to enable cyclists to continue safely north. Heading north, Head Street will see a temporary two-way protected cycle lane made permanent, with carriageway space reduced. This will connect to an on-road cycle route continuing north along North Hill and North Station Road where there will be significant public realm improvements. 20mph limits and school streets are also planned.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counter is located (green dot) and where the control counter is (black dot).

Figure 7 Essex's scheme (red line), intervention counter (green dot) and control counter (black dot)



The intervention counter is located on the western edge of Lexden Road, looking eastwards. The site currently has no cycle provision, with cyclists having to travel along the road or footpath. The route heads eastwards from the city-centre and therefore mostly sees commuter cycling at present. The control counter is located south of St. Botolph's

Circus roundabout, looking north. It records cyclists travelling along the road and pavement, with current use largely for utility purposes.

Figure 8 Looking west along the scheme route (Lexden Road) with its current painted cycle lane provision on either side of the road

Gloucestershire - B4063 Gloucester to Cheltenham (GL01)

The B4063 between Cheltenham and Gloucester was identified as one of the top-ranked roads in terms of cycling potential and spare space criteria by the DfT's Rapid Cycleway Prioritisation tool.

Funded from a range of sources, the B4063 Gloucester to Cheltenham cycle scheme will be a permanent two-way cycle track and protected footway that follows the northern verge along the B4063. It begins at Estcourt Roundabout (northeast from the centre of Gloucester) and runs past Longlevens and the village of Churchdown, before terminating at Arle Court Roundabout in Cheltenham (where it adjoins the recently completed pedestrian and cycle improvements as part of the West Cheltenham Transport Improvement Scheme). Once complete, the scheme will contribute to a continuous 26 mile 'cycle spine' that spans from Stroud in the South to Bishops Cleeve in the North.

The section between the M5 Overbridge and Estcourt Road will be funded by Tranche 2 Active Travel Fund money and from National Highways alongside County Council Capital contributions. Sustrans and other third-party contributions have been used to fund the works on the easternmost part of the route between the M5 Overbridge and Arle Court.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counters are located (green dots) and where the control counters are (black dots).

Figure 9 Gloucestershire's scheme (red line), intervention counter (green dot) and control counter (black dot)

The intervention counter is located along the B4063, to the west of where the M5 crosses over the road. The site of the intervention counter currently has painted cycle lane provision on both sides of the road, with the counter recording movements on both the painted cycle and the pavement. The route is likely used predominantly for utility purposes.

The control counter is located south-west of Gloucester city centre on Bristol Road. There is also painted cycle lane provision here, with the counter recording movements in both cycle lanes only. Like the intervention route, it is likely used mostly for utility purposes.

Figure 10 Looking west along the scheme route (B4063) towards Gloucester, with its current painted cycle lane provision on either side of the road

Source: Google Maps

Liverpool - Wirral - Leasowe Road (LP01)

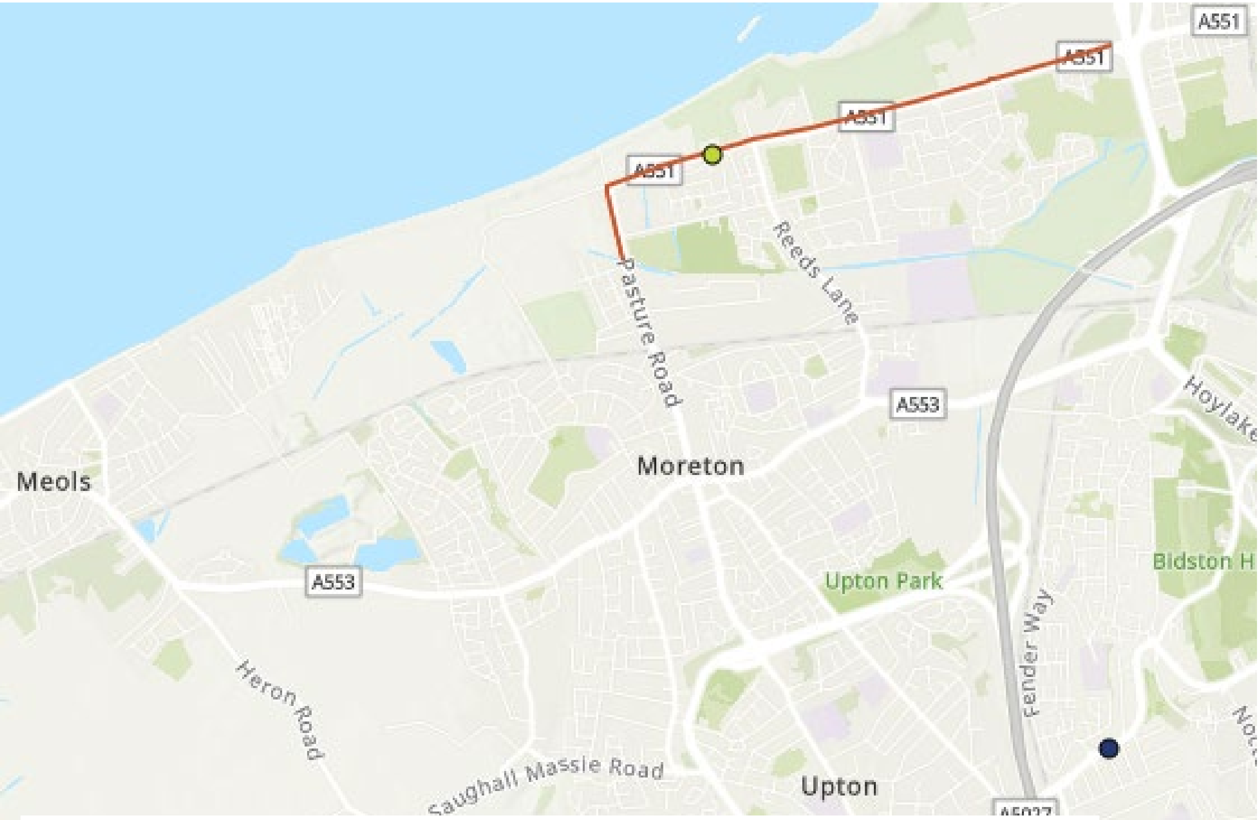
A separated cycle lane will be created along one side of Leasowe Road (the A551) and into Pasture Road, where there is no cycle infrastructure at present. The bulk of the route follows a dual carriage way. The works will include kerb lines, junction redesigns, speed limit reductions and alterations to bus stops and pedestrian crossings.

The scheme, which is in a leisure/residential district (with some links to employment areas) will provide linkages with other cycle routes. Wirral Council will contribute some funding to the scheme.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counter is located (green dot) and where the control counter is (black dot).

Figure 11 Liverpool's Leasowe Road scheme (red line), intervention counter (green dot) and control counter (black dot)



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.

The intervention counter is located on Leasowe Road where this is currently no cycling provision; the video counter records movements both on the road and the pavements on each side of the road. The control counter is located on Upton Road where there are also no cycling provisions – the video counter records movements on the road and on one pavement.

Figure 12 Looking east along the scheme route (A551) towards Wallasey with no current cycle provision

Source: Google Maps

Liverpool - Runcorn Busway (LP02)

The Runcorn Busway is a circular bus route created in the 1960s. It is presently only open to bus traffic (although the frequency of bus services has been reduced) and contains no cycle provision or footway. A temporary experimental order was in place between the end of August 2020 (for a maximum period of 18 months) which permitted cycle use of the busway during daylight hours.

The ATF-funded Runcorn Busway scheme will provide a permanent separated cycle track alongside the existing busway, running from Halton Hospital to Murdishaw local centre. The cycle lane will be separated from buses by curbing, and priority will be given to cyclists over buses at pinch points. The route is expected to serve utility journeys, enhancing hospital and employment access. It is planned for future measures to extend the scheme further at a later date, funding improvements to the whole bus route and linking the route link to Runcorn East and Whitehouse Industrial Estate.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line) and where the intervention counter is located (green dots). No single control counter could be identified for this scheme due to the unique nature of the busway. For the final evaluation report, data will instead be obtained from automatic counters located across the Liverpool city region to understand how background cycling flows are changing in the local area.

Figure 13 Liverpool's Runcorn Busway scheme (red line) and intervention counter (green dot)

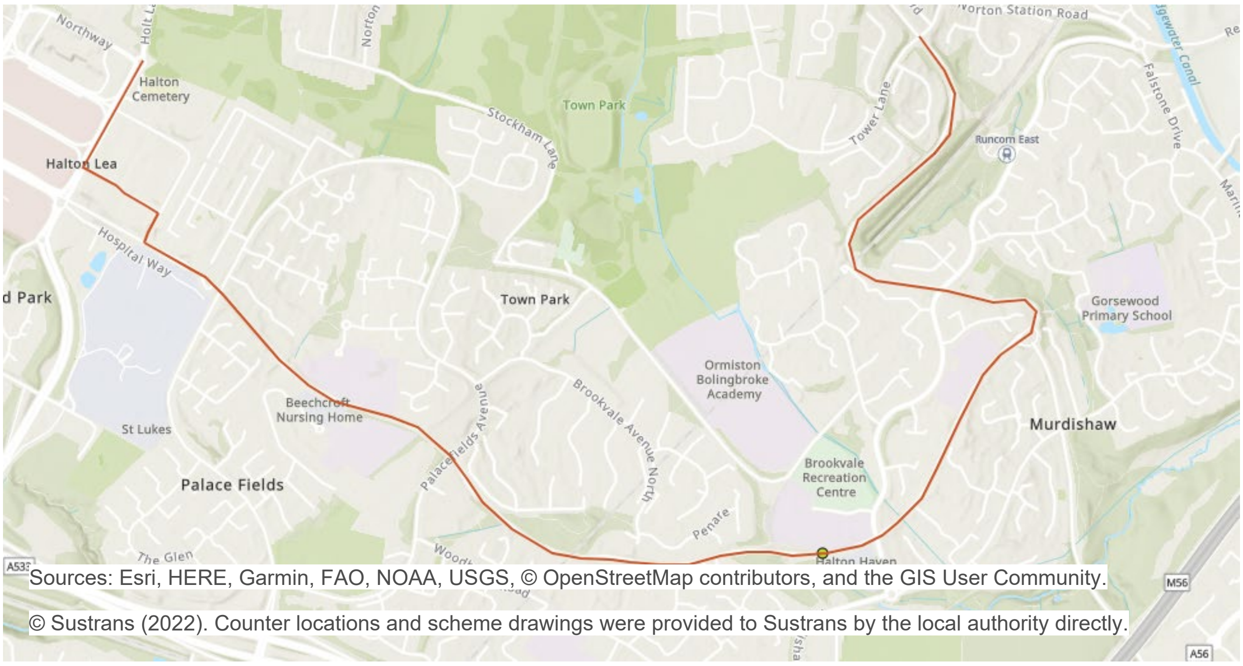


Figure 14 Looking west along Liverpool's Runcorn Busway scheme, with signs indicating the temporary (and now expired) allowance of cycle traffic along the route during daylight hours

Newcastle - Queen Victoria Road (NE01)

Phase 1 funding saw the reallocation of space away from cars on Queen Victoria Road through the temporary removal of 32 car parking spaces, and the installation of cylinders to narrow traffic lanes to create protected cycle tracks. Newcastle Hospitals welcomed the Tranche 1 improvements, which have helped both staff and the public to access healthcare services.

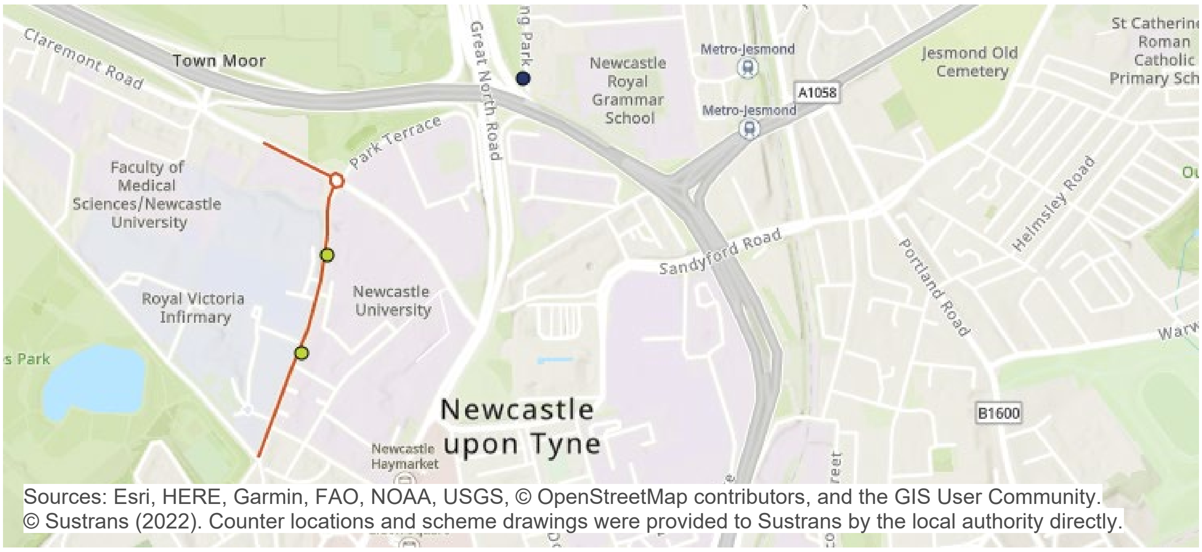
Through Tranche 2 (and matched funding) the removal of these car parking spaces will be made permanent, the road will be resurfaced, and changes will be made to provide a permanent protected two-way cycle track. Alongside improved crossings, the roundabout junction at the end of Queen Victoria Road will be upgraded to a signalised junction with a continuation of the protected cycling facilities.
The road link west from the junction (Claremont Road) will see the protected cycling link continued up to the exit of the Claremont Road car park, where a new signalised crossing facility will be installed.

Tranche 3 funding will be used to extend the cycle links onto the Town Moor cycle path, which is a traffic-free route and one of the most used routes by cyclists in the North-East.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counters are located (green dots) and where the control counter is (black dots). All counter data here has been supplied by TADU (Traffic and Data Unit – Gateshead Council).

Figure 15 Newcastle's scheme (red line), intervention counters (green dots) and control counter (black dot)



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.
© Sustrans (2022). Counter locations and scheme drawings were provided to Sustrans by the local authority directly.

The two intervention video counters are located on Queen Victoria Road, situated in between Newcastle University and the Royal Victoria Infirmary. The route would largely be used for utility purposes. The cameras record movements on the pavements, the road and temporary cycle lane provision.

The control counter is located on Brandling Park, towards the south-west corner of The Town Moor. It records users on an off-road cycle track shared with pedestrians and likely sees use for mostly utility purposes.

Figure 16 Queen Victoria Road where Newcastle's scheme is planned, showing the temporary intervention in place during the phase 1 funding

Source: Google Maps

Sheffield - Sheaf Valley Active Travel Lane (SH01)

In Sheffield, ATF phase 2 funding is being used to develop an enhanced cycle route between the city centre and Woodseats Road via Shoreham Street and Little London Road. Some scheme information has been obtained from:

https://connectingsheffield.commonplace.is/proposals/sheaf-valley-cycle-route#:~:text=The%20Sheaf%20Valley%20Cycle%20Route,Street%20and%20Little%20London%20Road

The route will link to existing cycle infrastructure, as well as improving links to Sheffield Midland train station and Sheffield Hallam University.

