

Transport for the North Scrutiny Committee Agenda

Date of Meeting	Wednesday 23 November 2022
Time of Meeting	11.00 am
Venue	The Carriageworks Theatre, The Electric Press, 3 Millennium Square, Leeds, LS2 3AD

Item No.	Agenda Item	Page
1.0	Welcome & Apologies The Chair to welcome Members and the public to the meeting. Lead: Chair	
2.0	Declarations of Interest Members are required to declare any personal, prejudicial or disclosable pecuniary interest they may have relating to items on the agenda and state the nature of such interest. Lead: Chair	
3.0	Minutes of the Previous Meeting To approve the minutes of the meeting held on the 15 June 2022 (including updates on agreed matters as appropriate). Lead: Chair	3 - 8
4.0	Appointment of the Chair and Vice Chairs of the Scrutiny Committee Members to appoint a Chair and a Majority and Minority Party Vice Chair to the Scrutiny Committee. Lead: Emma Young/Julie Openshaw	
5.0	Northern Powerhouse Independent Economic Review (NPIER) Update To consider the Northern Powerhouse Independent Economic Review update. Lead: Tim Foster	9 - 20
6.0	Rail Update To consider the update of the Strategic Rail Director on the issues of rail reform and rail performance.	To Follow

	Lead: David Hoggarth	
7.0	Strategic Transport Plan Development To consider the report of the Acting Head of Policy and Strategy and to receive an update on the development of the Strategic Transport Plan. Lead: Lucy Jacques	21 - 62
8.0	Transport and Health Policy Position To consider the draft Transport and Health Policy Position. Lead: Tom Jarvis	63 - 186
9.0	Date and Time of Next Meeting Thursday 2 March 2023 11am	

Scrutiny Committee Minutes

Wednesday 15 June 2022

Malmaison Manchester (1-3 Piccadilly, Manchester, England, M1 3AQ)

Present:

Attendee

Cllr Paul Haslam (Chair)
Cllr David O'Hara
Cllr Rod Fletcher
Cllr Andrew Cooper
Cllr Neil Hughes
Cllr Leo Hammond
Cllr Rodger Jones

Cllr Rhys Furley
Cllr Matthew Salter
Cllr Oliver Freeston
Cllr Stephen Fenton

Local Authority

North Yorkshire;
Blackpool;
Cheshire East;
Cheshire West & Chester;
Cumbria;
East Riding of Yorkshire;
Greater Manchester Combined
Authority;
Hull;
Lancashire;
North East Lincolnshire;
York;

Officers in Attendance:

Name

Martin Tugwell
Gary Rich
Rosemary Lyon
Lucy Jacques
Tim Foster

Paul Kelly
Manjit Dhillon
Caroline Young

Job Title

Chief Executive
Democratic Services Officer
Legal and Democratic Services Officer
Acting Head of Policy & Strategy
Interim Strategy & Programme
Director
Interim Finance Director
Senior Solicitor
Senior Project Manager Rail North
Partnership

Item No: Item

1. Welcome & Apologies

- 1.1 The Chair welcomed all in attendance and informed Members that the meeting is being streamed live. Apologies were received from Cllr Kaushik, Cllr Johnson, Cllr Wearmouth, Cllr Shorrock and Cllr Davison,

The Chair welcomed new Members Cllr Freeson, Cllr Furley and Cllr Hammond.

2. Declarations of Interest

- 2.1 There were no declarations of interest.

3. Minutes of the Previous Meeting

- 3.1 The minutes of the meeting held on 10 March 2022 and the Consultation Call on the Freight and Logistics Strategy on 16 March 2022 were considered and their accuracy as a correct record confirmed. The minutes were proposed by Cllr Salter and seconded by Cllr Fenton.
- 3.2 Cllr Hughes stated that he had sent apologies for the meeting on the freight strategy.

Resolved:

That the minutes of the meeting held on 10 March 2022 be approved as a true and accurate record and that subject to the inclusion of Cllr Hughes apologies for the consultation call on the Freight and Logistics Strategy on 16 March 2022 that these be approved as a true and accurate record.

4. Budget and Business Plan 2022/23

- 4.1 Members received the budget and business planning presentation from the Chief Executive and the Finance Director who addressed the key issues within the presentation. The Chief Executive was keen to stress that this year has been unusual due to receiving the funding letter late and having to understand the implications of it. He explained that due to this the report has been brought to the Committee at a later stage than usual.
- 4.2 Cllr Hughes sought clarification on reserve levels and asked if they had been depleted following the payment of one-off costs.

The Finance Director explained that the one-off costs will be drawn from reserves. He further stated that TfN is comfortable with the current and proposed level of reserves over the next three years.

The Chief Executive added that he wants TfN to be in a position where over a three year period the organisation can maintain and remain within the agreed reserve policy allowing for sustainability over the longer term. The Chief Executive added that, based on a series of planning assumptions, there is anticipated to be a sufficient levels of reserves over the next three years. This could include factoring in any variances arising from changes to budget assumptions.

- 4.3 Cllr Salter enquired as to what last year's budget would have looked like with the responsibilities of the current financial year. /The Finance Director explained that the position last year would broadly have been the same as this year, however last year there was the ability to mitigate

some of the costs into the Northern Powerhouse Rail (NPR) programme and a higher level of reserves. He explained that the budget represents an appropriate costs base to manage the core activities.

Cllr Salter stated that he was satisfied with the approach being taken but was unsure as to the full ramifications of the loss of resources.

Referring to the funding letter, the Chief Executive explained that the letter set out a slight increase in the core funding from the previous year as well as supplying an increase to undertake any functions relating to the co-sponsor role.

He informed Members that at a recent conference of the seven Sub-national Transport Bodies (STB) the Minister Andrew Stevenson stated that the Ministerial team value the STBs contributions and they are seen as integral to helping the Government with their work.

- 4.4 Cllr Jones expressed concern with the current situation and questioned the confidence that the Government and Ministers have in TfN. He stated that the Government's actions have weakened the organisation and have centralised the decision making process and have cut Transport for the North out. He suggested that Transport for the North make MPs aware of the strategy that they have for the North and ensure that they have a high profile at the three main political party conferences in the Autumn.
- 4.5 Cllr Hughes stated that TfN needs to make the case that it is the voice of the North. He expressed concern at the NPR co-sponsorship role and the fragility of the reserves levels in the organisation. He further stated that TfN should look for some quick win projects in order to look proactive.
- 4.6 Cllr Cooper believes that the biggest challenge for TfN will be retaining staff. He stated that the biggest part of the TfN budget is used on staffing and was concerned as to whether the budget covered any potential inflationary staffing costs and the backdating of these payments once agreed.

The Finance Director stated that provision has been made for pay awards.

- 4.7 Cllr Fletcher raised the issue of the Integrated Rail Plan, and the fact that it had been costed on 2019 prices. He was concerned that there would not be enough money to cover the work needed to be done with no inflation mechanism in place. He highlighted the scrapping of Goldborne Link and sought clarity as to whether the North had lost the £3 billion earmarked for that work as a result. He requested that TfN lobby Government to increase the amount of money there is available to take into account inflation.

- 4.8 Cllr Fenton asked if TfN is confident that it has the capacity to continue to tap into the requests of Local Transport Authorities.
- 4.9 The Chair raised the issue of communication and suggested that a standard communication be provided to Members to take back to their local authorities following Transport for the North Board and other TfN meetings.

The Chair then asked if Transport for North had considered in their plans the need for all Combined Authorities to have powers like Transport for London by 2030.

- 4.10 In response to the Committees questions and comments the Chief Executive explained that there had been a slight increase in the core grant and his priority is to retain the technical capability and capacity which he believes is the foundation for arguing for the need for further investment in the North. He highlighted the current recovery on rail in the North and explained that TfN have been getting the message out loudly that recovery in the North has been stronger than anywhere else./He reassured the Committee that TfN will be at the party conferences and communications will play an important role. He highlighted the work TfN does with the All-Party Parliamentary Group and supporting MPs and stated that this work will continue.

He highlighted the importance of the NPR co-sponsorship role for TfN as it ensures that the North's views are fed into the process, however as a Statutory Body Transport for the North retains the right to make TfN's formal position known.

Addressing the concerns regarding the cancellation of the Goldborne Link the Chief Executive stated that he expects there to be a conversation about this at Board on 30 June. He explained that TfN should be open to looking at alternatives but only if they achieve the desired outcomes. He explained that work needs to be done together with the Board to highlight what will work in terms of alternatives.

Resolved:

That the presentation be noted.

5. Strategic Transport Plan Development

- 5.1 Members received the report and the presentation from the Acting Head of Policy and Strategy.
- 5.2 Cllr Fenton welcomed the liaison that has taken place with local authorities to date, however expressed concern that only 18 out of the 20 Local Transport Authorities had received one to one sessions and asked for confirmation that the remaining two will be engaged with.

5.3 Cllr Jones suggested that any big government priorities including air quality and pollution as well as climate be linked into everything throughout the document.

5.4 The Chair suggested that a Communications Strategy should be considered as well as requesting that a short term date be set with a suggestion of 2030.

He also highlighted the importance of engaging with the energy networks as if this doesn't take place then TfN will be unaware as to whether they are going to be able to deliver on what is being proposed.

5.5 In response to Members comments and questions the Acting Head of Policy and Strategy explained that meetings had taken place with 19 out of 22 partners and everything possible had been done to try and engage with the other three and all efforts are being made to try and engage with them.

In relation to the comments from Cllr Jones she explained that Government priorities such as Brexit, net zero, Levelling Up, climate change and the Integrated Rail Plan would all be considered. On the question relating to a short term date of 2030, she suggested that this could be something discussed with Board later in the month. She stated that a systems based approach is needed to deliver on STP2 with a wider engagement beyond transport as well as engaging other Government departments and not just the DFT.

5.6 The Interim Strategy and Programme Director explained that TfN needs to be strong on the long term vision and actions to be delivered over next 5-10 years particularly those on carbon. He also stated the need to be clear on the uncertainty being faced post covid on the recovery and the future of travel demand.

5.7 Members expressed their concerns on the scrapping of the Goldborne Link. The Committee believed that TfN should have been advised about this prior to it being published on the website and requested that any consultation and discussion on alternatives be brought back to Scrutiny.

Cllr Fletcher enquired if STP2 will slow down some of the rail projects already underway to resolve the capacity issues that areas of the North are experiencing. He requested assurance that there would be no delays on proposals that are being developed. He also requested that the Committee be kept updated on projects that are about to be started in order that the Committee is aware of what is happening where and when.

5.8 Cllr Hughes stated the need for a reliable transport network in the North, and specifically highlighted the poor health of the rail network. He suggested that the Committee should be scrutinising the failing rail

system in the North and suggested that extra meetings be held in order to do so.

- 5.9 In summing up Members comments the Chair emphasised the importance of TfN communicating what is going on to Members. He also highlighted the need for the Government to inform TfN of changes to agreed plans before being put on the Website.
- 5.10 On the issue of the Goldborne Link the Interim Strategy and Programme Director explained that alternatives to it have been muted and until the announcement last week it was in hybrid 2b bill. He stated that the alternatives have not yet been seen and TfN are trying to understand the development of the alternatives and the timescales for delivering them. He stated that the main priorities are to put the sponsorship arrangements in place how long term outcomes are going to be delivered.

He then highlighted the opportunities that the creation of GBR will provide by bringing together the thinking around rail infrastructure and services.

He assured the Committee that the Strategic Transport Plan will be developed alongside all the work that will be done in conjunction with the Department, Network Rail and the GBR Transition Team on making sure existing schemes are delivered and where possible accelerated as well as making the case for the next phase of investment.

- 5.11 The Chief Executive explained that the Rail North Committee have the issues that the Committee discussed on their agenda. He stated that TfN have been instrumental in advocating the need for the blueprint with the Rail North Committee championing this. He explained that there has been a lot of work going on with the Manchester Recovery Taskforce and this is being reported to the Committee. The Committee were informed of the regular communication that goes out to Rail North Committee Members.
- 5.12 The Chair requested that the fortnightly communications that are circulated to the Rail North Committee also be sent to Members of the Scrutiny Committee as well.

Resolved:

- 1) That the report be noted.
- 2) That the Committees comments on the proposed structure for STP2 be noted.
- 3) That the Committees comments on the principles outlined in section 4 of the report be noted.

Meeting: Transport for the North Scrutiny Committee
Subject: Northern Powerhouse Independent Economic Review
Author: Brian Sloan
Sponsor: Tim Foster
Meeting Date: 23rd November 2022

1. Purpose of the Report:

- 1.1 Update on the Northern Powerhouse Independent Economic Review (NPIER) programme, specifically detailing the work on the ongoing refresh element of the programme.

2. Recommendations:

- 2.1 That the Committee notes the update and the intention to brief TfN Board on the emerging conclusions in December.

3. Main Issues:

The NPIER was published in 2016 and identified seven key sectoral capabilities in the North that had the potential to support transformational growth in the region if supported by policy initiatives such as investment in transport connectivity, skills, research & development, encouraging graduate retention and inward investment. By doing this the North could close the productivity gap with the rest of England and generate an economic prize of an additional £100bn GVA per year and create an additional 850k jobs than if a “business as usual” trajectory was followed.

- 3.1 The NPIER was first published in 2016, and a refresh of the work is being undertaken in the context of the changes in the near and longer-term outlook since that publication, and changes in the political landscape.
- 3.2 The programme to update the NPIER is taking place in collaboration with Northern Partners, including Local Transport Authorities (LTAs) and Local Enterprise Partnerships (LEPs). This work will provide the critical evidence to inform the economic objectives within the refresh of the Strategic Transport Plan currently being progressed by officers. The refresh builds on the extensive programme of research undertaken by TfN and the wider partnership about the scale of economic potential that could be unlocked and what would be required to deliver on that potential.
- 3.3 The current refresh programme has been split into two commissions, the first of which is complete and now informs the direction of the second commission, the “NPIER Economic Scenario Development”. The emerging conclusions from the first phase of work are as follows:
- A widening of the productivity gap between the North and other parts of the UK since 2016, making the closing of the gap harder to achieve by 2050.
 - The importance of the “foundational” economy to the North, alongside the seven prime and enabling capabilities identified in the 2016 NPIER.
 - The “foundational economy” is estimated to employ 67% of the workforce and generated 63% of all output on a GVA basis in 2018-19.
 - Baseline projections under “business as usual” showing the likelihood of stronger employment growth by 2050, but lower than required GVA growth to close the productivity gap or increase prosperity for households.

The “foundational economy” is that part of the economy engaged in providing the basic goods and services that people require, e.g. public services (including healthcare), utilities, critical transport and food/consumer essentials.

- 3.4 The consultants are currently modelling a number of future scenarios that will demonstrate the alternative trajectories under different policy scenarios and, ultimately, will enable the Board to agree the level of economic ambition in the Strategic Transport Plan. The emerging conclusions of both the research and scenario modelling will be presented to the TfN Board in December.
- 3.5 At the Committee meeting on the 23rd November, officers will briefly update the Committee on the latest position. It would be helpful for the committee to consider and discuss:
- The positioning of the NPIER within the next STP given the increasing economic challenges faced by the UK economy.
 - The links to local growth priorities, recognising that sustained growth will require a place-based focus and investment in wider policy levers such as skills and Research & Development (R&D).
 - The implications for transport investment following the Autumn Statement on the 17th November which is expected to clarify the status of the previous government’s Growth Plan which identified a wide range of Northern schemes that should be accelerated including Northern Powerhouse Rail and the A66 upgrade.

4. Corporate Considerations:

4.1 **Financial Implications.** The commission to cover this update is in the 2022/23 budget.

4.2 **Resource Implications.** Internal project management for the commission is fully resourced.

4.3 **Legal Implications.**

The contractors conducting the current commission were selected following a mini competition and have signed a contract with TfN. The work described helps enable TfN to fulfil its statutory duty and exercise its powers.

4.4 **Risk Management and Key Issues.**

Risks related to the commission have been recorded in the relevant risk register.

4.5 **Environmental Implications**

This report does not constitute or influence a plan or programme which sets the framework for future development consents of projects listed in the EIA Directive and therefore does stimulate the need for SEA or EIA.

4.6 **Equality and Diversity.**

Will be detailed in the presentation.

4.7 **Consultations.**

Will be detailed in the presentation.

5. Background Papers:

5.1 There are no background papers to be included with this update.

6. Appendices:

6.1 Appendix 1 - Presentation slide pack.

Glossary of terms, abbreviations and acronyms used (<i>if applicable</i>)	
a) NPIER	<i>Northern Powerhouse Independent Economic Review</i>
b) TfN	<i>Transport for the North</i>

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NPIER Refresh Programme Update

Scrutiny Committee 23 November 2022

Page 13

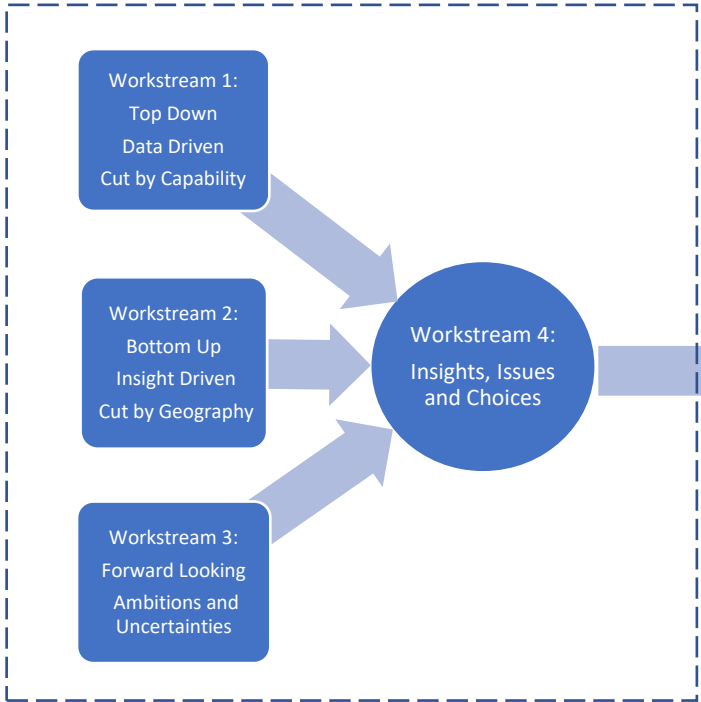


Northern Powerhouse Independent Economic Review Programme

- Collaboration across TfN, LEPs and Central Government
- NPIER published June 2016:
 - Defined seven key sectoral capabilities in the North
 - Identified £100bn pa additional GVA and an extra 850k jobs in transformational scenario
- Now undertaking a refresh programme in the context of:
 - TfN's role as a statutory body
 - Changing economic and political context since the 2016, and longer term economic outlook
- Refreshed NPIER (Autumn 2021 – end 2022) in collaboration with Northern Partners
 - Will provide critical evidence to inform the Strategic Transport Plan refresh

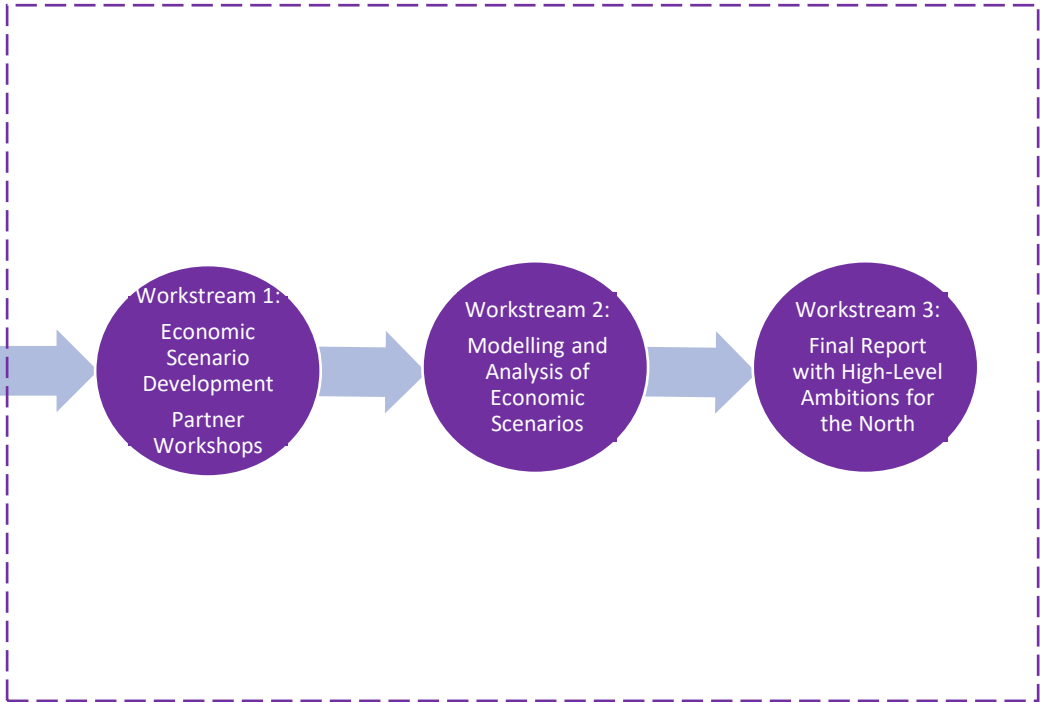
NPIER Refresh Programme – Two Commissions