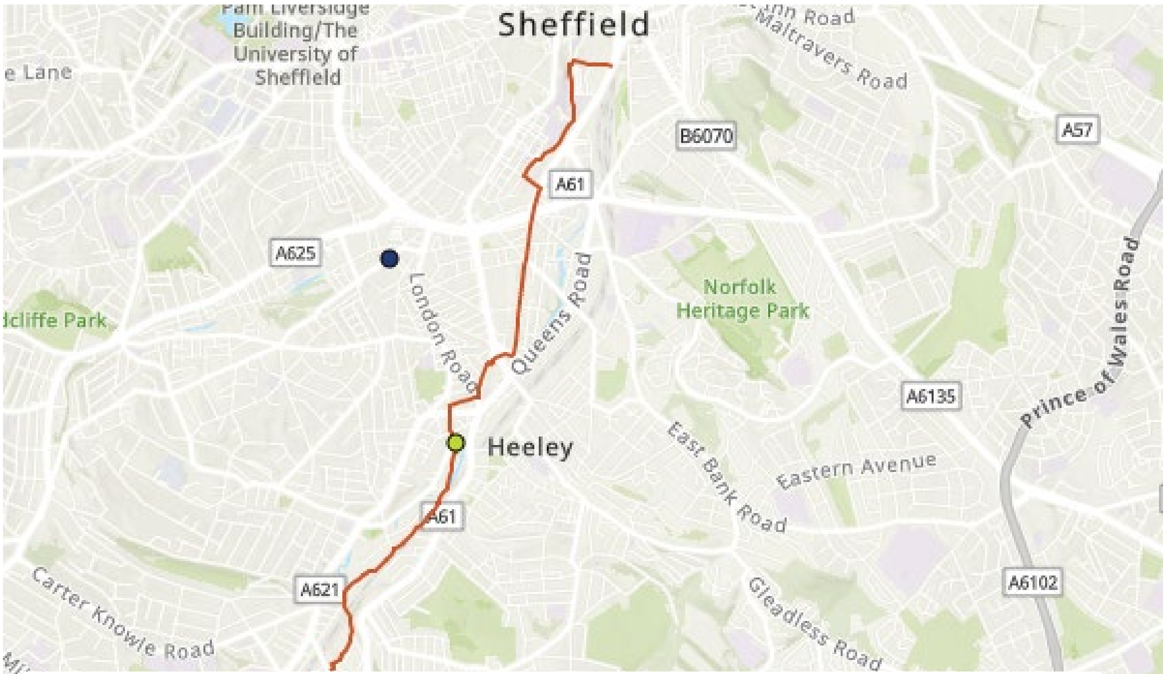
The proposed intervention includes sections of 3m wide two-way protected cycle tracks, 2m wide one-way cycle tracks, improved crossings, the removal of parking bays and carriageway space, road closures, and improved on-road sections. The scheme links with existing investments and is being implemented on a semi-permanent basis.

It is hoped that ATF3 funding can be used to further expand on cycling provision in the area; however, this evaluation will focus on the cycle track being delivered with ATF2 funding.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counters are located (green dots) and where the control counters are (black dots).

Figure 17 Sheffield's intervention location (red line), intervention counter (green dot) and control counter (black dot)



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.

© Sustrans (2022). Counter locations and scheme drawings were provided to Sustrans by the local authority directly.

The intervention counter is located on a traffic-free path, lined separated from pedestrians, between Broadfield Road and Chippinghouse Road. The route will largely be used for utility purposes at present. The control counter is located on Cemetery Road where there is currently no cycling provision and the route is used mostly for utility purposes.

Figure 18 Looking north along a traffic-free path on the scheme route between Broadfield Road and Chippinghouse Road, where the intervention counter is located

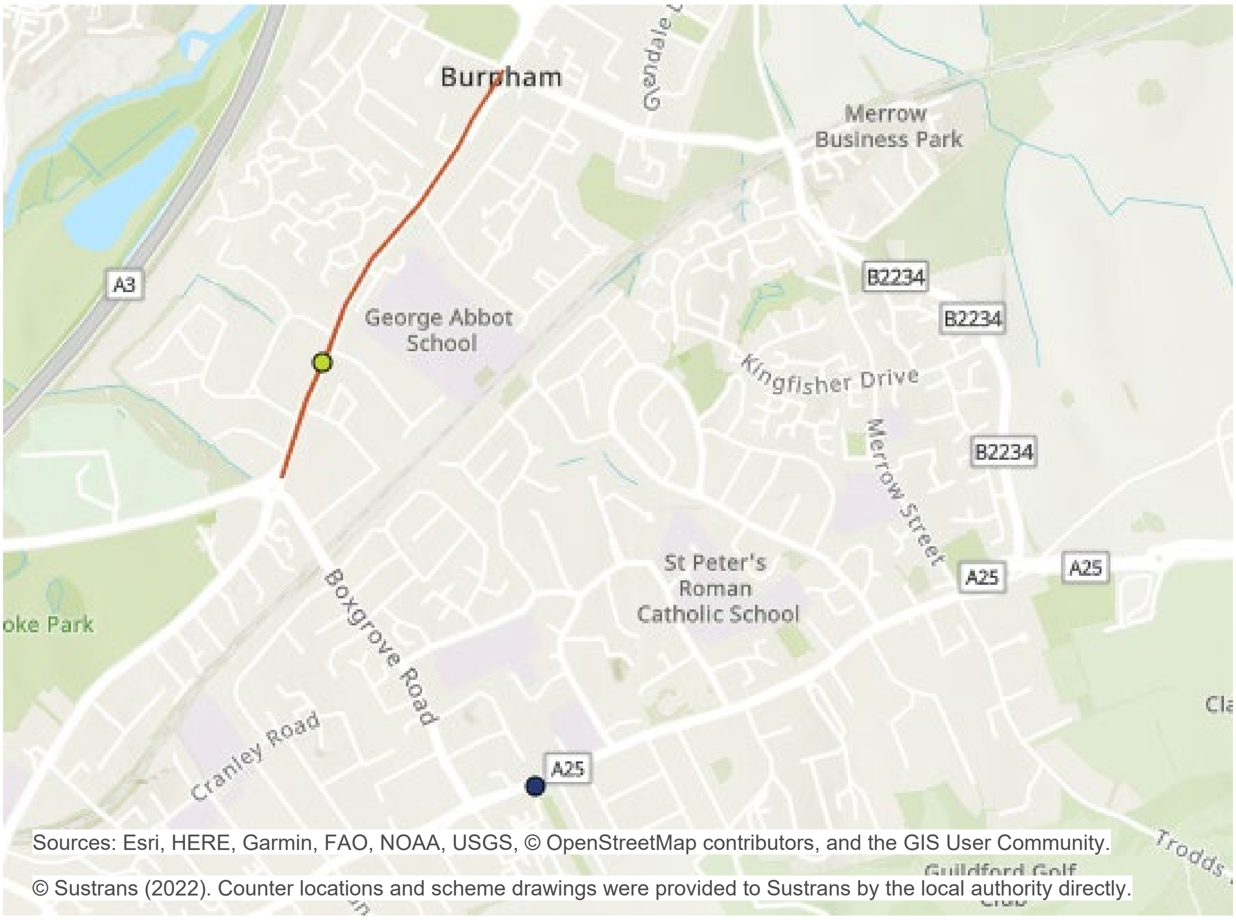
Surrey - Guildford to Burpham (SU01)

A second development in Surrey will see upgrades to the existing shared use path and creation of separated one-way tracks on both sides of London Road (the A3100), heading northeast out of Guildford towards Burpham. The scheme will include some junction redesigns and crossing upgrades

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counter is located (green dot) and where the control counter is (black dot).

Figure 19 Surrey's Guildford to Burpham scheme (red line), intervention counter (green dot) and control counter (black dot)



The intervention counter is located on London Road, north-east of Guildford city centre. The route currently has on-road painted cycle lane provision and is used mostly for utility purposes. The control counter is located on Epsom Road, east of Guildford city centre, and also has painted cycle lane provision and is used largely for utility purposes.

Figure 20 The London Road intervention site with its current on-road painted cycle lane provision

Source: Google Maps

Surrey - Woking to West Byfleet (SU02)

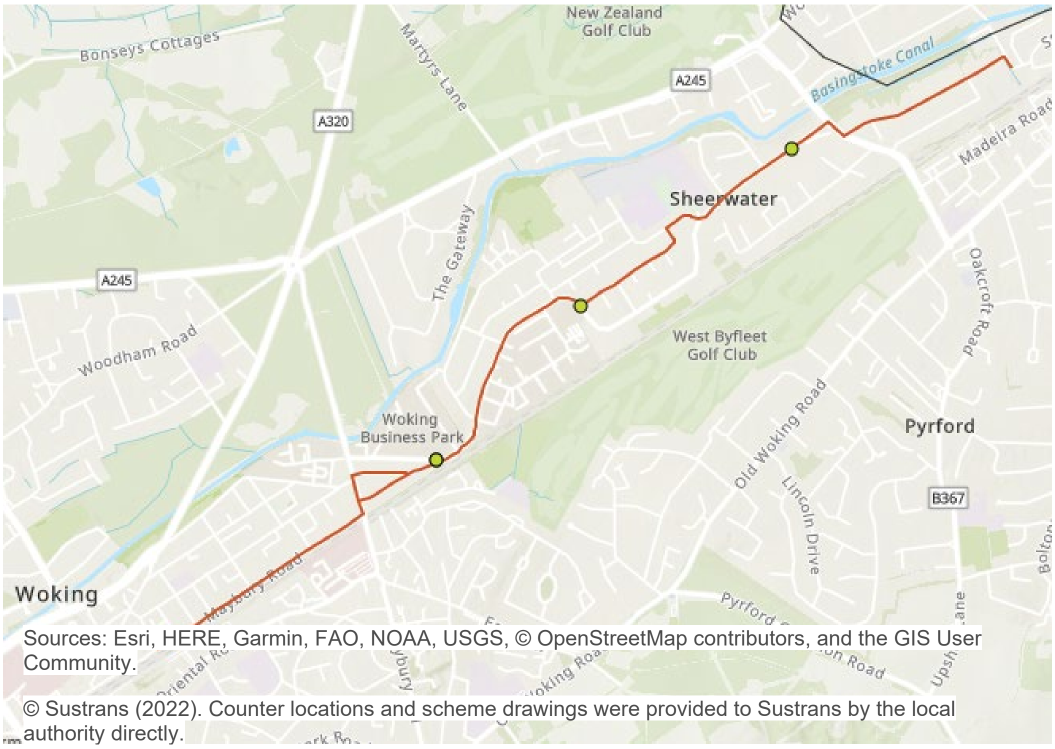
The route chiefly runs along Woodland Avenue, Albert Drive and Maybury Road. It runs parallel to NCN221, which follows the Basingstoke Canal. The canal path (which is primarily a leisure route) is unlit and becomes poor in wet weather conditions. The new route, known as the Ceres Trail, will better serve commuters and utility cyclists, fully connecting the West Byfleet area for the first time. The proposals will improve connections to Sheerwater and Maybury Estates.

An existing shared-use path on Albert Drive and (a short section of) Sheerwater Road will be upgraded to a two-way separated cycle lane. Toucan crossings will be installed for cycle and pedestrian traffic at the confluence of St. Michael’s Road and Albert Drive and between Stanley Road and Walton Road, while another will be upgraded where Albert Drive meets Sheerwater Road. Point closures will be introduced on side roads meeting Maybury Road, while side road priority will be introduced at the western end of Albert Drive. A 20mph speed limit will be introduced on Arnold Road and Eve Road.

Intervention and Counter Map

The map below indicates where the cycle track intervention route is proposed (red line), where the intervention counters are located (green dots) and where the control counters are (black dots).

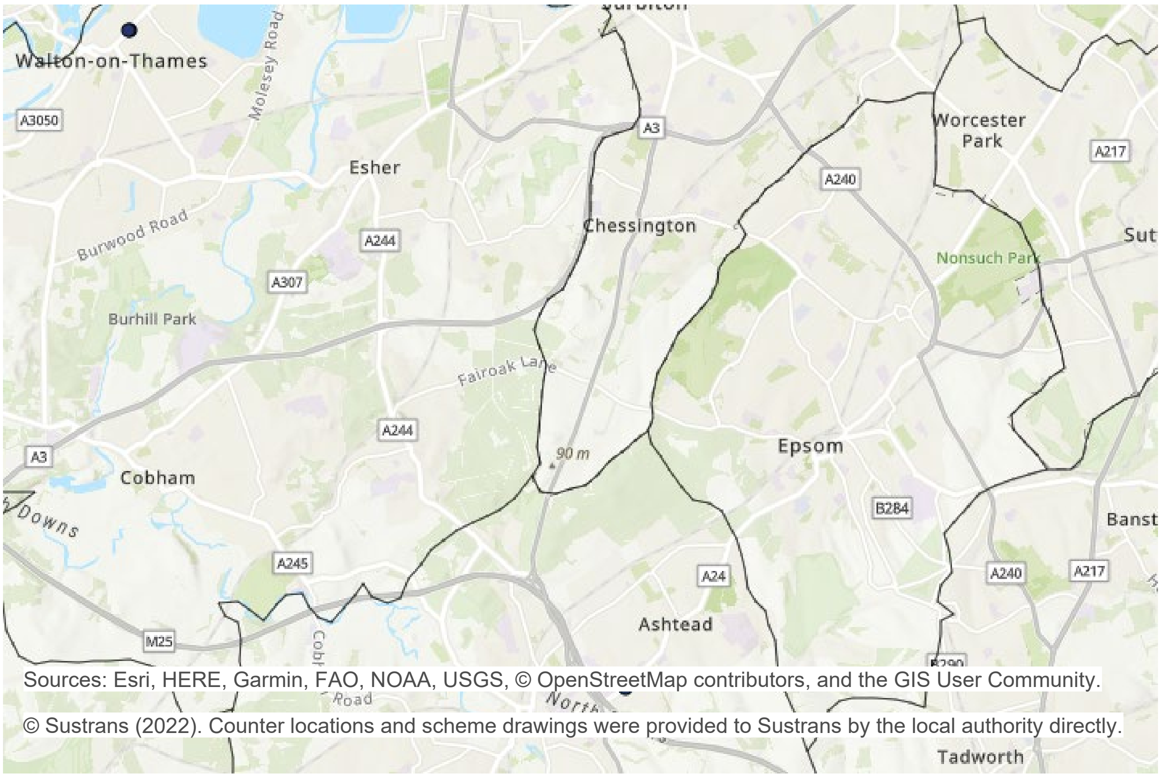
Figure 21 Surrey’s Woking to West Byfleet scheme (red line) and intervention counters (green dots)



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.

© Sustrans (2022). Counter locations and scheme drawings were provided to Sustrans by the local authority directly.

Figure 22 Surrey's Woking to West Byfleet control counter locations (black dots)



4 control counters have been proposed for the Woking to West Byfleet scheme (3 are installed and have been collecting data, and one is awaiting installation). Once data is available for the intervention counters, tests for suitability will be run to help decide which control counter(s) to use in the evaluation.

Figure 23 Looking west along the scheme route (Albert Drive) with its existing cycling provision on either side of the road

Source: Google Maps

A1.2 Data Collection and Analysis

Criteria for selection of counters

The following criteria was sent to each local authority to help them select their intervention counter(s):

- Located so as to capture the impact of their scheme intervention on cycling flows
- In a location where the change is *not* expected to mainly result from cyclists diverting from alternative routes
- In locations with as large a flow as possible (ideally, at least 100 cyclists per day in at least one direction)
- In locations where a comparable control counter is available
- Ideally, in locations with historic data (i.e. an existing counter). If possible, data as far back as 2018
- Ability to maintain data collection until at least spring 2024. Should any longer-term evaluation of ATF be desired, it was also strongly recommended maintaining at least some data collection beyond 2024 as well

To help the local authorities select suitable control counter(s), controls were asked to be comparable to the intervention counters in terms of:

- Levels of cycle flow (ideally +/-15% of the intervention counter flow)
- Distance from the city centre
- Type of road/route, path surface, wider environment
- Main types of trip (e.g. catering mainly for commuter cyclists, leisure cyclists or a mixture)

- If possible, showing a similar growth trend to the intervention counter (before the ATF scheme is built on it).
- Ideally, having data for at least as long as the intervention counter.

Counter Pairs

For the purposes of the evaluation, it was necessary to have a single counter pair identified for each local authority i.e. one intervention and one control counter to enable direct comparisons between cycling flows.

This section describes how the appropriate selection was made in those local authorities who suggested more than one intervention or control counter as suitable:

In Greater Manchester (Bolton, GM01), two intervention and two control counters were proposed for use. The two intervention counters are located on parallel sections of Manchester Road, with each road only permitting movements in one direction. As such each counter is likely to be recording different trips, and so counts from both counters are summed together and treated as one.

For the control counters, both are situated on St. Helen's Road, recording movements in opposite directions. Given the low likelihood that these counters will therefore be double counting the same trip, counts from both of these counters are summed together and treated as one.

In Newcastle (NE01), two intervention and two control counters were also proposed for use. The two intervention counters are both located on Queen Victoria Road, with one counter recording movements north to south, and the other south to north. Given the low likelihood that these counters will be double counting the same trip, counts from both of these counters have been summed together and treated as one.

Of the control counters, a decision was made to use the counter at Brandling Park rather than John Dobson Street. This was due to the likely similarity in use type at Brandling Park compared to the intervention counters on Queen Victoria Road - both routes are likely used by university students and therefore subject to similar patterns in use around university half-term and term dates.

For Surrey (Guildford to Burpham, SU01) 3 control counters were proposed for use. Here tests were conducted for comparability between the intervention and all 3 control counters to enable the identification of the best control counter to pair with the intervention. These comparability tests used data from before the intervention, as the change in comparability following the intervention was the focus of this study.

3 aspects of comparability were considered:

- *How similar is the magnitude of cycle counts prior to the intervention?*

    - The guidance to the local areas indicated that the control locations should have mean average flows within 15% of the intervention location. This was tested by checking whether the annual daily total of counts (ADT) in the control counters were ±15% of the intervention ADT.

- *Is the trend in usage over time prior to the intervention similar?*

    - Where there was at least 200 days of data in each of at least two calendar years for the control and/or intervention counters, the year-on-year trend in usage was calculated using a multiple negative binomial regression. Where there was sufficient overlapping data for the intervention and control counters, an interaction term for whether a counter is intervention or control was included. Where this term is a statistically significant component of the model, this indicates that there is a difference in the annual trend for the relevant data period between the control and intervention counter in the pair.

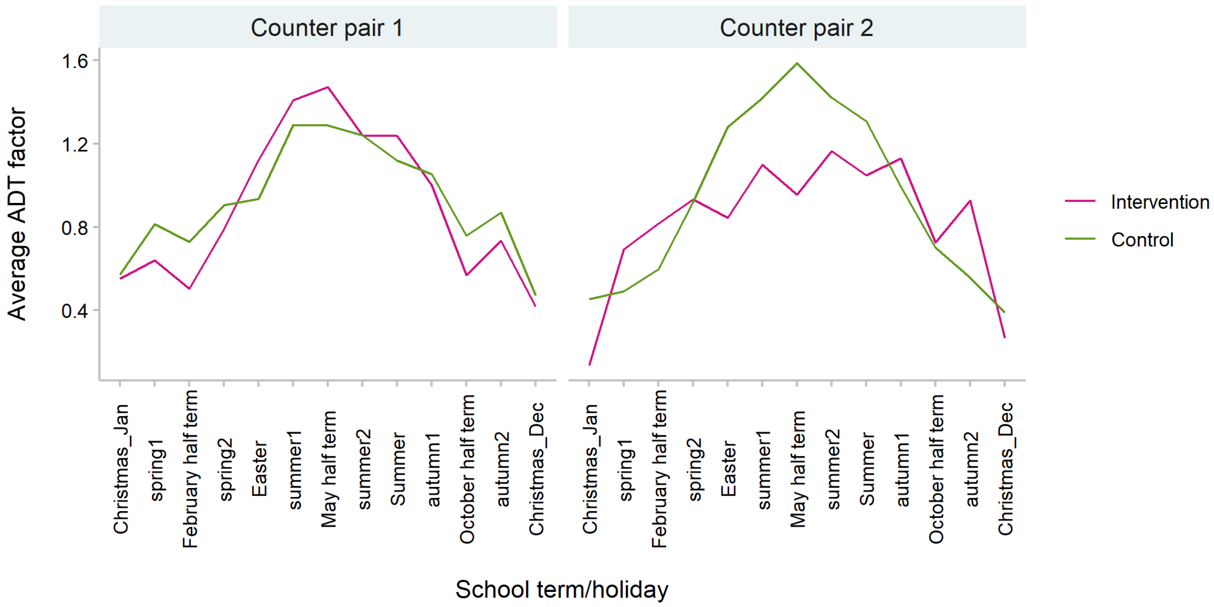
- *Do the data from the control and intervention locations have similar seasonalities prior to the intervention?*

    - For the purposes of this evaluation, the term 'seasonality' is defined as a characteristic of the cycle counter data, in which the data demonstrate regular and predictable changes that recur over a consistent time period. According to this definition, a single time series can have multiple seasonalities that occur over different time periods. For instance, there can be a seasonality that occurs over the course of a calendar year and also one that occurs over the course of each day. This evaluation considers 3 such seasonalities – those which occur over the course of a calendar year; between term time and school holidays; and between weekdays and weekends

    - The weekday/weekend day and term-time/school holiday seasonalities was tested by comparing the pre-intervention ADTs for the different day type categories. The relative difference between the day type ADTs and the overall ADT was calculated and the results for the control and intervention location compared. The most comparable pairs were those where the differences between the values for the control and intervention counters are ≤15 percentage points

    - Where there was at least 200 days of data in at least two calendar years for the control and intervention counters, the annual seasonality was also tested. The ADT factors for each counter (each day's count divided by the ADT for the whole period for which data are available) could then be averaged by school calendar period (e.g. Christmas holiday, spring half term 1, spring half term holiday). The results were then plotted against each other and reviewed for similarity. Examples of annual seasonality plots are seen in . Counter pair 1 would be considered a closer match than Counter pair 2.

Figure 24 Annual seasonality plots (used to assess counter comparability)



Only one of the proposed control counters for SU01 satisfied all 3 criteria – as a result just this single control counter has been used.

The above comparability tests will also be applied to Surrey (Woking to West Byfleet, SU02). Here multiple control counters have been proposed, but no intervention data is currently available to allow the above tests to be completed. This will be completed for the final evaluation report when intervention data will be available.

Table 20 below outlines the final counter pair selected for evaluation in each local authority:

Table 20 The counters being used to evaluate the impact of the cycle track interventions in each local authority, and whether they are intervention or control counters

Local Authority	Scheme	Counter name	Type
Bolton (Greater Manchester)	GM01	Sensor 3	Intervention[38]
		Sensor 4	
		Sensor 12	Control[39]
		Sensor 8	
Essex	ES01	L42	Intervention
		L15	Control
Gloucestershire	GL01	4796	Intervention
		4812	Control
Kent	KE01	TBC	Intervention
		TBC	Control
Liverpool	LP01	Leasowe Road	Intervention
		Upton Road	Control
	LP02	47 Busway Road, Barnfield Ave (Rd)	Intervention
		N/A[40]	Control
Newcastle	NE01	NclQueenVictoriaRdPercyBuilding	Intervention[38]
		NclQueenVictoriaRdBedsonBuilding	
		9772 - Brandling Park	Control
Sheffield	SH01	002 Broadfield Rd/Chippinghouse Rd	Intervention
		013 - Cemetery Road	Control
Surrey	SU01	A3100 06030X	Intervention
		A0025 06071X	Control
	SU02	TBC[41]	Intervention
		TBC[42]	Control

38 Data from more than one intervention counter have been combined for evaluation of cycling levels

39 Data from more than one control counter have been combined for evaluation of cycling levels

40 No control counter could be identified for this scheme

41 Three counters are being installed on the Woking to West Byfleet scheme – once data is available for these, a decision will be made as to which counter(s) to use for the evaluation

42 Four control counters have been proposed for SU02 (3 are installed and have been collecting data, and one is awaiting installation). Once data is available for the intervention counters, testing for suitability will help decide which control counter(s) to use in the evaluation

Data cleaning techniques

Once data had been received back from the local authorities, a two-stage data cleaning approach was undertaken - long sequences of zero counts and erroneously high counts were first removed automatically (counts above 5,000 cycles per day; or 5x the median daily total for that month). The remaining data was then plotted graphically and manually reviewed for errors. The following criteria was used to identify possible anomalous counts (and if there was no feasible explanation for the anomaly each was manually amended):

A. Isolated counts – if a counter had short periods of collecting some data followed by periods of not collecting data, it might indicate that something was wrong with the counter (e.g., a failing battery) and therefore not counting accurately. These instances were considered in the context of the overall trend, and if they looked atypical, removed.

B. Non-recurring anomalies – if an extreme peak in counts occurs at regular intervals (e.g. yearly), it might indicate a recurring event taking place (e.g. organised cycle rides). This is a legitimate count of path use and should remain in the data. However, if extreme and atypical peaks are present in the data (and haven't been removed from the automatic cleaning process), these were removed.

C. Extreme switches between high and low counts. Whilst this can sometimes happen between weekends and weekends, if this happens in the space of a day, it was explored as a possible anomaly to clean.

D. Inconsistent annual patterns - a counter would normally be expected to show a similar annual pattern of use.

E. For video counters, each countline was analysed and checked for anomalies separately. If a count was identified as an error on one countline, it was considered whether that same date should also be cleaned on all other countlines present on the same counter.

Analysis performed for each counter

Calculations for each counter pair are dependent on the specific dates of the relevant scheme construction (as specified by the local area) and the availability of data from the other counter within the counter pair. Using this information, the following metrics will be calculated for each counter:

- **Pre-intervention Average Daily Total (ADT):** the mean average daily count of cycles at each counter prior to the start of the scheme construction. Values will only be calculated if there is a period of at least 3 months when the counter has data (each month requires at least 20 days of data and with one or fewer months between each data month). Values will be calculated using the most recent time period before the start of construction, up to a maximum 365-day total. Ideally therefore values represent the mean average daily total for the year before construction starts. However, data availability means that in many cases, a continuous 12-month period of data will not be available. Where possible, the same time periods will be used to calculate the ADTs for both the intervention and control counters in each pair, which also limits the time periods that can be used in many cases.

- **Post-intervention Average Daily Totals (ADT):** the mean average daily count of cycles at each counter after the ATF scheme has been implemented. This will be calculated using the latest data that is available for the intervention and control counters after the scheme has been completed (intervention and control counters need to have at least 3 overlapping months of data with one or fewer months between each one, each with at least 20 days of data, up to a maximum 365-day total). Where possible, post-intervention ADTs will be calculated using the same months as the pre-intervention ADTs. Values will therefore ideally represent the mean average daily total for the year immediately before the final evaluation takes place. However, data availability, dates of scheme implementation, and the use of the same time period for intervention and control counters will dictate what is possible.

- **Pre-intervention trend:** the annual percentage change in cycling volumes before the intervention. This will be estimated using multiple negative binomial regression where at least 200 days of data in each of at least two calendar years for the control and/or intervention counter are available. School holidays and term times will be included as terms in the regression to account for the effect of seasonality on the year-on-year trend. The specific years of data used to calculate the annual change might vary between counter pairs but will be kept constant within pairs where trends are calculated for both control and intervention counters. More details of the process are given in Appendix 1.

- **Post-intervention trend:** the annual percentage change in cycling volumes after the intervention. This will be calculated in the same way as the pre-intervention trend, where there are at least 200 days of data in each of at least two calendar years for the control and/or intervention counter since scheme implementation. The number of counter pairs for which post-intervention trends can be calculated will be determined by the dates of scheme implementation and the final ATF evaluation.

Negative binomial regression for trend calculations

An annual percentage change in cycling volume estimates is derived using multiple negative binomial regression where there are at least 200 days of data in each of at least 2 calendar years for the control and/or intervention counter. School holidays and term times are included as terms in the model to account for the effect of annual and school period seasonality in the year-on-year trend. This approach is derived from work by Grainne Gordon (2013, Investigating Methodologies for Analysing Single Point Count Data to Estimate Volumes of Bicycle Traffic, DPhil Thesis, University of Bolton) and aims to provide a relatively sophisticated and robust method of calculating trends.

Regression is a statistical method that attempts to understand the relationship between at least one ‘dependent’ variable and at least one other ‘independent’ or ‘predictor’ variable. Regression produces coefficients for each predictor variable that, when put together into an equation, can be understood as a ‘model’ of that relationship. Entering values for the predictor variables into the equation will produce an estimated value for the dependent variable.

There are multiple different types of regression, each of which use different assumptions about the nature of the predictor and dependent variables to model the relationship. The extent to which these assumptions are true plays an important role in the validity and accuracy of the resulting model.

Many types of regression assume that the dependent variable is both continuous and normally distributed. Both assumptions are violated by cycle count data; it is not continuous (partial counts can’t exist) and cannot follow a normal distribution (it has a lower bound at zero as negative counts can’t exist). One approach that addresses these issues is Negative Binomial Regression. This assumes that the dependent variable follows a negative binomial distribution, which describes the probabilities of the occurrence of whole numbers greater than or equal to 0, and where the variance and the mean are not equivalent. This makes it well suited to for applying to count data.

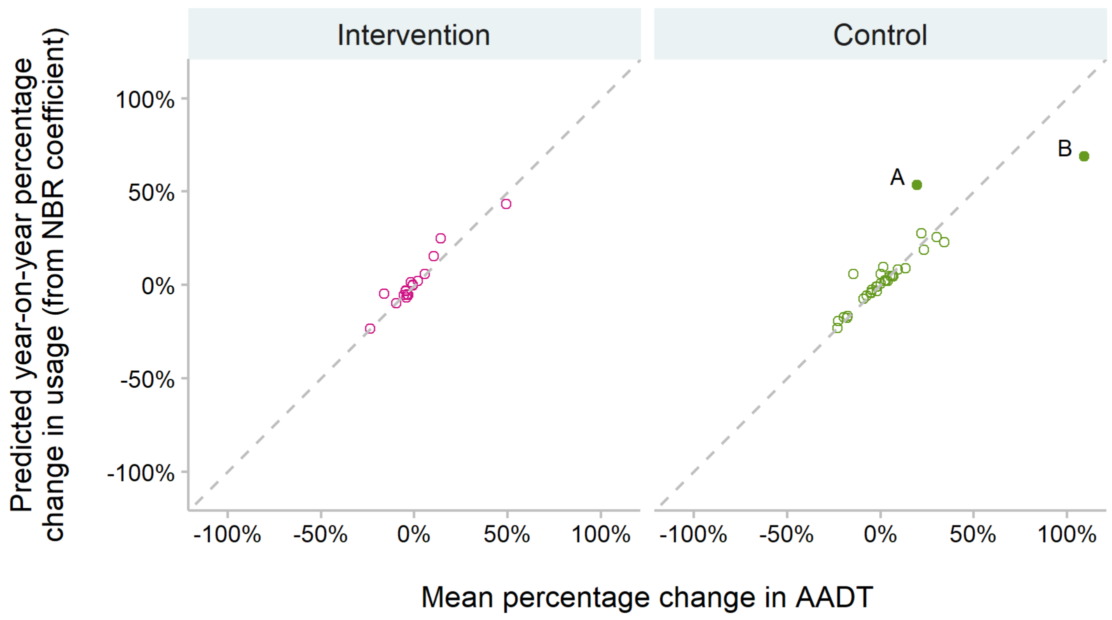
Conventionally, the year-on-year trend in cycle count data might be estimated by calculating the annual ADT (AADT) for each year for which there are data and taking the mean average of the percentage change in AADT each year. This approach can be seen as a simple model of the relationship between the AADTs and the year to which they relate.

However, this approach is problematic for various reasons, not least because data are not always complete for each year. Some AADT values may be derived from incomplete years of data, and as cycling is extremely seasonal, these may be misleading. For instance, consider an AADT calculated from data for June – September for a given year. Comparing this AADT with an AADT from the following year calculated using data from January-March would produce a misleading model of the change in cycling from one year to the next. It might be possible to compare AADTs using just the same months of data in each year, but if the dataset covers multiple years, finding sufficient comparable data in each year becomes increasingly challenging. This problem is compounded by the fact that changes in cycling flows are unlikely to be evenly distributed across a calendar year. Excluding data by attempting to use comparable months means that this aspect of the relationship is ignored.