Capabilities, Local Data and Narratives



November 2021 to May 2022

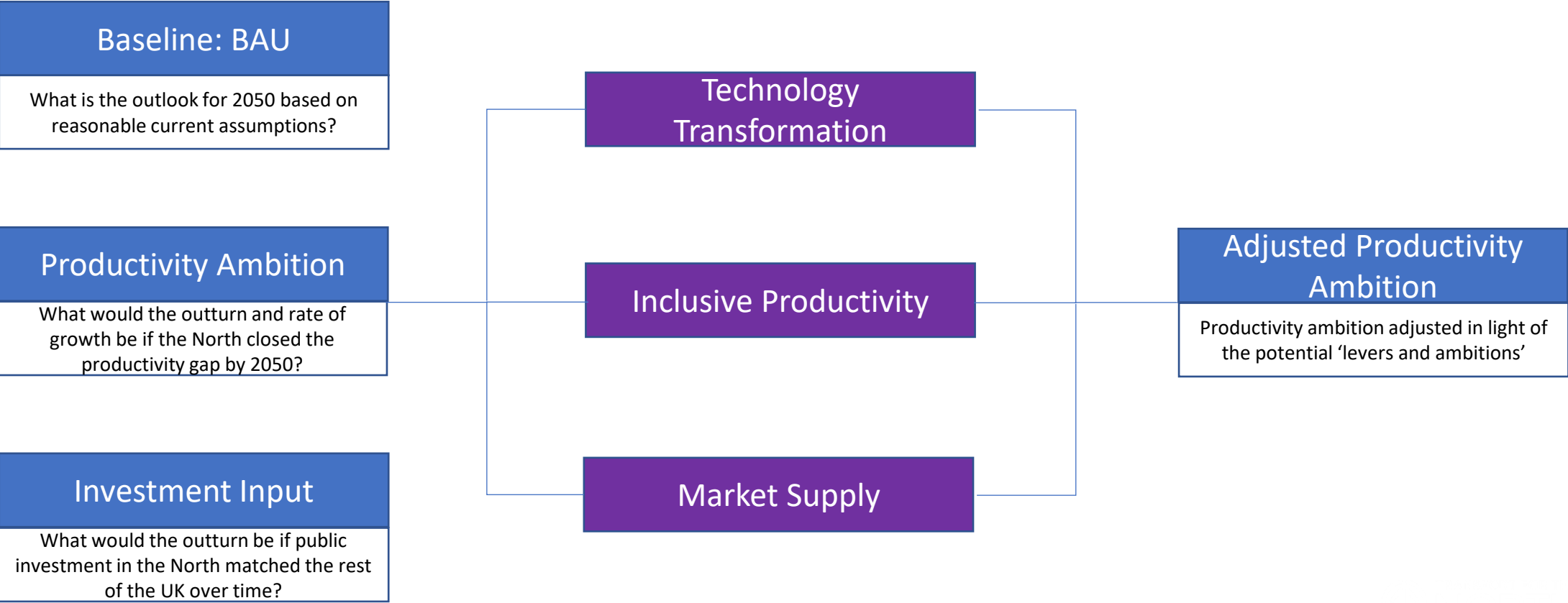
Economic Scenario Development



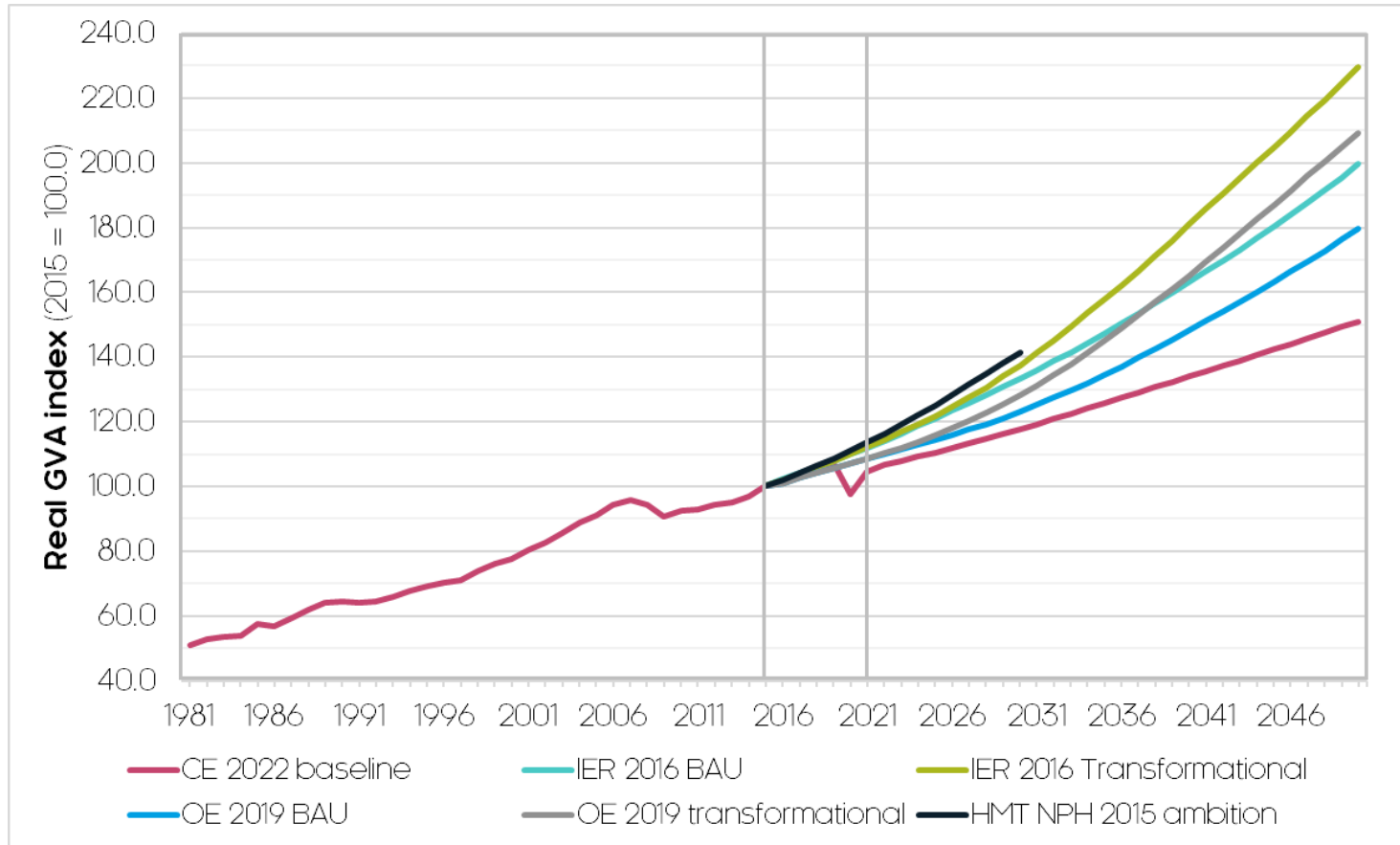
May to December 2022

Workstream 1 – Scenario Framework

Benchmarks → Change Scenarios → Adjusted Ambition



Workstream 2 – Baseline GVA Projection



- Outlook for GVA however much more pessimistic than previous projections
- Cambridge Econometrics '22 baseline 50% lower than NPIER BAU, 30% lower than Oxford Economic BAU in 2019
- Largely due to less optimistic productivity outlook
- Productivity forecasts over past decade consistently proven to be over-optimistic
- 'Low and slow' productivity growth now an accepted assumption
- Oxford Econometrics forecasts were already moving in that direction

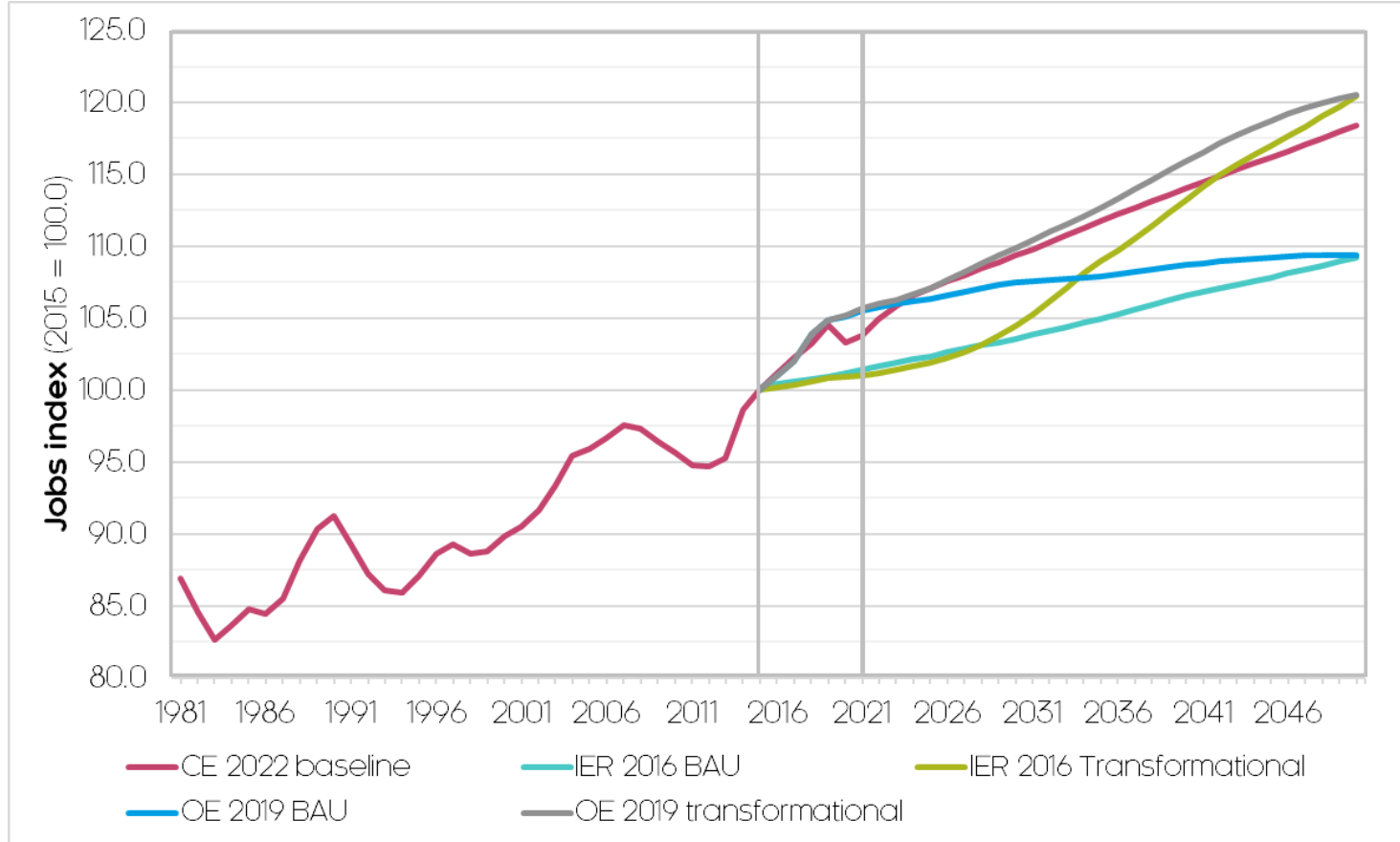
Source: various (Cambridge Econometrics, Oxford Economics, Northern Powerhouse IER)

Note: projections have been indexed to 2015 to allow comparison across different sources, timeframes etc.

GVA presented in real terms

Workstream 2 – Baseline Job Projection

Page 18

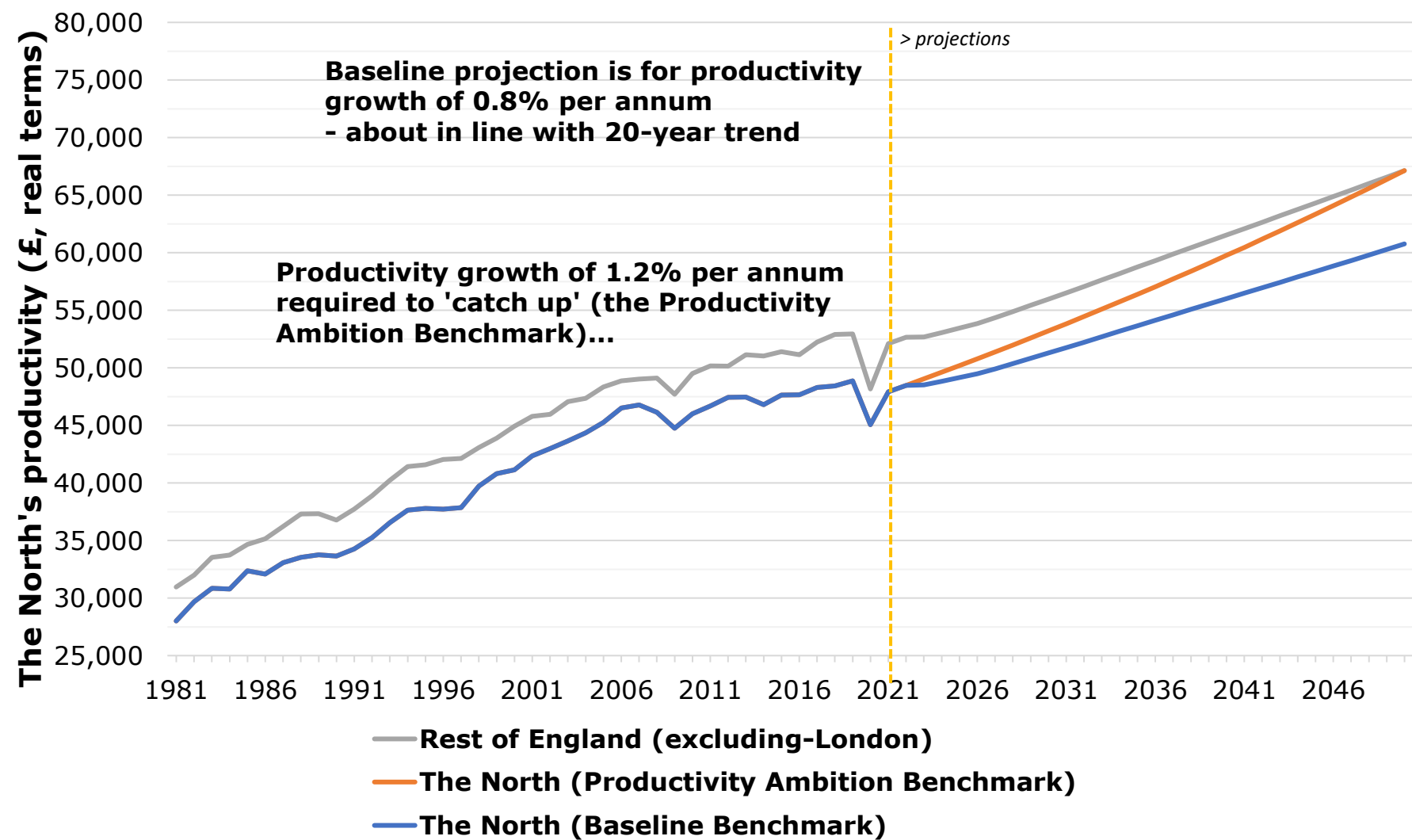


- Labour market outlook much more positive than in 2016
- Cambridge Econometrics' '22 baseline within distance of NPIER's and Oxford Economics transformational
- NPIER and Oxford Economics BAU, with hindsight, appear subdued
- Why the change in outlook? Labour market continues to prove doubters wrong
- Expected to remain highly flexible (esp. in terms of people moving into work)
- Post-Covid/Brexit prospects better for labour-intensive industries

Source: various (Cambridge Econometrics, Oxford Economics, Northern Powerhouse IER)

Note: projections have been indexed to 2015 to allow comparison across different sources, timeframes etc.