The method used here uses negative binomial regression to produce a model of the cycle counts in each year, derived from the observed counts, the calendar year and school year period (e.g. Christmas holiday, Spring half term 1, Spring half term holiday, etc, as per). The resulting coefficient for the 'year' variable can then be used to derive an estimated annual percentage change in usage for the period included in the model.

To assess the validity of the approach, values for the estimated year-on-year change have been calculated for the cycle counters assessed in this report using both the 'mean percentage change in AADT' and the negative binomial regression methods. The results are shown in the figure below.

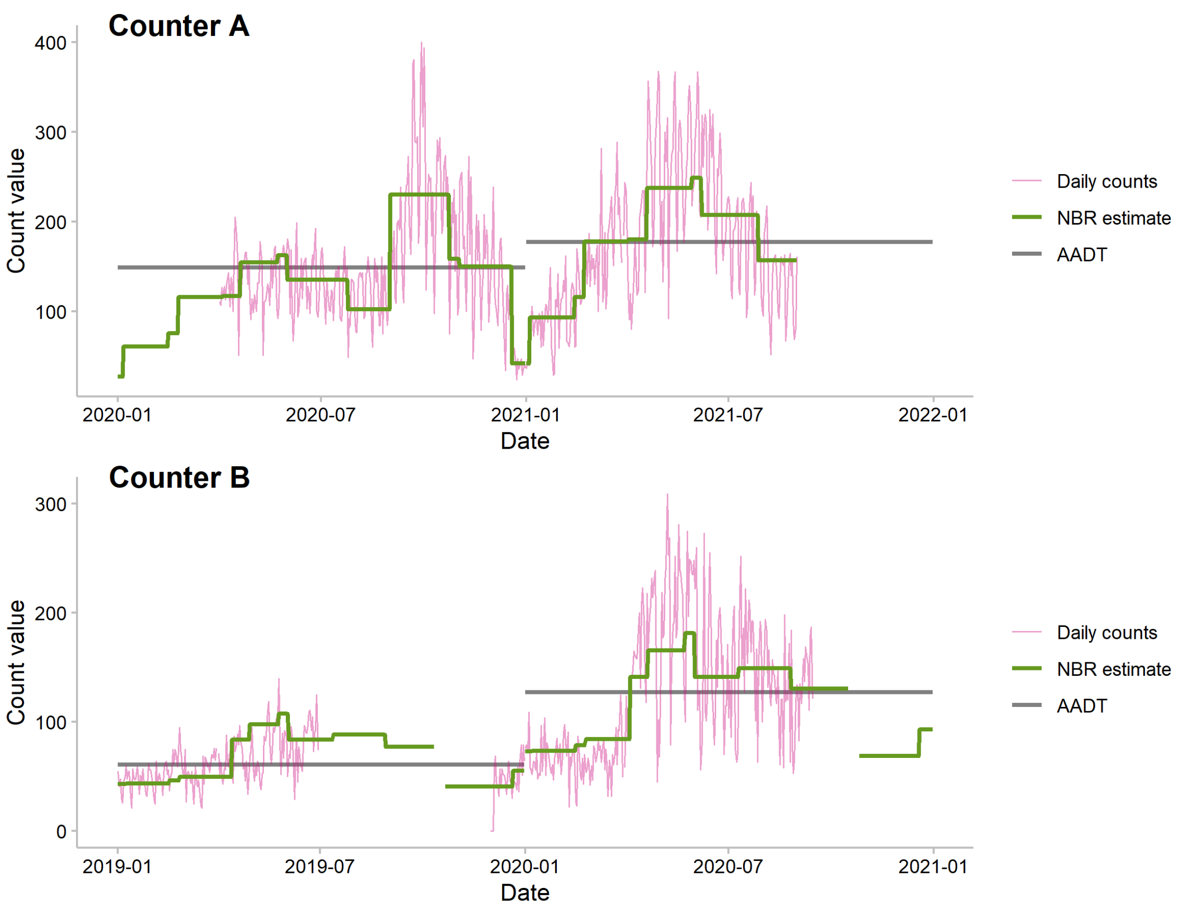
Figure 25 Comparing methods of calculating annual change in cycle flows



As shown, there is a strong correspondence between the two. The outliers labelled on the control graph help to illustrate why the negative binomial regression method may provide a better insight into the year-on-year trend.

For these 2 counters, illustrates the observed count data (the pink lines); the AADTs that would be generated from these data (the grey lines); and the 'modelled' data generated by the multiple negative binomial regression model (the green lines). As already highlighted, the negative binomial regression model produces an estimated count for each of 13 time periods, rather than just one average year value. There are 2 exceptions to this: where the pre-intervention period does not extend to the end of the year used in the regression calculation (as seen for counter A); and where there are no data for a given school period for any year used in the regression calculation (as seen for October half term for Counter B). In these cases, annual percentage changes are derived from the periods of time where there are data in at least 2 years.

Figure 26 Comparing approaches to calculating trends at two counters



The percentage change in AADT method implies an annual change of around 20% for counter A and over 100% for counter B. However, these values may be misleading.

The value for counter A is probably too low. There is a lack of data for the early part of 2020 when cycling flows would typically be low, meaning that the AADT for 2020 is potentially too high. Meanwhile, 2021 includes data from the earlier part of the year but not the latter (when cycling flows have typically been higher), meaning that the 2021 value is potentially too low. The negative binomial model suggests an annual change of around 50%, substantially higher than the value produced by comparing the AADTs.

The value for counter B is probably too high. There are a lack of data for the latter part of 2019 when cycling flows would typically be higher, meaning that the AADT for 2019 is potentially too low. Meanwhile, the data for 2020 show the effect of Covid-19 with a huge increase at the start of the first lockdown in March 2020. The data from the latter part of 2020 are also missing, which may have shown a reduction in the effect of Covid-19 on levels of cycling. This may mean that the AADT for 2020 is too high. The negative binomial model suggests an annual change of around 70% which is still high but may be more robust in regard to the missing data.

It should be noted that any estimation dealing with missing data is inevitably imprecise. This is particularly the case when considering the effects of Covid-19 on travel behaviour. For counter A, in addition to the missing data, there appears to have been some change in in-year patterns, with growth in cycling starting earlier in the year, and with a longer period of higher counts. This may have been as a result of Covid-19 reducing levels of cycle commuting during the first lockdown. Without more data it is not possible to know whether this change in seasonality was in fact a return to pre-Covid commuting travel patterns but it may be logical to assume that it was. Similarly for counter B, although it is possible that the increase in cycling at some non-commuting sites during Covid-19 was sustained throughout 2020 at the level seen during the first lockdown, data from other counters suggests this may be unlikely.

Appendix 2. LTN theme

A2.1 Cases

The following section describes LTN-type schemes currently included in the theme evaluation. As these are area-type schemes, some information is given about the authority/local area in which they are situated as well as the nature of the scheme itself.

First, Table 21 below provides more summary information about the fifteen schemes currently implemented, planned, or still judged as possibly to be implemented, including when data collection began and the nature of the scheme.

Table 21: Summary information about schemes and data collection.

Scheme	Scheme information	Data
Stoke Newington, Hackney	Has been implemented in a borough that already contains many LTN schemes, including adjacent or the other side of a boundary road. Unusually it included a formerly busy B-road and high street (Stoke Newington Church Street), which now has a 7am-7pm bus gate.	Sensor data. Scheme was implemented early thus relatively limited 'pre' data available (just under 3 weeks, from beginning of September 2021, if school holidays are excluded).
Camden Square, Camden	A relatively small scheme in a historic part of this Inner/Central London borough. Contains a park, the London Irish Centre, and is adjacent to cycle tracks that are being upgraded with improved signage.	Sensor data. 'Pre' data collected from June 2021.
St Mary's, Oxfordshire	One of 3 schemes implemented just East of the Plain roundabout by Magdalen College, Oxford. These have been controversial with high levels of vandalism reported from the start including the removal of bollards.	'Pre' data collected for 2 weeks in October 2021 (via counts, not sensors).
Crookes, Sheffield	Has been at least partially implemented although some vandalism appears to be limiting	Sensor data collected from December 2021. Some reduction in scope may affect data (one sensor being

	operation. There seem to be plans to remove some filters, however.	placed on a road which so far no longer has a modal filter).
St Ann's, Haringey	One of 3 LTNs planned by Haringey to be implemented in Autumn 2022. In the South of the borough near to the border with Hackney, which has implemented many schemes (although not in the far North of the borough).	Sensor data. 'Pre' data collected from June 2021.
Areas 5 and 6, Newham	Newham has implemented a number of 'emergency' LTNs and this adjoins them and is similarly designed. It will substantially reduce severance barriers to adjoining park.	Sensor data. 'Pre' data collected from March 2022.
Brixton Hill, Lambeth	Will join 5 LTNs implemented in Lambeth as emergency measures and now made permanent. Relatively large.	Sensor data. 'Pre' data collected from June 2021.
Streatham Wells, Lambeth	Will join 5 LTNs implemented in Lambeth as emergency measures and now made permanent. Relatively large and in a hilly area.	Sensor data. 'Pre' data collected from September 2021.
Kings Heath, Birmingham	Large and ambitious LTN that has been substantially delayed but still has a timeframe for implementation. Birmingham has implemented a number of 'emergency' LTNs and new cycle tracks and has a traffic circulation plan.	One month of 'pre' data collected (via counts) in October 2022.
Frizinghall, Bradford	One of 3 LTNs planned by Bradford to be implemented in Autumn 2022 (one other one, in Saltaire, has already been implemented). Since delayed.	Sensor data. 'Pre' data collected from January 2022.

Cumberland and Holborn, Newham	One of several potential LTNs that was selected for progression but failed to secure TfL funding and hence has been delayed. In the middle of the borough next to the A12 with some existing filtering present.	Sensor data. ‘Pre’ data collected from June 2021.
The Cally, Islington	A large and potentially ambitious LTN which returned to consultation; the scheme scope may reduce.	Sensor data. ‘Pre’ data collected from June 2021.
Fleetville LTN, Hertfordshire	Received 79% approval in a consultation for key elements including filtering in Spring 2021, but now seems to be delayed.	Sensor data. ‘Pre’ data collected from February 2022.
Edwards Lane Estate, Nottinghamshire	Scheme may be scaled back but this is as yet unclear. Was delayed with revised date of March 2023, but then was further delayed due to issues with another scheme in the same area.	Sensor data. ‘Pre’ data collected from September 2021.
Chapel Allerton, Leeds	Scheme may be scaled back but this is as yet unclear. Seems to have been delayed.	Sensor data. ‘Pre’ data collected from December 2021.

Stoke Newington, Hackney

Hackney is a North-Eastern Inner London Borough. It had in the 2011 Census the highest level of cycling to work of any London borough (15%) and has the highest all-trip mode share for cycling, at 8.9%[43]. 87% of all trips by borough residents are by walking, cycling, or public transport, second only to City of London (an atypical London district with few residents). Only 29% of households in the borough have one or more cars[44]. In Hackney, 19.6% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Hackney is ranked 19th most income-deprived[45].

Starting before the pandemic the borough has implemented a series of low traffic neighbourhood schemes and schemes on borough roads involving protected cycle tracks (e.g. Wick Road, Queensbridge Road). This latter marks a departure from the borough's previous approach of providing for cyclists on main roads via bus lanes.

The scheme included here sits directly North of an area that has already seen successive LTN-type interventions, including in 2021. It creates a large low-traffic area and incorporates a high street with bus routes running through it. The bus gates introduced as part of this scheme are operational between 7am-7pm daily, including weekends.

---

[43] https://tfl.gov.uk/cdn/static/cms/documents/travel-in-london-report-13-data.xlsx

[44] https://www.healthystreetsscorecard.london/results/results_outcome_indicators/

[45] https://www.ons.gov.uk/visualisations/dvc1371/#/E09000012

Figure 1: Stoke Newington Bus Gate (source: London Borough of Hackney, https://rebuildingagreenerhackney.commonplace.is/proposals/stoke-newington)

The scheme incorporates Cycle Superhighway One and separately links up to wand protected cycle lanes on Green Lanes between the junction with Petherton Road and the Haringey boundary. The Stoke Newington area contains relatively affluent enclaves, but, as with many parts of Hackney and Inner London more generally, is also home to much poorer communities.

Camden Square, Camden

Camden is a Northern Inner London Borough that runs from Central shopping areas to Hampstead in the North. Part of it lies within the Central Activities Zone. In the 2011 Census, 7% of Camden residents reported cycling to work, with TfL data showing an all-trip mode share of 2.4% (with 83% of trips made by walking, cycling, or public transport). However, Camden's streets are busier with cyclists than this might suggest, given that many people cycle commuting from boroughs such as Hackney or Islington will travel through Camden to get to work. 14.1% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Camden is ranked 91st most income-deprived[46].

The borough has a tradition of providing cycle infrastructure on its streets and through its estates, particularly in its Central and Southern parts. The Tavistock/Torrington Place cycle route is a major East-West desire line for cycling, and in recent years was upgraded from a narrow two-way track to two separate one-way tracks, doubling the space available for cycling by making the street one-way for motor traffic. The borough has pioneered new types of infrastructure, such as the Royal College Street cycle route, using what has been called 'light segregation' ('armadillo' blocks, car parking, and/or planters protecting cyclists) which was later upgraded and made 'heavier' and permanent.

Some areas constitute 'historic' low traffic neighbourhoods due to the design of its estates and/or measures to protect residents from heavy motor traffic on major roads crossing the borough. More recently additional schemes have been implemented but not badged as 'LTNs', covering both shopping areas such as Seven Dials and residential areas such as Camden Square.

46 https://www.ons.gov.uk/visualisations/dvc1371/#/E09000007

Figure 2: Camden Square showing the cycle route signs and the London Irish Centre (Rachel Aldred)

The Camden Square scheme is relatively small and sits towards the East of the borough, near the border with Islington. While predominantly residential, it contains the London Irish Centre at the South end, and St Paul's church at the North. Camden Square itself is a garden square surrounded by a mix of housing, including 18th century villas and 20th century social housing flats. A cycle route, which is being upgraded with improved signage, runs through the scheme.

St Mary's, Oxfordshire

St Mary's is one of 3 schemes being introduced in the East Oxford area, lying South-East of the City Centre. Oxford has relatively high rates of cycling to work; 19% in the 2011 Census. It has a population of over 150,000, comparable size to London boroughs. Around a fifth of the population are students and it is a tourist destination. Historically, the city was a centre of motor manufacturing, particularly the suburb of Cowley. However, post-war decline in manufacturing saw 18,000 jobs lost between the mid-60s and late 80s[47].

Although cycling has traditionally been a 'normal' way to get around the city, it has also traditionally lacked much high-quality cycle infrastructure and cycles are banned from some green spaces, such as the University Parks. The Local Cycling and Walking Infrastructure Plan for Oxford, dated March 2020, proposes an Oxford Cycle Network as the first 'pillar' and low traffic neighbourhoods as the second (other pillars include a workplace parking levy, city centre control points providing traffic reduction and bus priority, and speed and speed limit reductions on main roads). It provides a schematic outline of where LTNs might be possible within the city boundaries.