The Productivity Ambition – Closing the Gap



Headline Messages and Next Steps

Headline Messages:

- Refreshed NPIER will reset the 2050 outcomes, but the ambition remains about closing the productivity gap.
- Will use outputs as basis to agree the appropriate level of ambition in the STP.

Future Activity:

- Agree the conclusions from the evidence with LEPs and pan-Northern groups.
- Advise TfN Board in December on the implications for the STP.
- Wider conversation with Northern Partners early 2023 about broader implications and solutions emerging from this work.

Meeting:	Scrutiny Committee
Subject:	Strategic Transport Plan Development
Author:	Lucy Jacques, Acting Head of Policy and Strategy
Sponsor:	Tim Foster, Interim Strategy and Programme Director
Meeting Date:	Wednesday 23 November 2022

1. Purpose of the Report:

- 1.1 To seek comments on the “Policy and Place Framework” for TfN’s second Strategic Transport Plan (STP2) and provide an update on STP development progress ahead of the December 2022 TfN Board meeting.

2. Recommendations:

- 2.1 The Committee is asked to review progress in respect of the development of STP2.
- 2.2 The Committee are asked to review and comment on the policy and place framework discussed in Section 4 of the paper.

3. Main Issues:

- 3.1 TfN has a statutory duty to produce a Strategic Transport Plan on behalf of the North of England. The first Strategic Transport Plan was adopted by the TfN Board in Feb 2019. In September 2021, TfN Board agreed that TfN should commence work on a new programme of work to revise and update the Strategic Transport Plan (STP2) and seek adoption of the new plan no later than Spring 2024.
- 3.2 The executive is working closely with partner authorities to ensure that the next STP matches the vision and ambition of the original Plan, but also incorporates the very significant work undertaken by TfN since 2019 and with a recognition of the new context and challenges facing the transport network since the pandemic. A series of positions on key issues have been developed over the last two years and agreed with the Board, including:
- The TfN Decarbonisation, Freight and Socially Inclusive Transport Strategies.
 - A series of TfN Policy Positions covering topics including international connectivity, rural mobility and spatial planning.
 - TfN Board positions on critical infrastructure requirements such as Northern Powerhouse Rail and HS2.
- 3.3 The final elements of the evidence base, including TfN’s Rail Connectivity Policy Position are now being finalised and the implications for the STP will be factored into the advice officers provide to Board in December.
- 3.4 A draft Strategic Transport Plan will be presented for sign-off at the TfN Board in March 2023. A statutory consultation will then follow in the summer of 2023, with a post-consultation version of the STP presented to Board for adoption in December 2023.
- 4. STP Structure and Progress**
- 4.1 The TfN Board have agreed a revised structure for STP2, built around four key elements:

- The Case - Setting out the Case for Change around the economic, environmental and social challenges / opportunities for the North. What is the strategic rationale for investment in the North, and what is the multi-modal scale of challenge and opportunity to support the vision?
 - The Vision - Setting the Vision, Objectives for the North's transport network.
 - Policy and Place - establishing a Policy and Place Framework to deliver on our collective vision and objectives and agree policy priorities for each place type, as part of the North's connectivity network and Strategic Development Corridors
 - The Impact - Measuring our impact, the role and responsibilities of TfN, and funding principles required to deliver the North's vision.
- 4.2 Work is progressing on all four elements of STP2 with the current focus being on the vision and objectives, previously discussed with this Board, the "case for change" and the policy and place framework.
- 4.3 The Partnership Board held an initial discussion at the end of September on the **draft vision and objectives for STP2**. The Board agreed that STP2 will have a single vision for the North's transport network, to be supported by three strategic ambitions:
- Rapid decarbonisation of the transport network by 2045 (as agreed in the TfN Decarbonisation strategy adopted by the Board in November 2021);
 - Reducing transport related social exclusion (defined in the inclusive transport strategy being discussed by TfN Board in September); and
 - Transforming economic performance (as defined by the Northern Powerhouse Independent Economic Review currently being updated).
- 4.4 The high-level vision and strategic ambitions for the North will be underpinned by a clear set of outcome measures and supporting metrics that will, collectively, guide TfN and partner activities towards the delivery of the vision and ambitions by 2050. Interim milestones for key metrics will also demonstrate what progress is required over the next 10 years to deliver on the longer-term outcomes.
- 4.5 The **Policy and Place framework** has been developed to provide a more robust and transparent demonstration of what needs to be true to achieve the outcomes in STP2 across the different parts of the North. It builds on TfN's existing work on economic and social geography to present nine place typologies, developed through a series of workshops with partner officers. A working draft of the framework and narratives is attached to this paper. The intention is to seek Board sign-off to the framework in December.
- 4.6 Finally, the **case for change** is being updated from the original STP, retaining the original vision and scope of the previous version, but incorporating the significant change in context since 2019, the new evidence on inclusive growth and decarbonisation from TfN's work and will incorporate the emerging conclusions from the refresh of the Northern Powerhouse Independent Economic Review. We anticipate sharing the key messages from this section with the Board in December.
- 4.7 At the Board in December, officers will be seeking the Board's endorsement of the key principles, conclusions and remaining key elements of the evidence base for STP2 to enable officers to commence work on the draft STP in early 2023. We then envisage a draft STP will be ready for discussion at officer level in February 2023. At the meeting of Committee

5.0 Corporate Considerations

Financial Implications

- 5.1 No direct financial implications of these recommendations beyond resource implications noted below. However, TfN's ability to undertake this work in full will be subject to its 2023/24 funding allocation and the 2023/24 business planning process.

Resource Implications

- 5.2 The necessary resources to prepare the STP2 to the timeline set-out in this report have been identified and agreed aligned to TfN's Budget & Business Planning Process for FY2022/23.

Legal Implications

- 5.3 The statutory obligations on TfN under the Local Transport Act 2008 as amended by Cities and Local Government Devolution Act 2016 in preparation of the STP will be kept under review to ensure the STP is legally sound and complies with the legal requirements.

Risk Management and Key Issues

- 5.4 This paper does not require a risk assessment. TfN's Corporate Risk Register includes risks associated with STP2.

Environmental Implications

- 5.5 A full Integrated Sustainability Appraisal (ISA) is being prepared to accompany the preparation of the STP2, supported by external expertise. The ISA2 Report will be consulted upon alongside the draft STP2 during 2023.

Equality and Diversity

- 5.6 To accompany the revised STP we will also be undertaking an Equality Impact Assessment as part of the wider Integrated Sustainability Appraisal (ISA).

TfN's Transport Related Social Exclusion workstream will allow TfN and its partners to better understand the distribution and causes of TRSE in the North and will form an important part of the evidence base for the revised STP.

Consultations

- 5.7 A consultation is not required at this time; the statutory consultation planned for the revised STP in Summer 2023 will be undertaken in due course.

6.0 Appendices

- 6.1 Appendix 1 – STP2 Programme Update slide deck
6.2 Appendix 2 – Policy and Place narratives

Glossary of terms, abbreviations and acronyms used (if applicable)

Please include any technical abbreviations and acronyms used in the report in this section. (Please see examples below.) This will provide an easy reference point for the reader for any abbreviations and acronyms that are used in the report.

- a) STP2 Second Strategic Transport Plan

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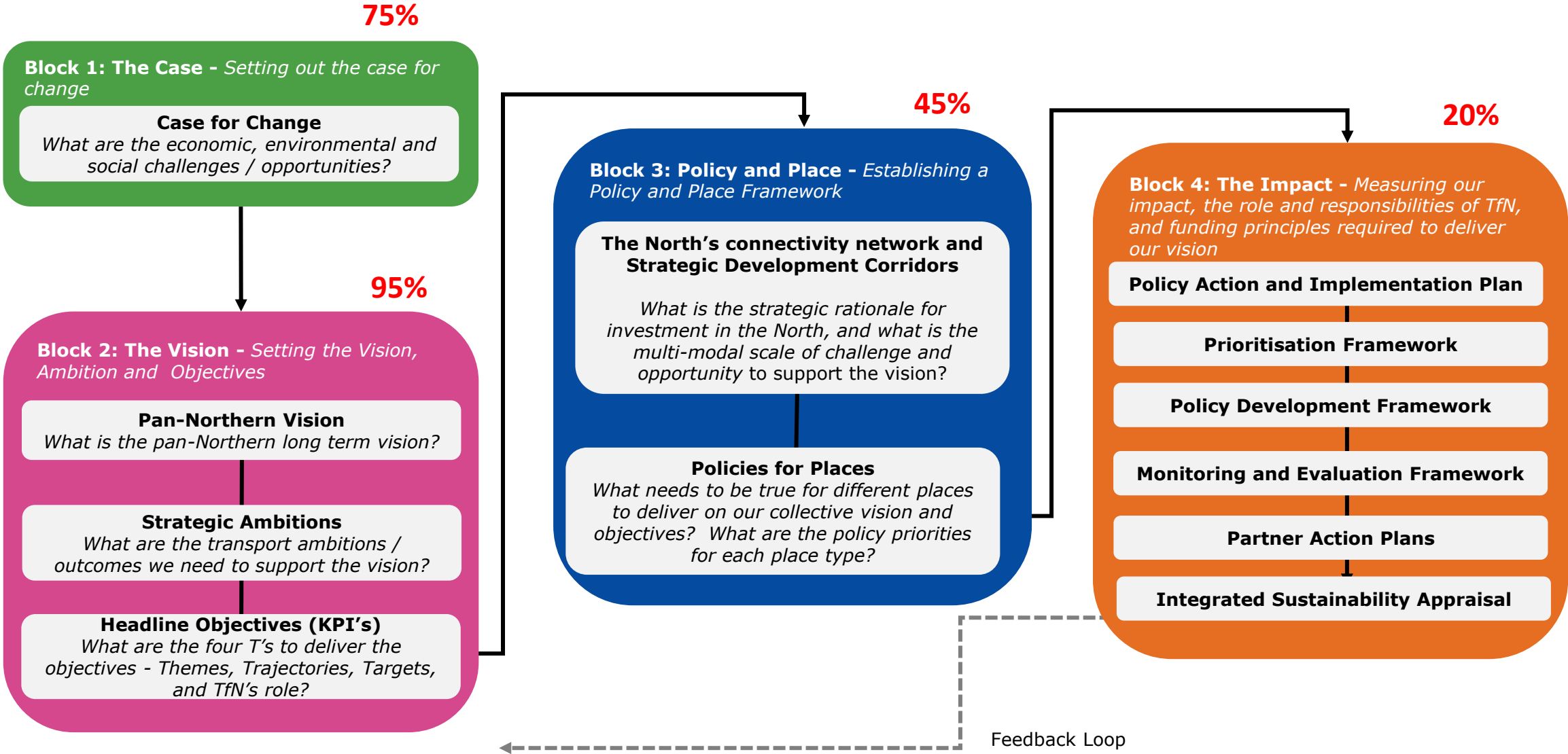
STP2 Development Update

Scrutiny Committee – 23rd November 2022

Page 25

STP2 Structure & progress

Page 26



Key STP2 Milestones

1. STP2 Evidence & Policies signed off and finalised by **December** governance.
2. Final drafting for STP2, **December – February**.
3. Engagement with DfT on full draft – **February 2023**.
4. Engagement with partners on draft & ISA2 (SOG, EB, PB) – **February 2023**.
5. Draft & ISA2 being taken to TfN board for sign off in **March 2023**.
6. Statutory 12 week consultation, **May – July 2023**.
7. Revisions post consultation – **September & October 2023**.
8. Final STP2 taken through TfN governance in **November / December 2023** for sign off and adoption.

The Case for Change



STP Case for Change Chapter

- Sets out why investment in the North's transport infrastructure is required
 - The economic case
 - The social case
 - The environmental case
- As with the 2019 STP:
 - The North continues to underperform in terms of productivity
 - The North's environmental, human and economic assets are dispersed and hampered by poor transport connectivity
 - Our towns and cities are sufficiently close together that transport connectivity could give rise to agglomeration benefits, including productivity.
- The case will be supported by TfN's expanded evidence base and the NPIER refresh

Vision & Objectives



Strategy Hierarchy for STP2



STP2 Vision & Strategic Ambitions

DRAFT VISION

By 2050 the North of England will have become be a thriving, socially inclusive region. Our communities, businesses and places will all benefit from sustainable economic growth, improved wellbeing and access to opportunities for all. This will be achieved through a transformed zero emission, integrated, safe and sustainable transport system, that will enhance connectivity, resilience and journey times for all users.