[47] https://www.keble-oxford-geography.info/?p=827

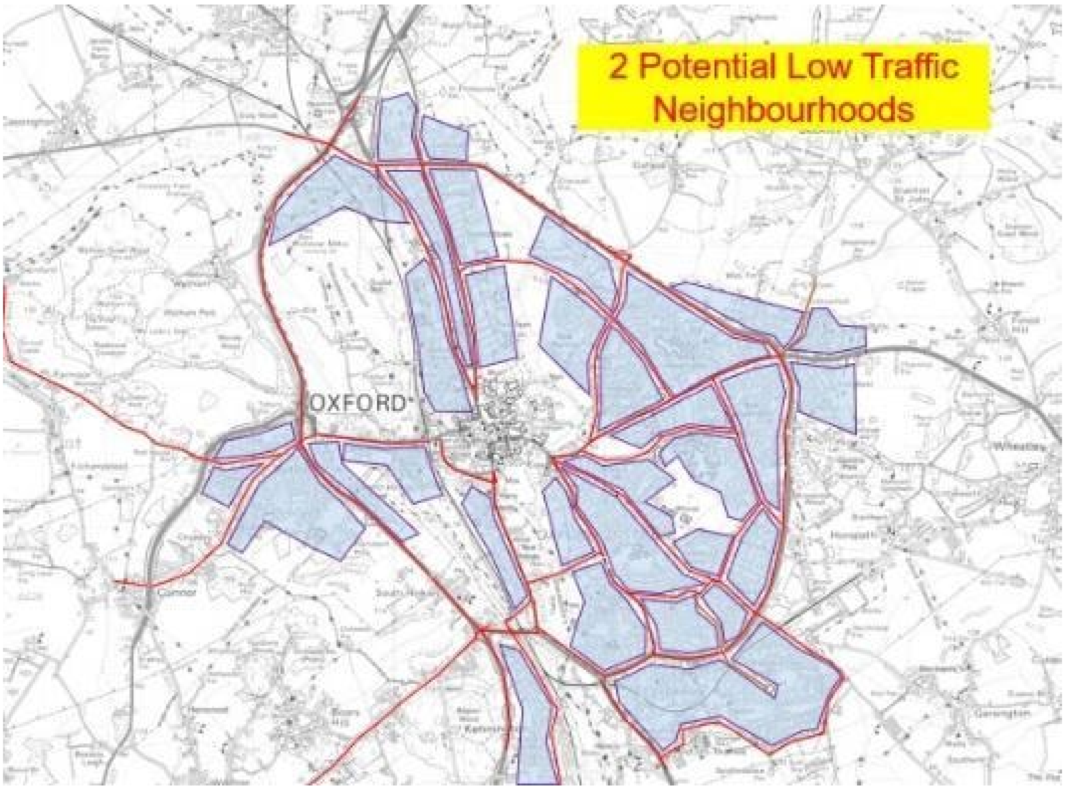


Figure 3: potential low traffic neighbourhoods in Oxford (Oxfordshire County Council)

During 2021, LTNs were introduced in the Cowley area, in Temple Cowley, Church Cowley and Florence Park. These were then in July 2022 made permanent. In May 2022, St Mary's (a triangle bounded by two arterial roads, Iffley Road and Cowley Road, and Howard Road to the South) and two other LTNs the other side of Cowley Road were implemented. Vandalism has been a problem from the start, with bollards set on fire and stolen, planters overturned, and plants destroyed, and the Council is considering the use of traffic cameras under new powers[48].

[48] https://www.thisisoxfordshire.co.uk/news/20256739.oxford-ltns-vandalised-everything-know-attacks/ , https://www.oxfordmail.co.uk/news/20519049.oxford-ltn-planter-vandalised/

Crookes and Walkley, Sheffield

Sheffield is a city in South Yorkshire, England, with a population of around 550,000. Sheffield has a 2% commute mode share for cycling and is a hilly city where e-bikes (pedelecs) could make a substantial difference to the cycling potential. The DfT-funded Propensity to Cycle Tool shows that if Sheffield residents cycled to work at the same rate as Dutch people (based on distance and hilliness of trips) the city would have a mode share of 12%; however, adding in mass access to e-bikes (based on rates of use of e-bikes in the Netherlands and Switzerland for longer and hillier trips) this increases to 22%. In Sheffield, 15.6% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Sheffield is ranked 61st most income-deprived.

Sheffield traditionally has relatively little dedicated cycling infrastructure. The city has a range of active and sustainable travel-related investment plans including radial cycle routes and 'active neighbourhoods' involving area-wide traffic reduction[49], although modal filters and 12-hour bus lanes in particular have proved controversial[50]. The Crookes scheme was implemented in May-June 2022 although it has experienced issues with vandalism and the scope has been somewhat reduced from plans that the research team originally received (with some modal filters in particular towards the North-east of the area not, or not yet implemented, although the scheme still constitutes area-wide traffic reduction). At the time of writing (October 2022), however, it seems that some filters may be removed.

[49] https://connectingsheffield.commonplace.is/

[50] https://www.thestar.co.uk/news/environment/little-london-road-reaction-as-sheffield-road-on-sheaf-valley-cycle-route-is-closed-to-cars-at-railway-bridge-3762397

Figure 4: Original plan of the scheme extent (pink), showing bus routes in blue (Sheffield City Council: https://connectingsheffield.commonplace.is/en-GB/proposals/crookes-active-neighbourhood/step1)

Woodgrange and Capel, Newham ("Areas 5 and 6")

Newham is in East London; an Outer London borough under the London Government Act 1963, but classed by the Office for National Statistics as Inner London. Like Sheffield, it had a commute mode share of 2% for cycling in 2011 (despite being entirely flat). The mode share for all-trips was similar, although the active and sustainable mode share is a healthier 76% (at 41%, the mode share for public transport is the highest of any London district. In Newham, 16.9% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Newham is ranked 43rd most income-deprived[51].

Newham had not implemented LTNs prior to the Covid period, when in 2020 it created a joint cross-borough LTN with Waltham Forest (covering in the map below, Area 1 and Area 2.) This had initially been proposed within Transport for London's Liveable Neighbourhoods programme, but when Covid-19 meant this was paused, the plans were taken forward in experimental form as Covid emergency schemes. Newham also implemented Areas 3, 4, and 7. Areas 5 and 6 (in peach, directly South of Wanstead Park) had at the time of writing not yet been implemented, with this due to happen in Spring 2023.

Cycle track 16 runs East-West from Stratford to the East end of Wanstead Park, though the LTN (Capel Road, which borders Wanstead Park to the South, will be modally filtered). Other cycling infrastructure is relatively limited. Cycle Superhighway Two enters the borough from the West and terminates at Stratford. The Northern Outfall Sewer or Greenway runs East-West across the borough to the South, while Cycle Superhighway 3 runs further South still, is largely comprised of repainted legacy infrastructure along the busy A13.

[51] https://www.ons.gov.uk/visualisations/dvc1371/#/E09000025

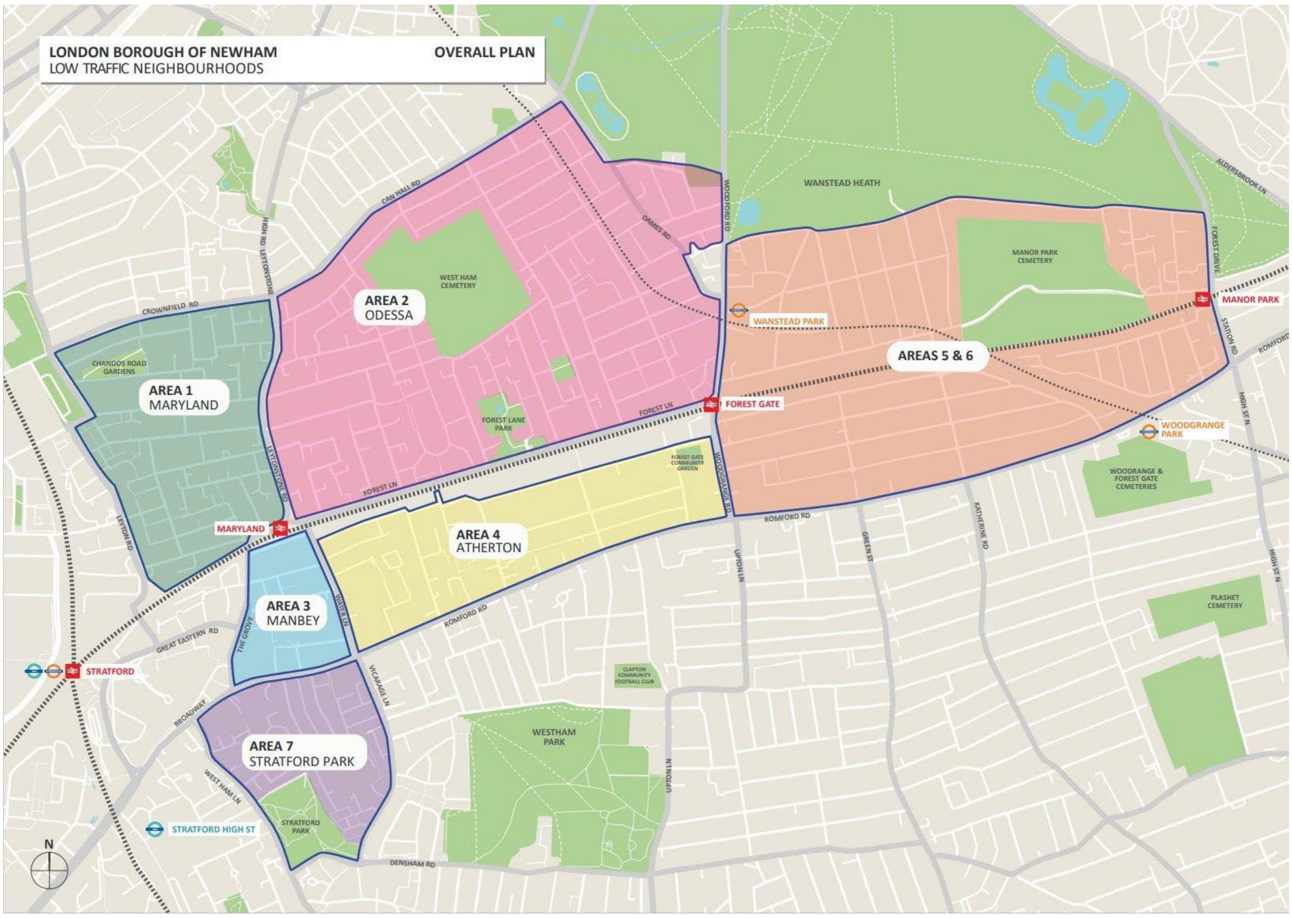


Figure 5: Capel and Woodgrange LTN, labelled here as Areas 5 and 6, in its wider context (London Borough of Newham)

St Ann’s, Haringey

Haringey, like Newham, is either Inner or Outer London depending on whether one uses the LGA or the ONS classification. It has a higher commute mode share for cycling, at 5%, and an all-trip cycling mode share of 3% (for all active and sustainable modes, the share is 74%). In Haringey, 17.0% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Haringey is ranked 42nd most income-deprived.

Haringey, like Newham, had not implemented LTN-type schemes despite being adjacent to a borough or boroughs where such schemes had previously been introduced. Unlike Newham, it did not build any during 2020-1. However, in 2022, the borough decided to introduce 3 LTNs, in Bounds Green (adjacent to an Enfield scheme), St Ann’s, and Bruce Grove. These have been built from mid-August onwards, sequentially.

The borough also lacks much cycle infrastructure, aside from Cycle Superhighway One which runs North-South through it. In March 2022, the council published its draft Walking and Cycling Action Plan[52], which acknowledged the low quality and sporadic nature of many cycle routes and included a chapter on Low Traffic Neighbourhoods as a way of (among other things) supporting walking and cycling.

---

52 https://www.minutes.haringey.gov.uk/documents/s130968/Appendix%20D%20-%20Walking%20and%20Cycling%20Action%20Plan.pdf

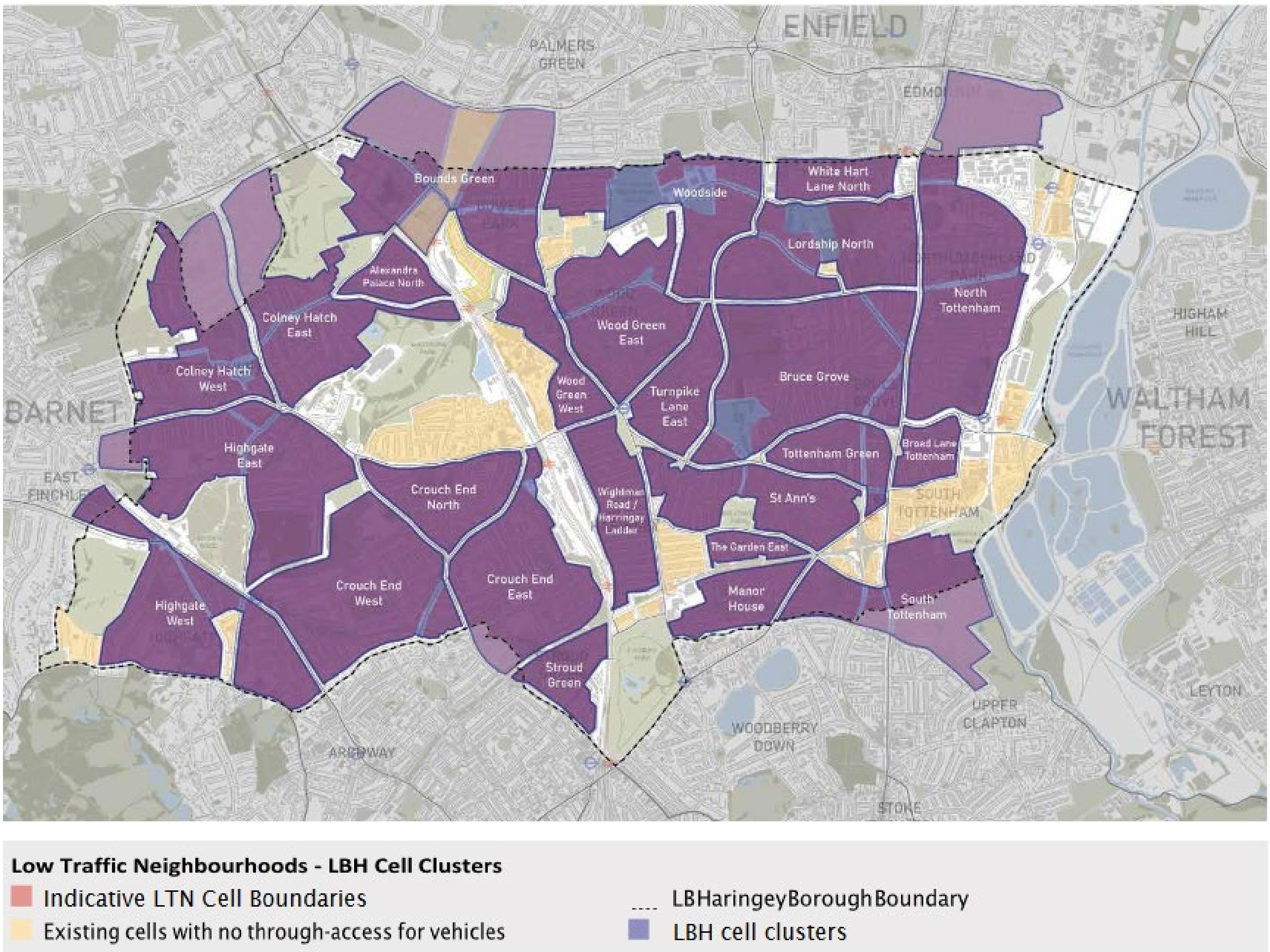


Figure 6: map of Haringey showing all possible and existing Low Traffic Neighbourhoods (London Borough of Haringey)

Brixton Hill, Lambeth; and Streatham Wells, Lambeth

Lambeth is an Inner South London borough stretching from the Thames Riverside down to Streatham in the South. It had 8% cycle commuting mode share in 2011, with an all-trip cycling mode share of 5% (78% all active and sustainable modes). The borough has hilly areas, particularly towards the south. In Lambeth, 15.3% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Lambeth is ranked 69th most income-deprived.

Lambeth proposed a series of LTNs as a part of the borough's long-term transport strategy which was launched following consultation in 2019. These plans were accompanied by a Healthy Routes Plan[53] by which the borough planned to supplement the North-South cycle superhighway built by TfL. Figure 7 illustrates one such route, completed in 2021 along a busy residential road which is also a Quietway Route.

Figure 7: Rosendale Road cycle track (Sustrans)

53 https://www.lambeth.gov.uk/sites/default/files/201947%20Appendix%20A%20Healthy%20Routes%20Plan%202019%20FINAL.pdf

With the Covid emergency in 2020, 5 LTNs were introduced as experimental schemes, and made permanent later with changes in some cases. Brixton Hill and Streatham Wells, in the centre and south of the borough respectively, are being introduced in Spring 2023.