DRAFT STRATEGIC AMBITIONS (and supporting strategies)

Growth and Productivity	<i>Transforming economic performance by closing the productivity gap by 2050 (Northern Powerhouse Independent Economic Review)</i>
Inclusive Transport	<i>Reducing level of transport related social exclusion to rest of England (ex London) by 2050</i>
Decarbonisation	<i>Net zero emissions from surface transport by 2045 (TfN Decarbonisation Strategy).</i>

Objective Setting

3 Core categories with clearly defined differences;

Headline metrics [18] – these are linked to the three strategic ambitions and have **SMART targets and trajectories**. They are methodologically robust as **highest profile, public facing objectives** that will drive TfN's strategic focus. **Objectives will be set for 2050, but with interim 2030 objectives wherever possible.**

Core metrics [50] – these provide the key evidence required to monitor the road and rail networks in the **short to medium term** and will form a **fundamental part of monitoring STP2**. They are methodologically robust, allowing TfN to track the data. However, **a 'good is' target is sufficient**, targeting sustained improvement in all areas, rather than specific targets and trajectories.

Supplementary metrics - provide **supporting evidence to understand the wider context** of the transport system and wider context. The Theory of Change between TfN's own work and these metrics is not as robust and monitoring these is a lower strategic priority.

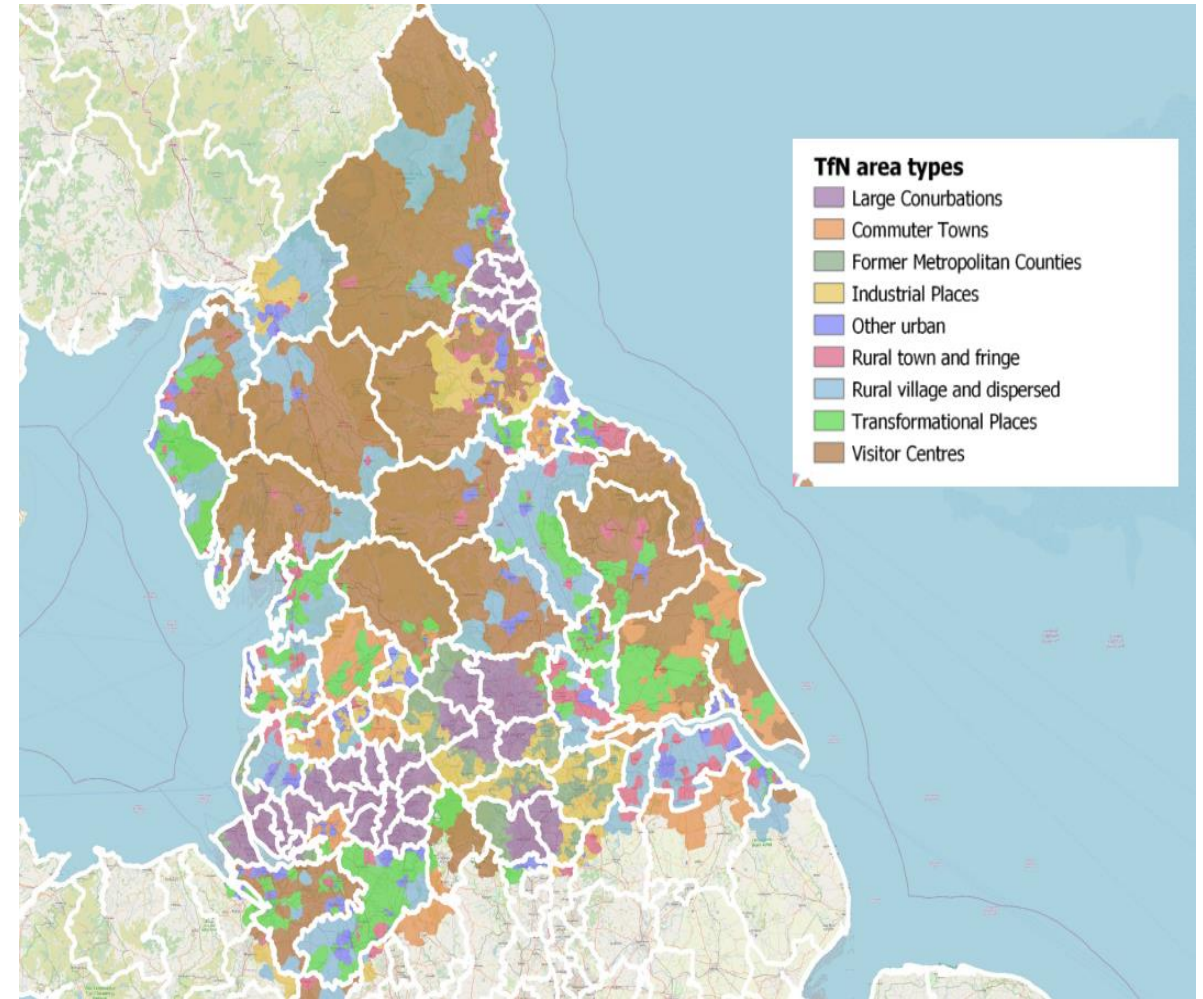
The final document we will be asking TfN Board to sign off in December was shared with Scrutiny committee for comment in September 2022.

Policy & Place Framework



TfN Place typologies

- Previously developed with and signed off by partners as part of the Agglomeration & Cluster research in 2018 and subsequently the SDC Economic Narratives work in 2020.
- Evidence led and analytically robust – definitions and assignment of those are derived from EU framework and ONS OAC classifications.
- Framework not a rulebook - enable flexibility and local interpretation.
- No local authority is 100% one place type so for STP2 and LTP's we need a mechanism to consider a suite of policies for different places.



Work completed to date & next steps

- ✓ Developed place-based narratives for nine place typologies outlining description of the place, the role of transport for that place and what policies are needed at a local level to deliver the STP2 vision.
- ✓ Internal workshop to encourage check and challenge from colleagues.
- ✓ Four focused workshops with partners to capture their feedback.
- ✓ Revised the nine narratives based on partner feedback.
- ✓ The policy and places narratives will be taken through TfN governance in November/December.
- ✓ Started drafting the strategic pan northern transport section for internal and partner review in late November / early December.
- ✓ The final outputs will be presented as the Policy and Places framework for Building Block 3 of STP2.

Note - Narratives have been shared with your SOG and EB officers.

Thank You

Page 37

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Transport for the North – Draft Policy and Place Framework

1. Commuter Towns

Description

Commuter Towns are typically smaller towns and suburbs which neighbour Large Conurbations, with strong economic and commuting linkages to these large cities. Commuter towns are frequently located adjacent to 'Transformational Places' and share similar characteristics, including a skilled workforce, high levels of longer-distance commuting (>10km), and above average employment and productivity.

These areas have the highest percentage of individuals with Level 4 qualifications and above (40.1%, compared to a Northern average of 33.1%) and the lowest share of people working within their residential local authority (51%, compared to a Northern average of 61%). Employment levels are high, with 40% in full-time work – greater than any other place type – and the proportion working in professional occupations) greater than the Northern average.

Examples: Areas across Lancashire (Preston, Burnley, Blackburn), North Yorkshire (Harrogate, Northallerton, Scarborough), parts of the East Riding of Yorkshire (Howden, Driffield), Warrington, Congleton, and Crewe.

Key role of transport

Commuting Towns are highly reliant on transport infrastructure to provide accessibility to employment opportunities across the North, including strong linkages to neighbouring Large Conurbations and strategic employment sites. Commuter towns also have a good share of local essential and leisure journeys, that may be articulated in multi-trip chains with commuting trips. Car usage is particularly common for local and commuting trips due to the absence of viable and cost-effective public transport and longer distances between housing and employment locations. Some commuter towns, such as Warrington, may generate a large amount of outbound commuting trips, but also inward commuting trips from surrounding towns that need to be catered to by the transport system.

The policies are set out to make commuter towns less car-dependent places through improving sustainable travel options and reducing travel distances, for all types of trips. This will allow for improved sustainable accessibility to opportunities, boosting local economies and businesses through reduced travel costs and journey times. Improved transport infrastructure can support a better job matching between job vacancies and skilled workers who best match skill requirements, by enhancing connectivity of skilled labour supply to areas that need it.

Policies: *what needs to be true?*

1. Delivering reliable multi-modal hub and spoke transport options will provide sustainable and low carbon access to opportunities to and from Commuter Towns.

1.1 Deploying a hub and spoke model that operates outside peak hours and seven days a week, with express services connecting commuter towns to their neighbouring large conurbations, will encourage modal shift away from private car for commuting trips. Local spinal services, or Demand Responsive Transport (DRT), should be implemented to connect to bus and/or rail stations.

1.2 Where available, rail services should be at least two trains per hour, and bus services should have a higher frequency to enable good inbound connections, as well as

connectivity to Large Conurbations. Timetables and ticketing should align with local services provided, including supporting the leisure and night-time economies.

1.3 Reliable journey planning tools, linked to viable and integrated ticketing products, that work across boundaries to support the hub and spoke model, should be implemented. This requires GPS management and could possibly require funding. Delay-repay fare guarantees for buses would provide confidence to commuters looking to switch from private car, and can be introduced in new franchise agreements. Fares should be affordable, equitable and cost-effective in comparison to private vehicles.

1.4 Existing rail and bus stations should be enhanced, and investment in new multi-modal mobility hubs should bring together existing and proposed public transport options, active travel, cycle parking, electric vehicle charging and car or lift share facilities. New hubs should be designed for mixed use, including drop and collect facilities for parcels, remote working hubs and new community uses.

2. For short and often multistage journeys within Commuter Towns active travel and reliable bus services should be the natural choice.

2.1 Delivering Local Cycling and Walking Infrastructure Plans (LCWIPs) will deliver attractive and localised walking and cycling infrastructure that is accessible to all users. In addition to traditional active travel interventions, this may include measures that support use of e-bikes and micro-mobility.

2.2 Many commuter towns may be in areas which struggle to finance bus services and would benefit from funding of their Bus Service Improvement Plans and other external funding. Reliable bus services should provide the necessary connectivity with essential services, such as healthcare, and educational establishments, with residential areas and multi-modal hubs, to provide sustainable transport options and multi-trip chain travel.

3. A holistic approach to spatial and transport planning should seek to reduce car dependency in Commuter Towns.

3.1 Road space should be reallocated to support bus and active travel priority measures, ensuring that buses and active travel are not the weak link in transport networks, ensuring safety and connectivity to encourage modal shift.

3.2 New developments should not lock in car dependency, and options to decouple parking provision from housing development supported by lift share schemes should be considered, complemented by good active travel infrastructure that connects to multi-modal hubs to town centres.

2. Large Conurbations

Description

Large Conurbations contain 51% of the North's population. They have a faster rate of population growth (2.0% compared to a Northern average of 1.5% between 2012 and 2017) and a more youthful population. Levels of skills are also above the Northern average. Large conurbations can also be places of great variation, and often face challenges around deprivation and poverty. They benefit significantly from economic agglomeration and generate greater productivity than the Northern average.

Examples: Major cities including Manchester, Leeds, Liverpool, Newcastle upon Tyne, and Sheffield.

Key role of transport

Large Conurbations become denser and grow their public transport demand closer to the city centre. As such, there are many public transport and active travel trips within cities, and a fair share of private vehicle usage in nearby towns, between other towns and to-and-from the city centre. Large Conurbations are also the areas which often face the most acute air and noise quality issues, particularly around arterial routes, and the Strategic and Major Road Networks. Therefore, policies which support viable sustainable transport options and improved connectivity within them should be the priority in Large Conurbations.

Key market failures facing large conurbations pertain to the need to support agglomeration – greater effective density within large conurbations - reflecting their density of economic activity and opportunity to support future productivity growth. However, increased population and employment density can place further pressure on the transport network, and other services, constraining future development. This creates the potential for new infrastructure investment to unlock land for development.

Our Large Conurbations should be attractive, lively, and exciting places that people want to spend time in, drawing in visitors from across the North to work, shop and socialise. Policies to encourage sustainable transport are critical to supporting economic growth and ensuring equitable development. Improved public transport will allow the implementation of demand management policies that can provide short and medium term significant increases in modal shift. Densification can also support reducing travel distances in the future.

Businesses in urban locations often cite difficulties they have in negotiating congested transport networks, or situations where disruptions have impacted business operations. Within urban locations, interventions which promote increased reliability and efficiency across the transport network, as well as shorter travel distances are most likely to benefit businesses in these areas.

Policies: *what needs to be true?*

1. Public transport must be integrated (ticketing, operations, infrastructure, and information) reliable, accessible, and inclusive for all users.

1.1 Bus services are the backbone of public transport networks in Large Conurbations, and franchising powers given to Combined Authorities offer the opportunity to provide affordable city-wide services and connectivity to other transport provision. For other authorities, enhanced partnerships also create the potential for a more strategic approach to managing bus networks. Large Conurbations should focus on diversifying or enhancing their bus services, particularly in orbital journeys that connect nearby towns

without travelling through the urban core and direct journeys in currently urban transport deprived areas. Bus infrastructure and services must enable easy access and swift transfers to rail and mass transit provision, through inclusive design.

1.2 Rapid transit should be an important part of the core transport network. Bus Rapid Transit (BRT), trams and other light rail-based modes provide additional capacity and connectivity and help to relieve congested road networks. Bus services should complement rapid transit services.

1.3 Introducing delay-repay assurances for different modes will further encourage people to shift to public transport. Capped fares will help achieve affordability and reduce the risk of transport related social exclusion.

1.4 Large Conurbations are perfectly located to maximise the benefits of multi-modal enhanced journey planning, to enable the services to function as a single, cohesive network. Integrated digital management systems can feed into journey planning tools should be implemented for providing a more reliable information base for users to make their travel choices.

1.5 Large Conurbations play a key role as a transport hub for wider connectivity on local and national networks. National and local strategic plans should be aligned to prioritise sustainable travel. Full integration of stations and their services with the local transport network needs to cater for passing travellers for maximisation of the role of transport hubs.

2. Spatial and transport planning must work symbiotically for sustainable, inclusive growth.

2.1 The densification of our urban areas can help to unlock agglomeration benefits and drive productivity growth across the North. As such, embedding new development within transport infrastructure will ensure both the success of new developments and increase the commercial viability of public transport. This would provide greater accessibility to populations without access to private car, especially for developments out of the urban core. Interventions can range in scale from station gateway developments to more localised measures such as integration with active travel networks.

2.2 Densification will also allow implementation of 15-minute cities and active neighbourhoods to provide basic services within a travel distance of 15 minutes by active travel and/or public transport. This will reduce trip lengths which is key to meeting carbon targets.

2.3 City and town centres should look to gradually re-allocate parking spaces in favour of additional cycle storage, wider pavements, and outdoor seating areas for use by local businesses, or aiming for pedestrianisation where appropriate with an inclusive design focus. Furthermore, providing high-quality and safe infrastructure for cycling and placemaking and improving public realm is encouraged. This will prioritise the movement of sustainable transport users encouraging modal shift and making large conurbations more attractive for businesses and residents.

3. Managing private vehicle demand and encouraging modal shift is key to achieve cities where people can have happy lives without cars.

3.1 Changes to local parking development policies can be explored to reduce private vehicle usage, however, this will vary from area to area. Some alternatives are reducing or removing minimum parking space requirements for new developments, work parking levies, reallocating road space, and increasing the cost of parking in city centres. This

should be complemented by consolidation of parking in out of city Park and Ride sites, where suitable, to avoid private vehicles travelling into city centres.

3.2 Congestion charging and Clean Air Zones are opportunities that should be considered to manage private vehicle trips and reduce emissions in city centres. There are also opportunities to consider demand management schemes as part of this, which may require support and development at a national level.

4. Decarbonising transport fleets is key for achieving national decarbonisation targets.

5.1 A key policy for large conurbations must be to decarbonise the bus and rail networks. Where there is high patronage and availability of infrastructure, there is a strong case to procure electric and hydrogen-fuelled vehicles and units to deliver a more sustainable solution. For buses, Zero Emission Bus Regional Areas (ZEBRA) funding has helped accelerate this in eight Local Transport Authorities (LTA) areas in the North, and there is an opportunity to further build on this.

5.2 All authorities should have an Electric Vehicle (EV) charging infrastructure strategy. Major EV charging facilities should mostly be focused on park and ride sites, multi-modal hubs and off-street parking sites, with on-street parking reserved for freight access.

5.3 The volume and concentration of people and businesses in Large Conurbations generates demand for high volumes of personal (food distribution, e-commerce, servicing) and retail goods. Last-mile delivery priority should be focused on utilising zero-emission vehicles and/or e-cargo bikes.

5. Freight and logistics movements in city centres can be avoided with more sustainable solutions to consolidate trips.

6.1 Solutions for freight and logistics should consider consolidation of freight on the peripheries of urban centres linked into the strategic freight corridors, prior to last-mile delivery, to minimise freight and goods trips into dense urban cores. In parallel, drop and collect facilities should be provided where population density warrants it, to reduce high volumes of multiple deliveries.

6.2 Micro-consolidation hubs have great potential in this typology as there is high residential and commercial density that can attract users. This can be serviced by low-emission vehicles or e-cargo bikes.

3. Rural Villages and Dispersed

Description

Rural Villages and Dispersed areas are rural districts geographically isolated from cities and towns. They have a slightly higher than average percentage of employment in tourism and an above average percentage of employment in advanced manufacturing and traditional industries. As would be expected, given their isolation, they have above average numbers of people commuting over 20km to work and over double the average percentage of people working at or from home. Their geographic size is reflected in their population density which is by far the lowest in the North and is growing at a rate below the Northern average. They have a large percentage of people aged over 65 (25%) and a below average percentage of people aged between 18 and 35.

Examples: These areas are mostly found interspersed with Visitor Destinations, although they can also be found in sporadic locations including directly north of Liverpool, North Lincolnshire, West Lancashire, and surrounding Carlisle.

Key role of transport

Rural Villages and Dispersed locations are generally characterised by long distances, poor accessibility, and high levels of car dependence which difficult implementation and encouragement of more sustainable travel modes. The 'right share' for this typology will be different to the pan-Northern target set in the STP's Vision & Objectives, as private vehicle is still likely to prevail on the modal share.

Rural Villages need to become places with a wider range of transport options as they have typically not been well-served by transport. This needs to be addressed through spatial, transport and digital solutions. Community based transport will play a key role in connecting rural villages and dispersed with their commuting and leisure needs, and with the existing transport infrastructure, for access to wider services and amenities. Recognising the high private vehicle usage, policy aims should look to make private vehicle travel more sustainable, for example by switching to electric vehicles and community-led car clubs.

While residents of these areas are typically among the least at risk of transport related social exclusion, TfN's research makes clear that the minority without access to a car experience a higher risk. Consequently, network planning cannot ignore the needs of those without access to a private car.

Policies: *what needs to be true?*

1. Transport should be at the heart of communities, providing more than just connectivity.

1.1 Investing and restoring village bus services as forms of social infrastructure will help to address potential social exclusion and car dependency. They are likely to require consistent subsidy or funding to be viable. The challenge to develop a cost-effective service can also be addressed through smaller and less-energy consuming vehicles. Some places in this typology might have strong connections to market towns that should be supported with bus services.

1.2 Demand responsive transport models have the potential to overcome commercial viability challenges and have already been successfully introduced in some areas as an affordable transport option. They need to be available 7 days a week and feed into multi-modal hubs.

1.3 Community led car clubs should be encouraged, particularly for those areas where people increasingly work from home, or do not have access to a private vehicle. Car clubs can be located within village centres and will facilitate longer, less frequent journeys.

1.4. Multi-modal hubs should focus on stations that provide travel options with connectivity for longer journeys and provide Park and Ride opportunities. Rural multi-modal hubs should provide a community asset that can be used to bring together a range of additional services such as health care, leisure opportunities, and click and collect facilities, to minimise first and last mile freight movements and encourage community use of the space by enhancing public spaces.

1.5 Implementation of new travel opportunities must simultaneously address the reliability and resilience of the road network, as often places in this typology have one road access making accessibility vulnerable to infrastructure fails.

2. A holistic systems-based approach is a fundamental foundation of facilitating sustainable growth to produce social-led outcomes

2.1 Enhancements in the coverage, reliability, and connection speeds of 5G and super-fast broadband networks should be at the heart of policy making. Digital connectivity is a foundation of delivering sustainable economic growth, reducing demand for journeys through greater opportunity for remote working and unlocking digitally connected demand responsive bus and logistics trips.

2.2 Where appropriate, implementing co-working spaces at multi-modal hubs, for enhanced digital connectivity, should be encouraged. This will promote benefits for businesses and the community, as well as reduce the need for longer-distance travel and its environmental impacts.

2.3 There is a need to promote a non-fossil fuelled energy network to promote uptake of zero-emission vehicles. There might be opportunities in certain places in this typology to work together with energy masterplanning and industry, which paired with public transport and spatial planning, can significantly impact decarbonisation. This can also be supported and implemented at mobility hubs.

3. Equitable transition to Zero-Emission Vehicles

3.1 Given the importance of agriculture, freight and agricultural machinery will remain significant traffic segment in these areas, so the use of zero emissions vehicles should be encouraged and can be supported through the location of hydrogen and biofuel supply sites. Low-emissions vehicles plug-in grant should be promoted for vans and trucks. Further support from government would need to be pursued to support the shift in other agricultural vehicles, which may reflect a challenging transition. The increased uptake of transitional fuels, EV charging, and the use of drop off and collect facilities at multi-modal hubs that minimises the need for first and last mile deliveries should contribute to decarbonisation.

4. Ensuring modal shift for new provision through behavioural change.

4.1 As the private vehicle modal share in this typology is high and the population tends to be older, they are likely to need behavioural nudges to uptake new travel options. Active awareness campaigns, training, and fare incentives should be considered for car clubs, DRT, and village services.

4. Rural Town and Fringe

Description

Rural Town and Fringe include rural areas (outside of a town with a population of less than 10,000 people) that are within closer proximity to nearby towns and cities. Unlike Visitor Destinations, Rural Town and Fringe areas rely less on the tourism sector for employment, with a broader mix across sectors, and an average unemployment rate. They have above an above average number of people employed in public sector occupations. Reflecting their rural geography, they have particularly low population densities compared to the more urban typologies, and a more elderly population, with fewer people aged between 18 and 35 and a greater number of people aged 65 and over compared to the Northern average. Their population growth tends to be below the Northern average.

Examples: Selby, North Lincolnshire, Hambleton, areas near Hull, and areas along the west coast of Cumbria.

Key role of transport

Low population densities pose a challenge to connecting residents to economic and social opportunities. An ageing population is likely to travel less, by all modes, due to physical accessibility and health issues. Consequently, there is a high amount of the population living at high risk of Transport Related Social Exclusion (TRSE). Levels of local transport services, particularly bus services, have declined in the last decade, leading to increased car dependency and severance due to major road infrastructure contributing to the risk for TRSE.

Fundamentally, Rural Town and Fringe areas should have enhanced accessibility to opportunities such as jobs, healthcare, and education, particularly healthcare due to the increasing ageing population. In many cases, these places are close to other towns and cities. Therefore, they could benefit from improved transport connectivity through demand responsive bus services and integration to urban services. These may need to be publicly funded to maintain the levels of services needed, to support sustainable transport options to deliver net zero in these areas.

Transport has the potential to improve the health of rural communities, through encouragement of active travel primarily for leisure trips rather than commuting given the distances between key centres. The walking and cycling infrastructure should be designed inclusively, particularly considering the ageing population, as car usage decreases dramatically for these groups. Making roads and pavements safer for active travellers needs to be a priority, particularly when considering that across the North, with retired people making an average of 19.5% of their journeys on foot.

Policies: *what needs to be true?*

- 1. There should be a wiseset of travel options, centred around public transport services and infrastructure that enhance accessibility to opportunities, particularly healthcare, integrating rural towns and fringe with nearby towns and urban areas.**

1.1 Scheduled bus services in rural areas, and accompanying infrastructure, need to be protected and where possible restored to provide access to key services and opportunities. This can prevent and reduce the high risk of TRSE. Services should provide attractive links to and from local centres, and to transport hubs that provide longer connectivity, and run 7 days a week. Real-time service information is particularly important in these locations given the relatively low service frequencies. Services are

likely to require subsidy to be viable, with strategies set out in Bus Service Improvement Plans and Local Travel Plans. Working with parish councils could further unlock opportunities for co-ordinating better public transport networks.