Figure 8: A modal filter in an earlier emergency LTN in Lambeth (London Borough of Lambeth)

Kings Heath, Birmingham

Birmingham is the UK's second largest city with a population of 1.145 million in the city proper, and 2.92 million in the West Midlands metropolitan county. In Birmingham, 22.2% of the population was income-deprived in 2019. Of the 316 local authorities in England (excluding the Isles of Scilly), Birmingham is ranked 7th most income-deprived[54]. Only 1.6% of commuters cycled to work in 2011, while 63.1% drove.

While Birmingham is known for relatively high levels of car dependence, it has ambitious plans influenced by the Belgian city of Ghent[55] to restrict driving into the centre. It introduced a number of experimental Low Traffic Neighbourhoods during 2020-1, including in the Kings Heath area, a suburb 4 miles South of the City Centre. The scheme included in this theme represents an extension to that scheme, covering an area where new filters will be placed when the scheme goes ahead in 2023.

[54] https://www.ons.gov.uk/visualisations/dvc1371/#/E08000025

[55] E.g. https://www.eltis.org/in-brief/news/ghents-traffic-circulation-alterations-inspire-birminghams-ambitious-new-transport

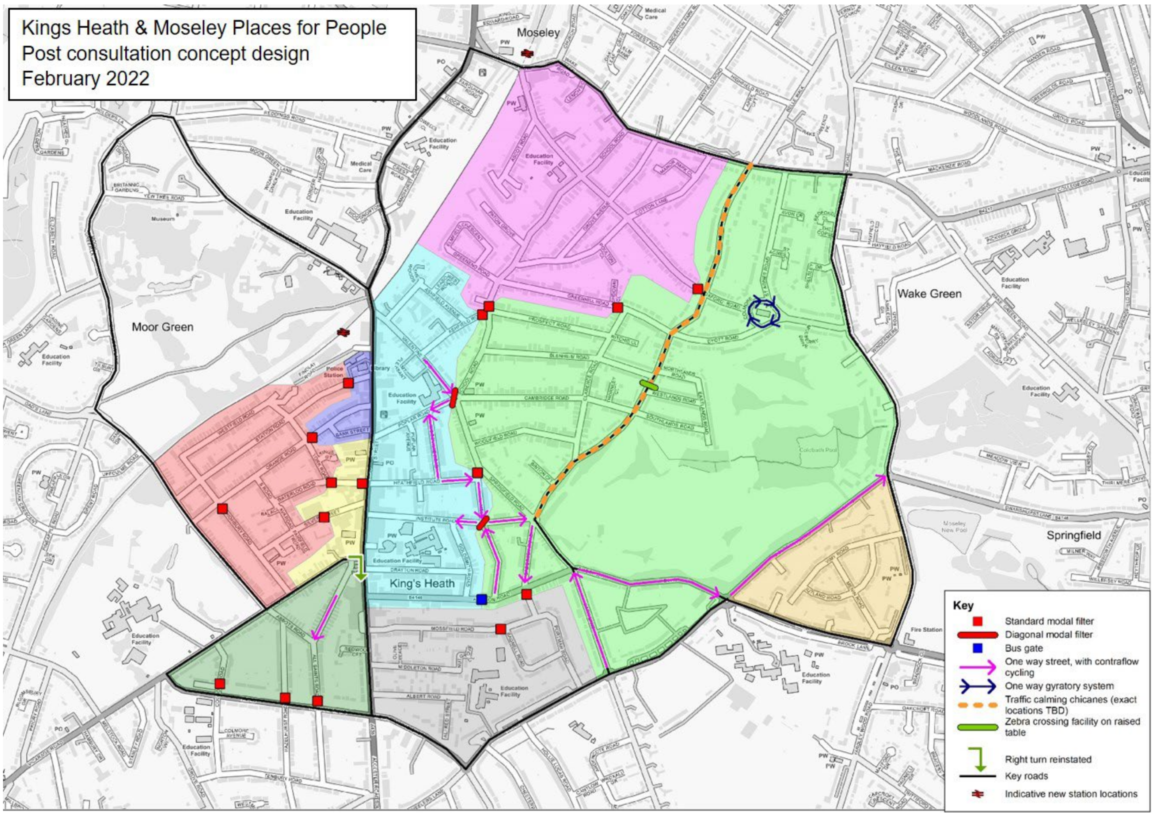


Figure 27: Concept Design, Kings Heath & Moseley Places for People. Birmingham City Council, Public update March 2022

LTNs classed as possible

These LTNs are included in the baseline data collection provided above but are not discussed here in detail as there are some questions over their scope and implementation. It is likely that only one or two might in practice be included in the evaluation.

- Cumberland and Holborn, Newham
- The Cally, Islington
- Fleetville LTN, Hertfordshire
- Edwards Lane Estate, Nottinghamshire
- Chapel Allerton, Leeds
- Frizinghall, Bradford

A2.2 Data Collection and Analysis

More information on road user classification and baseline data collection periods

Table 22 provides information about the categorisation of road users provided by the machine learning sensors.

Table 22. Classification of road users based on sensor data

Road user	Additional information
Car	Includes taxis and mini-buses
Pedestrian	Includes people in a wheelchair or pushing a pram
Cyclist	Includes cargo bike and e-bike
LGV	Road users classified as Light Goods Vehicle, typically with single rear wheels (includes delivery vans, transit vans, milk floats)
OGV	Road users classified as either OGV1 (larger rigid vehicles with 2 or 3 axles and double rear wheels) or OGV2 (all rigid vehicles with 4 or more axles)
Motorbike	Includes mopeds
Bus	Includes coaches

In the baseline data collection, all data has been downloaded for every sensor from the validation date (the date at which the sensor was validated, normally a couple of weeks after installation) to June or July 2022. Table 23 provides information regarding the data type, validation dates, intervention dates and the baseline analysis period for each LTN is outlined in for all 15 currently included LTNs. The start date for baseline data has been amended where, in the first few days or weeks from validation date, there still appears to be significant fluctuation. For each LTN-control pair, data is only included from the point at which the last sensor (in the set of pairs) was validated and to either June/July 2022 or, if the LTN has been implemented prior to this, the date at which the LTN had been implemented. Alongside the removal of missing/anomalous data across all LTN-control pairs, this ensures that, for each LTN, there is the same number of hours of data used for each sensor. Finally, any countlines that are road crossings have been dropped from the analysis alongside data from the obscured left-hand-side pavement on one of the control sensors in Camden Square.

Table 23. Data collection details for each LTN

Area	Council	LTN name	Data type	Validation date	Intervention date	Baseline analysis period in current document
Non-London	Bradford	Frizinghall	Vivacity sensors	20/01/2022		20/01/2022 - 12/06/2022
	Hertfordshire	Fleetville	Vivacity sensors	07/02/2022		07/02/2022 - 12/06/2022
	Nottingham	Valley Road	Vivacity sensors	27/09/2021		27/09/2022 - 12/06/2022
	Sheffield	Crookes	Vivacity sensors	01/12/2021	Partially implemented between end of May and early June 2022	01/12/2021 - 12/06/2022
	Leeds	Chapel Allerton	Street Systems sensors	12/01/2022		12/01/2022 - 06/07/2022
	Oxford	St Mary's (East Oxford)	Manual/ ATC		May-22	11/10/2021 - 25/10/2021
	Birmingham	Kings Heath	Manual/ ATC			01/10/2021-28/10/2021
London	Camden	Camden Square	Vivacity sensors	18/06/2021	23/12/2021	18/06/2021 - 23/12/2021
	Lambeth	Brixton Hill	Vivacity sensors	18/06/2021		18/06/2021 - 09/06/2022

London	Hackney	Stoke Newington Church Street	Vivacity sensors	30/07/2021	20/09/2021	30/07/2021 - 20/09/2021
	Islington	The Cally	Vivacity sensors	18/06/2021		18/06/2021 - 09/06/2022
	Haringey	St Anns	Vivacity sensors	18/06/2021	22/08/2022	18/06/2021 - 22/08/2022
	Newham	Cumberland and Holborn	Vivacity sensors	18/06/2021		18/06/2021 - 09/06/2022
	Newham	Areas 5 & 6	Vivacity sensors	10/03/2022		10/03/2022 - 09/06/2022
	Lambeth	Streatham Wells	Vivacity sensors	28/08/2021		28/08/2021 - 09/06/2022

Anomaly detection: more detail on processes used

Periods of missing data

The first task after downloading the data for all time periods and noting the validation/start dates for baseline, was to identify any periods of zero count data where the sensor is likely to have stopped recording data. An automated script examined counts from each direction for each sensor and identified days when there were either a) zero counts across all modes b) very low counts (less than 3) across all modes. Sensor data has been removed from the analysis (and subsequent analyses) if it meets any of the following criteria:

Zero count day: On this day, there were zero counts for all modes for this countline direction

Very low count day: On this day, the counts were so low (less than 3) for all modes that it appears there was a sensor malfunction

Between zero count days or very low count days: The day falls between two zero count days or two very low count days. E.g. the day before and day after both have zero counts, making it likely the data on this day is unreliable.

Buffer before zero count/very low count day: A 'buffer before' period is a time period on the day prior to the zero count day on which data is not considered reliable. This is either 'buffer before time', which sets the start of the buffer as the start of the very last 3 hour period of time in which there was a non-zero/non very low count.

Buffer after zero count/very low count day: This is the same principle as above but after the zero count or very low count day.

In the baseline analysis, if one of the sensors in an LTN-control set has missing data, data is removed for all of the sensors at the same time period. This is to ensure that the comparison is precisely like-for-like and that any findings are not distorted by the exclusions of time periods from one but not all sensors. The same principle is applied to cases where anomalous data has been removed, as is discussed in the following section.

Night-time automated anomaly detection and imputation

The first stage of detecting anomalies uses a method of time series decomposition that combines short and longer-term trends to identify anomalies in one-hour periods at night time (between 10pm and 6am). By analysing data over an extended time period, this method can account for patterns that arise in the count data e.g. fluctuations at different points in the day, weekend versus weekday changes, seasonal changes. More typical statistical tests of clustering methods would fail to incorporate any of these time-based changes so would perform poorly in identifying outliers. In short, the time series decomposition uses the seasonal trend and the longer-term trend to essentially create a predicted value for each count data point for each mode separately. A 'remainder' value is created that is the difference between the observed value and predicted values. Anomalies are detected when, based on the information from the long-term trend, short-term trend and the 'remainder' values, they fall outside of pre-set upper and lower limits, based on the interquartile range (IQR) (For more details see: https://cran.r-project.org/web/packages/anomalize/anomalize.pdf and https://towardsdatascience.com/why-1-5-in-iqr-method-of-outlier-detection-5d07fdc82097). The IQR of the 'remainder' values is defined as Q3-Q1 where Q3 is the 75th percentile of the remainder values and Q1 the 25th percentile of the reminder values. The analysis applies an IQR Factor of 6 to this, such that observations are considered outliers if either:

$y_t < Q1 - 6 \times IQR$ or

$y_t > Q3 + 6 \times IQR$

Using such a large IQR Factor ensures that a narrow definition of an anomaly is used. In addition, an additional filter is applied to ensure that anomalies are only detected when the 'remainder' – that is the difference between the estimated and observed values, is greater than 15 in the one hour period. The total proportion of anomalies has also been capped for each sensor at a maximum of 5% of all hourly data points. The reason for using such a narrow definition with a filter and cap is because, in the end, the research team replace this data with the predicted values from the time series decomposition. It is therefore desirable for it to be very likely that a) the observed data is not real; b) the observed data could have a significant impact on the analysis. For instance, only excluding data points where the remainder is greater than 15 ensures that a case where, say, a group of 8 cyclists on a road at 11pm are not removed from the data because there is a predicted value of less than 1 cyclist per hour.

This process of anomaly detection has been replicated for each mode and sensor separately. For anomalies detected in the time series decomposition that also meet the criteria outlined above, they have been removed from the data and the values have been replaced with the predicted values that account for seasonal and short-term trends in the data. Data has been imputed rather than removed because during the night, with a narrow classification of anomalies, the risk of replacing real values is low. This, in combination with the lower variation in night-time values across all modes provides greater confidence that the imputed values are likely to be good estimates for the actual values. Finally, the night of 31st December has been removed from the anomaly detection due to increases in all modes that are highly likely to be real.

Day-time automated anomaly detection

After imputing the anomalous night-time count data, the research team have then detected anomalies specifically during the daytime (6am-10pm) using the same time series decomposition approach, with some modifications. Firstly, because of the greater variation in daytime count data, anomalies are not replaced with missing values, as there is a higher risk that the observed data is real rather than the result of a sensor malfunction/ miscounting. Instead, the identified anomalies are manually reviewed before deciding whether they should be included/excluded from any analysis, as described in the next section. Secondly, anomalies have been detected in the daytime at the day-level i.e., identifying anomalies for each mode for each day, rather than at the hourly level. The reason for this is to make the subsequent manual process more manageable across a small team – there would simply be too many anomalies to review manually if they were detected at the hourly-level. Thirdly, the narrow classification of anomalies used at night-time has been replicated, apart from a filter has not been applied to the value of the 'remainder'. The remainder values and the variation in counts are generally much larger for day-time counts meaning any filter would be likely both unnecessary and ineffective.

Manual review of anomalous data

The aim of the next stage of the process was twofold:

To identify whether pre-identified day-time anomalies should be excluded or included in the final, cleaned data for analysis.

To identify any other longer-term trends (rather than short-term, daily anomalous points/fluctuations) that are unusual and come to a decision about whether this data should be included or excluded.

This is a manual task that has been completed by several members of the team, referred to here as ‘reviewers. Each reviewer had access to the identified anomalies, the predicted values, weather and bank holiday data, the tracks images on the Vivacity dashboard for each sensor, the day-time daily counts for each sensor (including anomalies) and a daytime count graph of pedestrians in the road. Using a combination of this data, in respect to objective 1 above, the reviewer was tasked with making a decision about whether each anomalous data point should be removed from the data or kept in. Table 24 below was given to each reviewer with instructions for how to make the decision and how to code the decision for future reference/analysis. The logic behind the table was that:

- All obvious sensor malfunctions/miscounting should be removed
- Anomalies likely to be caused by one-off or non-repeated events should be removed
- Anomalies likely to be caused by roadworks either in the LTN/control area or nearby should be removed.
- Anomalies likely to be caused by bank holidays, weather conditions or recurring events should be retained.
- Anomalies that appear to be real and would have a low impact on any analysis (e.g. rare vary low counts) should be retained.
- Anomalies that appear to have some other cause that is real (e.g. children playing) should be retained.
- All other anomalies without an explanation should be removed.

This is a careful balance between objectivity and subjectivity, and there are going to be discrepancies with any method that is used here – people can interpret and apply the instructions slightly differently and there are time constraints. However, prior to the reviewers conducting this manual process, meetings took place to carefully consider examples of each type of anomaly and how they can be identified from the tracks or any other data. In addition, uncertain cases were flagged and subsequently reviewed by the team to make a collective decision. The approach also seems more logical than including all anomalies because, particularly if they ended up in the future ‘pre’ or ‘post’ analysis, they could distort any analysis, violate key assumptions and ultimately lead to false conclusions from the data. On the contrary, if all anomalies were excluded, results could be skewed by the exclusion of real data and statistical power could be reduced by larger periods of missing data.