1.2 For rural communities, the introduction of multi-modal hubs can enhance the attractiveness of public transport services and integrate sustainable journeys. Facilities at multi-modal hubs, such as click and collect lockers, community hubs, public health facilities, and learning amenities can also reduce vehicle trips. Park and Ride hubs, either bus and/or rail based can consolidate demand, underpinning more frequent services for commuting travellers into nearby towns and cities, as well as for leisure and social travel needs.

1.3 Demand Responsive Transport (DRT) with smaller and more efficient vehicles can integrate dispersed communities with existing transport networks in urban areas via multi-modal hubs – creating sustainable door-to-door journeys. This typology is likely to have more demand for DRT than Rural Villages and Dispersed which makes it an optimal starting point for these services. To support the successful application of DRT and maximise access to information and timetabling, digital infrastructure (5G and super-fast broadband) must be enhanced and reliable, to enable users to access the required apps to utilise the system. DRT should feed into multi-modal hubs and core scheduled services.

1.4 Bus services can be complemented with car clubs and travel reward schemes to further reduce car dependency. Car clubs can be located within rural town centres within easy walking distance and will facilitate longer, but less frequent journeys. Businesses in rural areas are less likely to have car-dependency reduction policies in place, consequently, there should be targeted support to introduce them.

2. Active Travel should be promoted for shorter journeys that will require road safety enhancements

2.1 Active travel provision is a viable option for rural towns given the possibility of short distance journeys to the PT network or leisure activities which can be enhanced. New infrastructure and share schemes should be implemented and complemented with store and charge e-bike and e-scooters at multimodal hubs. This will help overcome longer distances and challenging topographies and incorporate active travel in multimodal trips for work, study, and longer leisure trips, in line with the Local Cycling and Walking Infrastructure Plans (LCWIP)

2.2 Safe provisions for pedestrians, cyclists and equestrians on rural 'B' and 'C' roads must be provided. Traffic calming measures to reduce speeds should be implemented alongside junction design enhancements, with crossing times accounting for ageing populations and ensuring that strategic roads do not prevent pedestrians accessing key services. This will also address the severance effect of rural roads, supporting business growth. Improving and implementing street lighting will also contribute to pedestrian, cyclist, and equestrian safety.

3. Equitable transition to Zero-Emission Vehicles

3.1 Even with improved public transport provision, it is still likely that there will be a high proportion of private vehicle trips in rural areas, where communities are likely to need the most support for switching to zero-emission vehicles. Local authorities should prioritise funding EV charging infrastructure in rural towns, villages and dispersed places, particularly around multimodal hubs to facilitate linked sustainable journeys. Promotion of electric car clubs can be an alternative for lower-income population to ensure inclusive decarbonisation.

3.2 Given many rural businesses are reliant on their own vehicles for deliveries and trade, incentives need to be provided to support the decarbonisation of these fleets. Low-emissions vehicles plug-in grant should be promoted for vans and trucks. Delivery of EV charging infrastructure and hydrogen refuelling stations should be supported with adequate grid infrastructure improvements.

4. Ensuring modal shift for new provision through behavioural change.

4.1 As the private vehicle modal share in this typology is high and the population tends to be older, they are likely to need behavioural nudges to uptake new travel options. Active awareness campaigns, training and fare incentives should be considered for car clubs, DRT, public transport, and active travel.

5. Transformational Places

Description

Transformational Places have a wide geographic spread across the North. They can be characterised as particularly dynamic and successful local economies, with productivity and employment growth above the national average.

They have relatively high percentages of people with Level 4 or above qualifications (36.8%), high GVA growth and, compared to Large Conurbations, low population densities. They have seen a large growth in the number of people employed within advanced manufacturing, and more than double the Northern average of the proportion employed within Knowledge Intensive Business Services (KIBS) sectors. Reflecting their dynamic economies, these areas have the lowest unemployment rate of any place type.

Examples: York, Cheshire East, Redcar & Cleveland, West Cumbria, and South Ribble.

Key role of transport

Transformational Places are more varied than any other place typology, and face a variety of economic and transport constraints, and market failures.

Given their often semi-rural and dispersed geography, Transformational Places are highly reliant on their transport infrastructure. Infrastructure must facilitate sustainable and flexible commuting flows to key employment sites and neighbouring Large Conurbations, as well as catering for high levels of logistic delivery trips due to low population densities. Ensuring that transport connectivity is sufficient to continue to attract investment remains a key issue of many Transformational Places and their economic sectors, particularly improving links to international gateways for export-related firms in advanced manufacturing.

Transformational Places provide a significant opportunity for rapid transport decarbonisation. Transport policy should be focused to reduce car dependency, particularly for new residential and industrial sites, through planning policy that builds active travel and public transport into the fabric of communities. Given the high levels of GVA and high car ownership, policies are required to improve the coverage, frequencies, and operating hours of public transport. However, with higher economic outputs, there is a greater propensity for the population to transition into electric vehicles, with associated consideration for supporting this transition with adequate charging infrastructure.

Policies: what needs to be true?

1. Local public transport should be designed to fit with employment patterns in key sectors and prioritised for medium and long-distance journeys.

1.1 Due to high levels of car ownership associated with workers in knowledge intensive jobs, there is a need to prioritise modal shift from private car to public transport. Public transport must be integrated, reliable, accessible, and inclusive. Integrated ticketing with larger conurbation mass transit networks is required to support those in KIBS jobs to access centralised offices directly via public transport. For large centres of employment, such as Sellafield, timetables should be aligned with working patterns.

1.2 Ticketing must be smart and flexible, ensuring value for money for non-5-day commuters, as well as those working outside of conventional working times. Furthermore, due to high levels of flexi commuting, existing bus and rail stations should be adapted to act as integrated multi-modal hubs with inclusive design. Information and

journey planning tools should complement the integrated transport system for users to make their travel choices.

1.3 Multi-modal mobility hubs should be situated in accessible locations to unlock the potential for Park and Ride connectivity, with appropriate EV charging point capacity. They should be complemented with providing opportunities for consolidated parcel drop off/pick up, cycle parking, electric bike/e-scooter charging facilities and other amenities. Transformational Places attract residents and leisure visitors, which provides an opportunity to upgrade public realm around multi-modal hubs.

1.4 Buses must be of a high quality, with wi-fi and charging facilities, with express services to neighbouring conurbations. Continuity of services outside of the peaks will increase patronage, particularly for non-commuting trips, but may require subsidies due to market failure. They can be complemented with incentives programmes for use of bus services with local employers.

1.5. Transformational Places should ensure that there are alternatives to car to access out of town employment centres, including industrial sites, which could include bespoke shuttle services to industrial parks that work as Demand Responsive Transport. Service patterns should be designed to fit with work shifts. Given highly skilled workers at these sites are likely to commute over longer distances, these should be integrated with medium distance rail services.

1.6 Rail services must be reliable, frequent, and consistent, such as 2 trains per hour every day of the week. There should timetables interconnected with the local bus and DRT networks. Opportunities to develop new stations, re-open stations close to growing settlements or large employment sites, should be explored, along with the extension of mass transit systems using tram and/or tram-train technology.

2. Targeted spatial planning policies and transit orientated development can support the rapid decarbonisation of the transport network

2.1 Short distance trips should result in a high mode share of active travel usage. As Transformational Places are attractive places to live and visit for leisure and recreation, reallocation of road space away from private cars to public realm and active travel infrastructure can both encourage modal shift and attract further footfall. This can boost local business and economies.

2.2 New residential and commercial developments should be built with EV charging points as standard and be prioritised where active travel and public transport cannot compete. They should be designed in a manner to actively promote sustainable travel options by building active travel infrastructure into the fabric of communities. Safe, accessible, and well-lit access to public transport must be mandated in the planning process. Community EV car clubs, potentially funded by developer contributions, will further incentivise the take up of car-lite development.

3. Consolidating and decarbonising the logistics networks

3.1 The nature of Transformational Places' successful dynamic economies and low population densities results in large volumes of home delivery and freight trips. This must be underpinned by an efficient, reliable and carbon zero freight and logistics network. First-last mile deliveries should be provided by zero emission vehicles, with trips minimised through coordinated dynamic information systems consolidating loads from periphery consolidation centres.

3.2 To support continued inward investment in advanced manufacturing, consolidation centres should be situated adjacent to the strategic rail or road network with direct

access to key gateway ports and airports for exports to international markets; with innovation in digital and technological advances, helping to reduce unnecessary trips by shortening supply chains.

6. Other Urban

Description

Other Urban areas have the second highest population density of all the typologies across the North, with lower population growth of 1.0% compared to the Northern average of 1.5%. They are distinguished from Industrial Places by having a low number of people working in traditional industries (3.4%) and a high number of people working in the Public Sector (38.7%), similar to Former Metropolitan Counties. Like Industrial Places and Former Metropolitan Counties, Other Urban areas have a low percentage of people with level four qualifications or above, a small percentage of people working in KIBS and have an above average unemployment rate (though not quite as high as industrial areas).

Effectively, they represent a more geographically focussed version of Former Metropolitan Counties, with a similar employment breakdown, but are more geographically isolated and further from the Larger Conurbations.

Examples: Near or within smaller cities and larger towns like Carlisle, Workington, Whitehaven, and Middlesbrough

Key role of transport

The approach for these communities will depend on whether they are part of major metropolitan areas, for example Middlesbrough, or individual areas, for example Carlisle. The former may present opportunities to better integrate the area into a city region's mass transit system or zonal area, with the latter lending itself well to active travel and rail connectivity. Their location away from Large Conurbations presents an opportunity to support long-distance journeys with strategic rail and transforming stations into multi-modal transport hubs. Furthermore, there are more opportunities to unlock land development. Encouraging the role of rail needs to be balanced with local regeneration policies to avoid unnecessary outbound long-distance travel and encourage local trips.

Other Urban areas are significant contributors to the Northern economy, and transport can help support growth and decarbonisation challenges. The high relative population density in Other Urban areas provide the market demand to drive the uptake of sustainable travel patterns, whilst also strengthening the case for urban regeneration. This typology is comparatively well served by rail and has the second highest number of rail journeys. Consequently, the focus should be on reducing private vehicle travel and maximising and complementing the existing rail network.

There is above average risk of social exclusion and car dependency in these areas, and private vehicles often offer the only means of access to key destinations. This supports the case for complementing the existing rail network with affordable public transport provision and active travel infrastructure in order to effectively reduce.

Policies: what needs to be true?

1. Maximising and filling the gaps in the existing public transport and active travel networks to support more sustainable travel patterns

1.1 Strategic rail connectivity should support both outbound and inbound commuting, as well as providing connectivity to encourage inbound investment. Train operators and Local Transport Authorities must focus on strengthening cross-boundary and cross-border integration and ticketing.

1.2 Implementing radial and orbital local bus services can support full origin-destination public transport trips, particularly supporting access for areas currently identified as transport deprived, reducing the fragmentation associated with hub and spoke service delivery common in these areas. Supporting the affordability of bus services is necessary to reduce risk of TRSE, underpinned by integrated fares across mode and operators.

1.3 Multi-modal hubs at rail stations can bring together integrated interchange between local transport services and active travel modes, furthermore, places in this typology such as Darlington and Carlisle, can provide wider strategic rail connectivity to the North. Multimodal hubs should also consider enhancing public realm and providing community and commercial spaces, as there is considerable redundant space at rail stations across the North. This will support local economies and regeneration initiatives, as well as supporting the reduction of TRSE. These hubs should also consider Park and Ride, and pick-up and drop-off provisions, where reasonable, and provide access to the wider major road network.

1.4 E-bikes and cycling could play in providing a zero-carbon option for the first and last mile of people's journeys, making cycling a viable option for a wider group of people. This can be complemented with cycling training and incentives.

1.5 Other Urban areas are often associated with a limited number of key organisations who employ a disproportionately large share of the working age population in an area, such as large industrial sites, hospitals, universities, and colleges. Local Authorities should work with large employers to develop effective sustainable travel plans, including consideration of Demand Responsive Travel (DRT) services outside of traditional public transport operating times, sustainable travel reward schemes, formalised car sharing programmes and workplace parking levies (with proceeds invested back into facilitating sustainable travel to work).

1.6 There are opportunities for demand management through spatial planning and 20-minute neighbourhoods in Other Urban areas. This includes through encouraging more local services to be based in suburbs, including those close to transport hubs, targeting densification on public transport corridors, and restricting parking.