Table 24. An outline of the exclusion and inclusion rules for anomalous data points

Decision	Description	What to write in 'code' column
Exclude	anything that is an obvious sensor malfunction e.g. a completely implausible count.	Implausible
Exclude	an obvious case of mis-counting a parked motor vehicle or pedestrian, as shown by a circle/group of tracks in one location/on one spot.	Miscounting
Exclude	one-day or short-term spikes that do not seem as if they could be repeatable i.e. if there is no reason to believe that this might be the result of some event that might happen again next year or a bank holiday etc. In practice this means the default for 'anomalous for unknown reasons' is exclude.	Unknown
Exclude	anomalous days that may be roadworks. These are not an artefact in that it captures something that happened in the world, but are not expected to be consistent between the LTN/control area or pre-/post, and are arbitrarily based on where there is a specific sensor. *Roadworks on the road itself are likely identifiable by a fall in all forms of motor traffic (not just cars), though there could also be a very high number of LGV/OGV as a van/digger works near the countline. Possibly also the pedestrian tracks show construction workers concentrated on a site. Also, look at the pedestrians in the road graph*: *there could be an increase during periods of construction. Be careful not to confuse school holidays for roadworks.*	Roadworks
Exclude	one-off unusual days due to highly localised one-off things e.g. a non-repeating street party. I suggest exclude on basis that are similar to road-works in being highly localised and potentially sporadic? plus in practice it may be hard to tell the difference.	One-off event
Include	unusual days due to school holidays/bank holidays etc. Also unusual days due to unusual weather, e.g. snow	Weather/Holiday

	suppressing cycling. These fluctuations are real and may be expected to be consistent pre/post and between LTN/control, and also to have been seen regardless of where the sensor is.	
Include	periodic / recurrent unusual days, e.g. a market every Saturday. Since should see this pre/post consistently.	Recurring event
Include	Any recurrent but low counts e.g. a bus which is normally zero being 2.	Recurring low count
	Other reasons to include might be seeing something like a spike in cyclists in school holidays or summer months. If tracks are legitimate, one might conclude that this is likely children playing.	Other

Identifying unusual long-term trends

While the time series decomposition performs well in identifying single-day anomalies, it is less effective for identifying longer time periods of unusual data points. For instance, in the case that there are roadworks affecting a road for a month, counts could be affected across the entire time period, but would likely be considered part of a seasonal trend rather than anomalous data points. To address this, the research team have manually inspected the daily count graphs for each sensor/mode across the baseline period to identify any unusual long-term trends. These can resemble longer-term periods of fluctuation, spikes or counts that are for some reason consistently higher or lower than the average for a period of several days or weeks. When these were identified, they have been 'flagged' by the reviewer and subsequently assessed collaboratively in a meeting. Generally, the same logic for removing or keeping the data has been applied to these longer-term trends as used for the daily anomalies. That is, if the data appears to be a malfunction/miscalculation or the result of roadworks/a one-off event, it has normally been removed. If the unusual data is caused by something unknown or for instance school holidays (recurring), data has been retained. Note that in this case, unlike with the daily anomalies, unknown cases have generally been retained, mostly because of the loss of statistical power associated with removing data across multiple sensors and many days and weeks.

Further comparisons between sensor data at LTN and control sites

Generally, the LTN-control count differences across different time periods matched that across all time periods, with no time periods standing out as markedly different.

Table 25. Baseline counts by mode across all LTN schemes for different time periods

Time period	Type	Pedestrian	Cyclist	Car	Bus	Motorbike	LGV	OGV
Daytime	LTN	5,519,683	1,227,317	7,722,157	78,210	662,485	1,267,770	88,528
Daytime	Control	5,764,198	1,077,271	10,045,771	101,854	640,065	1,396,339	108,311
Night-time	LTN	297,041	97,221	1,251,313	13,387	74,785	82,972	17,261
Night-time	Control	354,899	93,785	1,533,007	15,859	86,746	97,062	10,371
Peak	LTN	1,890,807	504,701	2,463,424	27,186	165,636	454,363	30,149
Peak	Control	2,024,733	421,131	3,270,436	35,460	163,018	510,452	38,108
Interpeak	LTN	1,801,254	295,524	2,122,866	26,073	181,590	575,201	44,975
Interpeak	Control	1,934,813	272,337	2,823,511	37,843	166,614	620,582	53,936

Weekend 7am to 7pm	LTN	1,215,385	239,792	1,704,656	13,118	135,812	160,682	8,204
Weekend 7am to 7pm	Control	1,138,060	211,238	2,160,116	16,385	128,565	173,982	11,213
Other	LTN	612,237	187,300	1,431,211	11,833	179,447	77,524	5,200
Other	Control	666,592	172,565	1,791,708	12,166	181,868	91,323	5,054

Table 26. Baseline counts by mode across all LTN schemes for weekday and weekends

Day type	Type	Pedestrian	Cyclist	Car	Bus	Motorbike	LGV	OGV
Weekday	LTN	4,351,122	1,023,839	6,387,902	71,718	526,073	1,156,770	92,449
	Control	4,699,156	898,022	8,361,240	94,318	518,376	1,282,381	104,697
Weekend	LTN	1,465,602	300,699	2,585,568	19,879	211,197	193,972	13,340

	Control	1,419,941	273,034	3,217,538	23,395	208,435	211,020	13,985

Table 27. Daily summaries of counts across all LTN schemes

		Daily summaries		
Mode	Type	Mean	Median	Standard deviation
Bus	LTN	239	142	281
Bus	Control	307	310	168
Car	LTN	23,368	25,261	8,688
Car	Control	30,153	28,573	11,794
Cyclist	LTN	3,449	3,501	1,692
Cyclist	Control	3,050	3,092	1,439
LGV	LTN	3,518	3,488	1,894
LGV	Control	3,889	4,090	1,955
Motorbike	LTN	1,920	1,954	927
Motorbike	Control	1,893	2,031	681
OGV	LTN	276	282	155
OGV	Control	309	345	171
Pedestrian	LTN	15,148	16,016	6,087
Pedestrian	Control	15,935	17,065	6,528

Table 27 above presents a statistical summary of the daily values across the LTN-control pairs by mode. For all modes, except cars, the mean values for LTN sensors and control sensors are very similar, implying that LTN and control areas are well matched. While there is a significant difference between the mean daily counts for cars, the median counts by LTN and control group are much closer. The implication is that across LTN sensor pairs, there is a negatively skewed distribution of daily car counts, with the distribution affected by a small number of very low counts. The reverse is true in control areas, where there is a positive skew. In general, the variance – measured by the standard deviation – is fairly similar across LTNs and control area sensors by mode type. However, the standard deviation of daily car counts is considerably higher in control areas compared to LTNs. The implication is that there is more variation amongst the daily car counts across control area sensors i.e. a greater number of daily counts are far from the mean.

Pedestrians

below presents the baseline mean, median, and standard deviation for the daily pedestrian counts for each LTN pair and control pair of sensors for each scheme. For pedestrians, most schemes in London were well matched, with especially similar counts at Camden Square, St Ann’s, The Cally and Brixton Hill LTN/controls. In contrast, the median daily pedestrian count for sensors in the Stoke Newington Church Street LTN was some 8,863 - considerably higher than the median value of 5,961 in the control area. In the non-London schemes, there was much more variation, with Crookes LTN and Frizinghall having much higher median counts in the control areas whilst in Chapel Allerton in Leeds the reverse trend is observed. Note that Frizinghall and Chapel Allerton are considered two of the schemes less likely to proceed, however, and have not yet been implemented.

Table 28. Daily baseline pedestrian count summaries across all LTN schemes and control areas

			Daily pedestrian summaries					
			Mean		Median		Standard deviation	
Location	Council	LTN name	LTN	Control	LTN	Control	LTN	Control
London	Camden	Camden Square	1,731	1,930	1,747	1,901	339	325
	Hackney	Stoke Newington Church Street	9,147	6,157	8,863	5,961	1,294	944
	Haringey	St Anns	1,805	2,256	1,744	2,147	441	576
	Islington	The Cally	3,977	3,550	4,053	3,470	770	939
	Lambeth	Brixton Hill	3,729	3,701	3,705	3,803	836	727

London	Lambeth	Streatham Wells	3,451	2,061	3,557	2,320	851	806
	Newham	Areas 5 & 6	774	1,697	777	1,690	121	306
	Newham	Cumberland and Holborn	1,146	2,471	1,133	2,493	315	578
non-London	Bradford	Frizinghall	647	1,219	629	1,183	189	352
	Hertfordshire	Fleetville	1,660	1,879	1,676	1,888	347	445
	Leeds	Chapel Allerton	1,539	671	1,574	703	239	169
	Nottingham	Valley Road	296	188	294	185	86	62
	Sheffield	Crookes	835	1,991	818	2,059	218	557

Cyclists

Table 29 below presents the baseline mean, median, and standard deviation for the daily pedestrian counts for each LTN pair and control pair of sensors for each scheme. In London, all schemes except The Cally and Stoke Newington Church Street had very similar median values. In both The Cally and Stoke Newington Church Street, there were considerably more daily cyclists recorded by the LTN sensors than those in the control areas. Outside of London, the schemes were also well matched, with the only significant exception being Sheffield Crookes where the median daily count in the LTN sensors was 136 compared to 612 in the control area sensors.

Table 29. Daily cyclist count summaries across all LTN schemes and control areas

			Daily cyclist summaries					
			Mean		Median		Standard deviation	
Location	Council	LTN name	LTN	Control	LTN	Control	LTN	Control
London	Camden	Camden Square	300	315	297	320	82	75
	Hackney	Stoke Newington Church Street	2,565	2,136	2,611	2,165	429	510
	Haringey	St Anns	277	199	271	195	83	55
	Islington	The Cally	1,345	756	1,356	767	380	196
	Lambeth	Brixton Hill	1,198	1,278	1,204	1,268	335	299
	Lambeth	Streatham Wells	430	292	434	292	131	103
	Newham	Areas 5 & 6	175	225	171	228	32	32

	Newham	Cumberland and Holborn	71	278	69	275	22	73
non-London	Bradford	Frizinghall	33	56	26	52	21	30
	Hertfordshire	Fleetville	226	172	231	169	72	54
	Leeds	Chapel Allerton	75	32	76	30	30	14
	Nottingham	Valley Road	31	15	29	13	12	10
	Sheffield	Crookes	34	154	34	153	14	53

Cars

The trend in daily car counts () follows that of pedestrians: across the London schemes, there are fewer substantial differences between LTN sensors and those in corresponding control areas. Both LTNs in Newham have especially close median values, as well as those in The Cally, St Anns, and Camden Square. The two LTNs in Lambeth have greater incongruence: in Brixton Hill the median daily LTN count is 3,593 compared to 10,022 in the control area; in Streatham Wells the trend is reversed. In schemes outside of London, counts are significantly higher in control areas than LTNs, with the exception of Nottingham Valley Road.

Table 30. Daily car count summaries across all LTN schemes and control areas

			Daily cars summaries					
			Mean		Median		Standard deviation	
Location	Council	LTN name	LTN	Control	LTN	Control	LTN	Control
London	Camden	Camden Square	2,926	1,684	2,893	1,663	333	270
	Hackney	Stoke Newington Church Street	9,936	6,053	9,973	5,995	895	478
	Haringey	St Anns	1,470	2,849	1,469	2,875	179	284
	Islington	The Cally	4,835	2,849	4,835	2,835	583	474
	Lambeth	Brixton Hill	3,684	10,092	3,593	10,022	535	1,068
	Lambeth	Streatham Wells	8,970	3,757	8,953	3,966	1,448	987

	Newham	Areas 5 & 6	1,809	2,287	1,821	2,288	200	291
	Newham	Cumberland and Holborn	3,425	3,797	3,490	3,793	552	336
non-London	Bradford	Frizinghall	1,789	4,463	1,802	4,512	208	412
	Hertfordshire	Fleetville	2,676	5,455	2,805	5,578	553	841
	Leeds	Chapel Allerton	2,141	4,092	2,166	4,394	273	795
	Nottingham	Valley Road	569	461	580	463	102	65
	Sheffield	Crookes	2,716	7,417	2,779	7,686	430	1,233

Injury Data Comparisons

Table 31: Injury numbers inside the LTN and Control areas, for the 8 London schemes

		All injuries			KSI injuries		
		No./year inside LTN areas	**No./year inside control areas**	**p-value for difference in in trend**	**No./year inside LTN areas**	**No./year inside control areas**	**p-value for difference in in trend**
Casualty using	2012-14	39.0	38.3	0.27	7.9	5.4	0.20
any mode	2015-17	45.7	53.3		4.2	4.8	
	2018-20	43.7	57.0		2.7	4.7	
Pedestrian	2012-14	9.7	9.3	0.51	2.3	1.0	0.75
casualty	2015-17	8.7	11.7		1.8	2.0	
	2018-20	11.0	15.7		1.7	1.7	
Cyclist	2012-14	7.3	6.3	0.91	1.6	1.2	0.86
casualty	2015-17	10.7	8.0		0.8	1.3	

	2018-20	7.7	7.0		1.0	1.3	
Car driver or	2012-14	12.0	13.0	0.88	0.6	1.3	0.33
passenger	2015-17	17.3	19.3		0.9	0.5	
casualty	2018-20	14.3	18.0		0.0	0.3	

KSI = Killed and Seriously Injured. LTN = low traffic neighbourhood. P-values for association calculated using Fisher's Exact chi-squared tests for association (this is effectively equivalent to testing for a difference in trend between the LTN and control areas, i.e., examining if the distribution of casualties by year varies between the two groups).

Table 32: Injury numbers inside the LTN and Control areas, for the 10 non- London schemes

		All cause injuries			KSI injuries		
		No./year inside LTN areas	**No./year inside control areas**	**p-value for difference in in trend**	**No./year inside LTN areas**	**No./year inside control areas**	**p-value for difference in in trend**
Casualty using	2012-14	27.3	18.3	0.38	7.2	3.9	0.92
any mode	2015-17	31.0	25.0		7.4	3.6	
	2018-20	20.7	19.7		4.5	2.5	
Pedestrian	2012-14	11.0	4.7	0.45	3.3	1.2	1.0
casualty	2015-17	8.3	5.7		2.8	1.2	
	2018-20	5.3	4.0		1.1	0.1	
Cyclist	2012-14	6.0	5.0	1.0	2.2	0.9	0.61
casualty	2015-17	5.3	4.7		1.2	1.2	
	2018-20	4.7	4.0		2.2	0.8	
Car driver or	2012-14	6.7	7.0	0.15	0.5	0.7	0.28

passenger	2015-17	14.7	12.3		1.6	0.8	
casualty	2018-20	6.7	11.3		0.4	1.5	

KSI = Killed and Seriously Injured. LTN = low traffic neighbourhood. P-values for association calculated using Fisher's Exact chi-squared tests for association (this is effectively equivalent to testing for a difference in trend between the LTN and control areas, i.e., examining if the distribution of casualties by year varies between the two groups).

Table 33: Injury numbers inside the LTN and Control areas, for the 18 London and non- London schemes

		All cause injuries			KSI injuries		
		No./year inside LTN areas	**No./year inside control areas**	**p-value for difference in in trend**	**No./year inside LTN areas**	**No./year inside control areas**	**p-value for difference in in trend**
Casualty using	2012-14	66.3	56.7	0.07	15.2	9.2	0.49
any mode	2015-17	76.7	78.3		11.6	8.4	
	2018-20	64.3	76.7		7.2	7.1	
Pedestrian	2012-14	20.7	14.0	0.11	5.6	2.2	0.83
casualty	2015-17	17.0	17.3		4.6	3.2	
	2018-20	16.3	19.7		2.8	1.8	
Cyclist	2012-14	13.3	11.3	0.93	3.8	2.1	0.75
casualty	2015-17	16.0	12.7		2.0	2.5	
	2018-20	12.3	11.0		3.2	2.2	
Car driver or	2012-14	18.7	20.0	0.29	1.1	2.0	0.15

passenger	2015-17	32.0	31.7		2.6	1.3	
casualty	2018-20	21.0	29.3		0.4	1.8	

KSI = Killed and Seriously Injured. LTN = low traffic neighbourhood. P-values for association calculated using Fisher's Exact chi-squared tests for association (this is effectively equivalent to testing for a difference in trend between the LTN and control areas, i.e., examining if the distribution of casualties by year varies between the two groups).

Traffic speed data

Additional data on baseline speeds

			Number of journeys		Mean speed		Median speed		Speed standard deviation	
Council	LTN	Time period	LTN	Control	LTN	Control	LTN	Control	LTN	Control
Birmingham	Kings Heath	All time periods	20,089	15,785	17.3	19.3	18.2	19.4	6.2	3.6
		Tuesday early morning	1,372	1,078	23.2	22.1	23.8	21.6	4.3	3.9
		Tuesday morning peak	3,626	2,849	16.5	18.1	16.7	19.1	5.9	4.3
		Tuesday inter-peak	4,115	3,234	16.6	19.2	17.8	19.2	6.2	2.9
		Tuesday evening peak	4,116	3,234	15.7	18.4	16.4	18.8	5.6	2.9
		Tuesday evening post-peak	2,744	2,156	19.4	21.0	20.5	20.4	5.2	3.0
		Saturday daytime	4,116	3,234	16.8	19.4	18.2	19.5	6.6	3.3
Bradford	Frizinghall	All time periods	68,872	80,356	18.5	22.0	19.2	23.1	4.6	4.5
		Tuesday early morning	4,704	5,488	22.2	25.8	23.0	26.9	4.1	3.4
		Tuesday morning peak	12,424	14,504	17.5	21.2	18.2	22.2	4.8	4.6
		Tuesday inter-peak	14,112	16,460	18.2	21.9	19.2	23.2	4.3	4.2
		Tuesday evening peak	14,112	16,464	16.8	20.1	17.4	20.3	4.7	4.5
		Tuesday evening post-peak	9,408	10,976	20.7	23.4	21.9	24.6	3.7	4.0
		Saturday daytime	14,112	16,464	18.9	22.6	19.7	23.7	4.2	4.1
Leeds	Chapel Allerton	All time periods	137,752	80,352	16.8	20.3	16.3	20.1	6.9	6.4
		Tuesday early morning	9,408	5,488	19.7	26.1	20.0	27.1	6.8	4.7
		Tuesday morning peak	24,860	14,504	16.9	20.6	16.7	21.2	7.0	5.9
		Tuesday inter-peak	28,220	16,464	16.5	20.1	15.9	19.5	6.7	5.9
		Tuesday evening peak	28,224	16,464	15.8	17.6	14.6	16.4	7.1	6.7
		Tuesday evening post-peak	18,816	10,976	17.8	21.4	17.5	20.1	6.8	6.2
		Saturday daytime	28,224	16,456	16.4	20.4	15.6	20.1	6.7	6.2
Nottingham	Edwards Lane	All time periods	57,396	57,392	20.4	20.8	19.8	21.5	5.5	5.3
		Tuesday early morning	3,920	3,920	24.2	24.8	23.5	25.3	4.5	4.6
		Tuesday morning peak	10,360	10,360	19.2	20.1	18.8	20.6	5.4	5.1
		Tuesday inter-peak	11,760	11,760	20.6	20.2	19.6	20.8	4.9	4.7

			Number of journeys		Mean speed		Median speed		Speed standard deviation	
Council	LTN	Time period	LTN	Control	LTN	Control	LTN	Control	LTN	Control
		Tuesday evening peak	11,756	11,760	18.2	19.4	18.1	20.2	5.6	5.6
		Tuesday evening post-peak	7,840	7,836	22.8	22.9	22.2	23.7	4.7	4.7
		Saturday daytime	11,760	11,756	20.8	20.7	19.8	21.8	5.2	5.1
Oxford	St Mary's	All time periods	10,548	8,631	15.6	20.7	15.9	22.7	4.9	8.2
		Tuesday early morning	704	576	21.4	23.0	21.8	26.2	4.2	8.8
		Tuesday morning peak	2,035	1,665	15.7	19.9	16.1	21.0	4.6	7.6
		Tuesday inter-peak	2,112	1,728	16.0	20.7	16.4	22.7	4.4	8.0
		Tuesday evening peak	2,112	1,728	13.1	19.0	12.8	20.0	4.5	7.7
		Tuesday evening post-peak	1,408	1,152	16.1	22.1	16.5	25.4	4.8	8.8
		Saturday daytime	2,177	1,782	15.5	21.5	15.9	24.0	4.5	8.3
Sheffield	Crookes	All time periods	55,876	60,900	16.8	16.3	16.6	16.1	4.2	6.2
		Tuesday early morning	3,744	4,080	19.2	22.0	19.5	23.4	4.1	6.0
		Tuesday morning peak	10,612	11,580	17.7	16.8	17.6	16.8	4.3	5.7
		Tuesday inter-peak	11,232	12,240	16.4	15.6	16.2	14.7	3.8	5.5
		Tuesday evening peak	11,232	12,240	16.1	15.4	15.5	14.7	4.2	5.4
		Tuesday evening post-peak	7,488	8,160	17.5	19.0	17.2	20.6	4.2	5.5
		Saturday daytime	11,568	12,600	16.0	13.8	15.8	12.2	3.9	6.6
St Albans	Fleetville	All time periods	22,958	24,390	18.3	19.4	17.6	19.8	5.8	3.4
		Tuesday early morning	1,568	1,666	23.1	22.9	23.1	23.3	4.6	3.0
		Tuesday morning peak	4,143	4,403	17.5	18.5	17.0	18.9	5.6	3.7
		Tuesday inter-peak	4,704	4,995	18.1	18.9	17.0	19.3	5.6	2.8
		Tuesday evening peak	4,704	4,997	17.1	18.5	15.7	18.8	5.4	3.5
		Tuesday evening post-peak	3,136	3,331	20.3	21.4	19.7	21.7	5.4	2.3
		Saturday daytime	4,703	4,998	17.5	19.3	16.4	19.7	6.0	3.2

Council	LTN	Time period	Number of journeys LTN	Number of journeys Control	Mean speed LTN	Mean speed Control	Median speed LTN	Median speed Control	Speed standard deviation LTN	Speed standard deviation Control
Camden	Camden Square	All time periods	31,608	35,120	11.3	12.2	11.3	11.6	3.7	4
		Tuesday early morning	2,088	2,320	15.3	15.4	15	15.9	4.9	4.2
		Tuesday morning peak	6,264	6,960	10.5	12.1	10.1	11.6	3.8	3.8
		Tuesday inter-peak	6,264	6,960	10.7	12	10.7	11.3	3.2	3.9
		Tuesday evening peak	6,264	6,960	10.4	11.3	10.4	10.8	3.2	3.9
		Tuesday evening post-peak	4,248	4,720	12.7	12.8	12.7	12.7	3.3	4
		Saturday daytime	6,480	7,200	11.2	11.9	11.6	11	3.2	3.9
Hackney	Stoke Newington Church Street	All time periods	18,548	27,840	12.5	10.6	12.4	10.5	3.4	4.1
		Tuesday early morning	1,200	1,800	17.5	15.9	17.6	16.6	2.8	4.7
		Tuesday morning peak	3,600	5,400	12.1	10.8	12	10.7	3.3	3.5
		Tuesday inter-peak	3,600	5,400	11.9	10	12	10.2	2.9	3.9
		Tuesday evening peak	3,600	5,400	11.1	9.2	11.3	9.1	3.1	3.7
		Tuesday evening post-peak	2,476	3,720	12.9	11.8	13.2	12.1	3	3.8
		Saturday daytime	4,072	6,120	12.8	9.9	12.6	9.6	3.2	3.6
Haringey	St Ann's	All time periods	121,844	76,160	13.6	12	13.8	11.9	3.6	4.2
		Tuesday early morning	8,064	5,040	18	16.3	18.1	17	3.1	4.6
		Tuesday morning peak	24,184	15,120	13.4	12.1	13.6	12.1	3.1	4.3
		Tuesday inter-peak	24,192	15,120	13.2	11.4	13.5	11.4	3.2	3.9
		Tuesday evening peak	24,192	15,120	11.9	10.6	12.1	10.7	3.3	3.5
		Tuesday evening post-peak	16,256	10,160	14.7	13.1	15.2	12.6	3.4	3.7
		Saturday daytime	24,956	15,600	13.7	11.6	14.1	11.8	3.3	4.2
Islington	The Cally	All time periods	111,324	79,516	12.7	11.2	12.6	11.4	3.2	2.7
		Tuesday early morning	7,392	5,280	16.2	15.9	16.8	15.4	3.3	3.2
		Tuesday morning peak	22,176	15,840	11.9	11.1	11.9	11.3	3	2.3
		Tuesday inter-peak	22,176	15,840	11.9	10.7	11.6	11	3	2
		Tuesday evening peak	22,176	15,836	11.8	10.2	11.4	10.7	2.8	2.3
		Tuesday evening post-peak	14,896	10,640	13.7	12.5	13.5	12.5	2.9	2.2

Council	LTN	Time period	Number of journeys LTN	Number of journeys Control	Mean speed LTN	Mean speed Control	Median speed LTN	Median speed Control	Speed standard deviation LTN	Speed standard deviation Control
		Saturday daytime	22,508	16,080	13.2	10.6	13.2	10.9	2.8	2.1
Lambeth	Brixton Hill	All time periods	136,740	119,276	12.1	11.9	12.4	11.7	3.6	4.1
		Tuesday early morning	9,080	7,920	16.2	15.7	17	16.3	3.9	5
		Tuesday morning peak	27,236	23,756	11.7	11.2	12.3	10.9	3.5	4.1
		Tuesday inter-peak	27,240	23,760	12.1	12	12.4	11.9	3.4	3.8
		Tuesday evening peak	27,240	23,760	11.1	10.8	11.3	10.8	3.1	3.5
		Tuesday evening post-peak	18,304	15,960	13.1	13	13.4	13.1	3.2	3.8
		Saturday daytime	27,640	24,120	11.7	11.8	12.2	11.7	3.5	3.8
Lambeth	Streatham Wells	All time periods	98,736	98,976	13.8	12.8	13.9	13.2	4.2	4.1
		Tuesday early morning	6,584	6,600	18.1	16.5	18.4	16.4	3.7	4.4
		Tuesday morning peak	19,752	19,800	12.9	12.5	12.9	12.8	4.1	3.9
		Tuesday inter-peak	19,752	19,784	14	13	13.9	13.5	3.8	3.8
		Tuesday evening peak	19,752	19,796	12.6	11.9	12.6	12.5	4.1	3.9
		Tuesday evening post-peak	13,168	13,196	15.1	13.7	15.3	14.4	3.6	4.1
		Saturday daytime	19,728	19,800	13.4	12.2	13.5	12.7	4	4
Newham	Areas 5 and 6	All time periods	23,853	27,830	15	14.9	14.3	15.2	5.2	3.4
		Tuesday early morning	1,584	1,848	20.2	17	20.4	17.1	4.3	3.9
		Tuesday morning peak	4,752	5,544	15.7	15.3	15.1	15.5	4.8	3.4
		Tuesday inter-peak	4,750	5,543	14.7	15	13.7	15.5	5	3.3
		Tuesday evening peak	4,752	5,544	13.3	13.9	12.5	14.5	5	3
		Tuesday evening post-peak	3,192	3,724	15.5	15.2	14.5	15.6	5.1	3.2
		Saturday daytime	4,823	5,627	14.2	14.5	13.7	15.1	4.9	3.3
Newham	Cumberland	All time periods	17,890	23,854	16.2	15.6	13.7	15.9	10.9	3.1
		Tuesday early morning	1,188	1,584	22.4	19.4	19.9	19.6	9.8	2.5
		Tuesday morning peak	3,564	4,752	17.3	15.7	14.3	15.9	11.7	3.1
		Tuesday inter-peak	3,564	4,752	16.4	15.7	13.7	16	10.9	2.8
		Tuesday evening peak	3,564	4,750	12.1	13.8	11.1	13.9	8.1	2.9

Council	LTN	Time period	Number of journeys LTN	Control	Mean speed LTN	Control	Median speed LTN	Control	Speed standard deviation LTN	Control
		Tuesday evening post-peak	2,394	3,192	17.5	16.3	14.8	16.4	11	2.6
		Saturday daytime	3,616	4,824	16.3	15.7	13.5	15.9	11.5	2.6

Analysis and Modelling: further details

The splitting of the boundary roads data into intervention (LTN) and control groups allows us to utilise a quasi-experimental approach (Difference-in-Differences) to compare the changes in speeds across the pre- and post-intervention time periods for the LTN and control boundary roads. The LTN treatment upon the speed of vehicles can be calculated by comparing the change in speed between the pre- and post-intervention time periods on LTN boundary roads with that on control boundary roads. This analysis is based on a key assumption – the "parallel trends assumption", which states that without the LTN intervention, the treatment group (LTN boundary roads) would follow the same trend as the control group (control boundary roads) between the pre- and post-intervention time periods. In our case, this assumption rests on control and LTN boundary roads having similar characteristics and both being unaffected by extraneous variables such as roadworks or other active travel interventions. Note again that the LTN and control areas have been chosen following discussions with council stakeholders that have confirmed that other nearby active travel schemes are not planned in the study time period. In the analysis that follows, the regression models do not control for differences between LTN and boundary road characteristics. It is anticipated that the final analysis will control for any periods of known roadworks as well as boundary road classifications (A road, B road, minor road etc.).

Research question: Has the Camden Square LTN intervention resulted in a change in motor traffic speeds on boundary roads?

Hypothesis: Boundary roads around LTN interventions will see a reduction in speeds compared to boundary roads around control areas.

The Difference-in-Differences (DiD) model used is specified as follows:

$$Y = \beta_0 + B_1 Treatment + \beta_2 Time + \beta_3 Treatment * Time + \varepsilon$$

The DiD estimator in the model is the interaction effect between the two dummy variables: 1) Treatment, where LTN = 1 and control = 0; 2) Time, where post-intervention = 1 and pre-intervention = 0.

The results from the regression analysis are outlined in the table below. The coefficient presented as DiD (-0.747) is the Difference-in-Differences estimator and is the most important value here. This is an estimate of the treatment effect and tests whether the expected mean change in speed (mph) changes from the pre- to post-implementation period with the implementation of an LTN. In this case, the treatment effect is -0.747 and is statistically significant ($p<0.05$). This indicates that the LTN implementation resulted in a decrease in mean speed of 0.747 mph from the pre-implementation to post-implementation period. With respect to our research question, this indicates that the implementation of the LTN has had a small, but statistically significant, negative effect on mean traffic speeds on the boundary roads.

Other values presented in the regression table are of less significance. The coefficient presented as Treatment (-0.932) is the expected mean change in speed between control and LTN boundary roads in the pre-treatment period only. Essentially, it is the "baseline difference" in mean speeds on control and LTN boundary roads. The Time coefficient (0.048) is the expected mean difference in speed in the pre- and post-implementation period. This is essentially the effect of moving from pre- to post-implementation in the absence of the LTN being implemented. The constant coefficient is the mean speed associated with the control group in the pre-implementation period. In brackets, the standard errors are presented. These are estimates of the standard deviation in the coefficient and are not of interest in themselves. Of more importance are the p-values and accompanying asterisks which denote statistical significance. In the case of the DiD estimator (our treatment effect), $p<0.01$. This indicates that, given the null hypothesis of no relationship between LTN implementation and change in speed, the probability of obtaining a result as observed here (-0.747), is less than 0.01. Therefore one can reject the null hypothesis that there are no effects on speed associated with LTN implementation.

Table 34. Regression output for DiD model predicting speed (mph)

	Dependent variable:
	Speed (mph)
Treatment (LTN = 1)	-0.932***
	(0.030)
Time (post-intervention = 1)	0.048*
	(0.028)
DiD	-0.747***
	(0.040)
Constant	12.200***
	(0.021)
Observations	151,084
R^2	0.033
Adjusted R^2	0.033
Note:	*p<0.10**p<0.05***p<0.01

Car journey times data

To collect the car journey times data, the research team have taken a random selection of 10 census output area centroids inside each LTN/control area plus 10 centroids outside the areas but <500m from the boundary. For each centroid, the nearest destination (by straight line distance) of the following types of destination was selected:

- Very local destinations: Doctors surgeries, Primary schools, Convenience stores and independent supermarkets, Post offices.
- Additional destinations: Supermarket chains, Accident & Emergency hospitals, Shopping centres and retail parks, Vets and animal hospitals, Recycling centres, Hospices.

Data collection uses Google API to route each journey by car every Tuesday (at 08:30, 13:00, 17:30) and Saturday (at 13:00). For each journey, Google estimates the duration in seconds given live traffic conditions. Analysis will examine how the average duration and/or variability of journeys changes in LTN areas versus control areas.