2. Targeted spatial planning policies for active travel and public spaces will result in regeneration of Urban Centres

2.1 The delivery of high-quality public realm and upgraded active travel infrastructure is supported by relatively high densities and combined with improved public transport. This can support regeneration priorities, and increase footfall into these urban centres. Improvements should prioritise the quality of space and functional active travel infrastructure connecting to transport hubs. Reducing pavement parking, improving pedestrian crossings, and reallocating space away from road users to active travel users and e-cargo bikes will contribute to local regeneration and address severance. Furthermore, improving lighting and foliage can also improve perceived safety. This will establish Other Urban places as destinations and attractive places to live, work and visit.

2.2 The commercial centres of market towns, particularly those with seasonal tourism, should consider revised parking controls to re-allocate parking spaces (permanently or seasonally) for use as wider pavements, additional cycle storage and/or additional trading space and outdoor seating for use by local businesses. An increase in cost of on-street parking compared to off-street parking in city and town centres has the potential to free up tradeable space but also reduce cruising by private vehicles. Further travel demand management can be enforced through work parking levies.

3. Freight and logistics movements inside urban centres need to be addressed with more sustainable solutions.

3.1 Other Urban areas typically contain (or are near to) strategic road and rail corridors. Therefore focus should be on developing the network to support economic efficiency, reliability of goods movement, and a greater resilience of the freight network. This includes repurposing brownfield sites to support lorry parks, refuelling, warehousing, and consolidation centres, for reducing overall travel distances. This will additionally boost employment and drive the levelling up agenda.

3.2 To ensure efficiencies in deliveries and minimise conflict with active travel modes, adequate kerbside provision should be available as appropriate and managed/coordinated using dynamic information systems.

3.3 Drop and collect facilities should be provided to support residents and businesses, linked to the development of multi-modal hubs and/or district centres to minimise home deliveries. First-last mile connectivity for freight should be by EV vans and e-cargo bikes; the use of the latter can be consolidated with the drop and collect facilities in denser areas.

3.4 There will likely be a higher requirement for LGV and HGV charging or refuelling in these areas, to support goods and services movements. Consequently, integration of rapid electric charging should be implemented on-route in these areas, to ensure a whole network coverage of EVs.

7. Visitor Destinations

Description

Visitor Destinations are rural destinations and towns that attract large numbers of tourists each year. They tend to be within and surrounding National Parks and Areas of Outstanding Natural Beauty, or areas of historical significance and some coastal resorts. These areas have relatively low levels of population growth, low population density and a comparatively elderly population, with an above-average proportion of over-65s and a below average proportion of people aged between 18-35 compared to the Northern average, which are characteristically similar to rural areas. Of all the place typologies, Visitor Destinations are defined by having the highest proportion of people employed in the tourist sector (26.2%), including large numbers working in sectors such as food and accommodation.

Examples: Areas near or in National Parks, Northumberland, Cumbria, Blackpool, and Whitby.

Key role of transport

Visitor destinations tend to experience seasonal demand which requires a careful consideration for the transport infrastructure and modal splits in these areas. Consequently, there are two different but equally significant user groups: tourists and local population. Policies must accommodate the seasonal demand of tourists whilst also supporting the needs of the local population, particularly addressing the above average risk for Transport Related Social Exclusion.

Visitor centres are attractive places for tourists, and its important the impacts are mitigated for local residents. Therefore, policies should concentrate on preserving the natural/built environment which generates tourism attraction, as well as enhancing local transport provision and encourage local regeneration to benefit residents. Visitor centres often offer significant employment opportunities with labour shortages in some key sectors. Improved transport links to surrounding areas can support skilled workers in accessing these.

Due to high car dependency and low density, we must recognise that the 'right share' for this typology will be different to the pan northern target set in the Visions and Objectives chapter, including different splits between tourists and the local population. However, the policies are aiming to encourage tourists to arrive to Visitor Destinations by public transport.

Policies: *what needs to be true?*

1. An improved transport provision that provides sustainable travel options to meet the seasonal demand of visitors and workers linked to the tourism industry.

1.1 Rail provision in Visitor Destinations can support viable alternatives to car travel, as well as provide onward connectivity into wider national parks and areas of natural beauty. A leisure focused service should be prioritised, 7 days a week and outside commuting peak hours, alongside commuter services if relevant to the specific place, connecting the North's visitor centres to our main metropolitan areas' large conurbations, via other more urbanised place typologies. Trains must provide spacious luggage storage for travel bags and leisure equipment (i.e., cycles, paddle boards, etc). They should provide a less costly, reliable, and more comfortable experience, in comparison to the car, to encourage modal shift to rail for leisure travelling.

1.2 Developing regional hubs on mainline railways and run subsidised buses to tourist attractions and worker areas from these hubs is key. Local authorities can work with train and bus operators to deliver a tourist-industry friendly offer and timetable, complemented with reliable information systems, for example Settle to Carlisle rail, Hadrian's Wall country bus, the Dales Bus in North Yorkshire, or the Cat Bells shuttlebus in the Lake District. Leisure cross-modal ticketing could increase public transport provision uptake.

1.3 Co-ordination between tour operators and transport operators can aid to ensure end-to-end provision of shared transport options, particularly for more isolated tourist areas, with multimodal hubs equipped with organised tour drop and collect facilities. This will need to be complemented with an overall improvement of coach access through enhancing roads for bigger vehicles, parking facilities with charging for electric coaches and kerbside/stops provision that allow drop-off/pick-up. This includes focused leisure ticketing, and the provision of journey planning tools in a standard language to encourage visitors in using local networks. Journey planning can be approached through one booking system where different transport providers can provide different parts of the trip.

1.4 It is still likely that, even with an enhanced rail service, tourists will be driving into Visitor Centres, therefore a shift from diesel-fuel to EV and more sustainable modes needs to be encouraged. Park and Ride sites on the edge of protected parking zones, equipped with sufficient electric vehicle charging infrastructure can help accelerate decarbonisation for long distance trips. E-bike and e-scooter hire will allow enhanced accessibility for longer last-mile trips.

1.5 Freight flows will remain significant in these areas all year round. The use of zero emissions vehicles should be encouraged and can be supported through EV charging and cargo e-bikes, particularly for shorter distance journeys. The use of drop off and collect facilities at multi modal hubs should minimise the need for first and last mile deliveries. Niche remote tourist accommodations could potentially be supported by drone deliveries, reducing congestion on the ground network, and improving speed of delivery.

2. Preserving the environment and village centres of visitor destinations.

2.1 Multi-modal hubs in these areas should be established, bringing together bus, DRT, car/lift share, park and ride facilities and e-bike hire/charging which will help reduce the private vehicle trips within the main attraction centres to avoid congestion and negative environmental externalities. These hubs can be used to bring together a range of additional services such as health facilities, tourism information centres and upgraded public realm to encourage community use of the space. All of which will increase footfall to support local economies and add to placemaking aspirations which in turn support the reduction of TRSE. They should include extensive slow EV chargers (recognising many vehicles will be left for multiple hours and the likely constraints on grid capacity).

2.2 Considering that the active travel share is likely to be lower than the pan-northern target currently set, there is a lot of potential for leisure cycling, walking and e-bikes for short distances within visitor destinations. Appropriate routes should be identifying to support leisure trips and complemented with wayfinding, and e-bike and bike hire facilities.

2.3 Demand responsive travel options (e.g., minibuses with ability to carry pets and bulky equipment) will be important. Given the extreme numbers who may arrive in-season, the extra capacity that could be afforded on transport networks by autonomous travel should also be considered, with on-demand driverless pods recently trialled in the

Lake District. DRT services importantly can support local communities, utilising demand from tourists to provide services where scheduled bus services currently miss.

2.4 Seasonal parking bans should be considered to condense demand to multimodal hubs, potentially with Temporary Park and Ride locations on the edge of controlled zones during busy tourist periods. This will reduce environmental impacts whilst retain access for residents and businesses and increase footfall within village centres to maximise economic potential.

3. Safer roads and footpaths for all users

3.1 It is also important to consider limiting vehicle speeds and improving lighting on routes where active travel is being promoted, as well as improvements to road junctions where B and C roads meet the MRN, with crossing times accounting for the both the needs of an ageing population as well as supporting the needs of other road users including active travel (walking, hiking, and cycling).

3.2 Footpaths and Green Routes are essential transport active travel infrastructure. Improvements to signage, wayfinding, and integration of long-distance footpaths into travel planning apps can help drive sustainable active travel usage.

3.3 Reliability and resilience of the road network needs to be improved alongside safety enhancements, as often places in this typology have limited road access making accessibility vulnerable to infrastructure fails.

8. Former Metropolitan Counties

Description

Former Metropolitan Counties share characteristics with Large Conurbations and Industrial Places, reflected in their geographic distribution. They are prominent around Leeds, Manchester, and Sheffield, where they can be found intermingled with Industrial Places and adjacent to large Conurbations, and surrounding Liverpool and Newcastle upon Tyne. Only a low percentage of people work in traditional industries (3.4% compared to 25.4% in Industrial Places) and a high percentage of people work in the public sector (35.7% compared to 19.8%). They also have a low rate of growth in employment within advanced manufacturing (15.9% compared to 52.3% in industrial areas).

Examples: Keighley, Barnsley, parts of Kirklees and Calderdale, Southport, and Doncaster.

Key role of transport

Former Metropolitan Counties face a similar set of challenges around both attracting business investment and improving skills as Industrial Places. Due to the major roads near and in Former Metropolitan counties, there is severance and negative environmental externalities. There is a strong case for improving their town centres to attract more business investment, increasing job opportunities.

Due to their proximity to Large Conurbations and high percentage of people commuting, there is an opportunity for connectivity to large urban centres (with stronger employment markets) to support labour supply effects and address the risk of TRSE linked to basic services access in these areas. Many towns in these areas already benefit from well-used railway stations. This needs to be balanced with local regeneration and improvement of town centres to avoid excessive amounts of commuting in peak hours and encourage more local trips, hence, the first policy focuses on 15/20-minute neighbourhoods. To further local regeneration in the future, densification should be a long-term goal.

Policies: *what needs to be true?*

1. Creating 15/20-minute neighbourhoods with good public transport connectivity by working together with spatial planning.

1.1 Investment in housing and office developments with good active travel infrastructure and reducing car-dependency in existing housing sites is key for creating 15/20-minute neighbourhoods. This should be complemented by road space reallocation to active travel infrastructure on local roads; reduction of pavement parking and improvement of junction safety to minimise severance between communities; and complementary planning policies to encourage access to essential services within close proximity of residential areas.

1.2 Former metropolitan counties are typically well served by rail or are located near a large conurbation well served by rail. Rail services into large conurbation should be frequent and reliable to facilitate accessibility to jobs, as there is high unemployment. For former metropolitan counties with limited rail connectivity, or no possibility to improve the frequency (i.e., outside of peak commuter hours) 'hub and spoke' bus services should be implemented to provide the necessary accessibility to jobs and basic services, including linking to stations.

1.3 15/20-minute neighbourhoods should be complemented with multimodal hubs where feeder bus services that link with rail stations are provided and/or for hub and spoke

services. Multimodal hubs can also support new commercial, leisure and social uses as increased footfall is attracted to these hubs, supporting wider regeneration opportunities for the area (including essential community services and remote working hubs), coupled with increased public realm and active travel linkage.

2. Demand Responsive Transport and active travel support can sow the seeds for future densification.

2.1 In these areas of lower population density, demand-responsive bus services can provide an effective transport solution for many, particularly for those without access to cars. These can be linked with effective shared mobility and travel reward schemes, although any digital accessibility requirements will need to cater for all age brackets effectively. DRT schemes can support sustainable regeneration and growth until the quantum of people can support a scheduled service.

2.2 Given the need for regeneration and driving footfall into local centres, twinned with proximity to large conurbations, active travel/public realm links to transport hubs can provide access to the wider regional transport area.

9. Industrial Places

Description

Industrial Places are areas where employment is focused around 'traditional' industries, with typically lower levels of productivity and higher levels of economic inactivity and unemployment. Typically located surrounding Large Conurbations such as Liverpool, Manchester, and Sheffield, together with other large urban areas such as Hull and Carlisle. Industrial areas have a higher percentage of people employed in traditional industries than any other typology (25.4% compared to a northern average of 8.1%), together with the highest percentage of people employed in advanced manufacturing and the highest growth of employment in this area (52.3% compared to a northern average of 32.8%). Despite this, they also have the highest unemployment rate (at 5.7%) and the second lowest percentage of people with Level 4 skills or above (29.3%, Northern average 33.11%).

Examples: Colne, Areas of Barnsley and Calderdale, County Durham, Gateshead, Hyndburn, and Doncaster.

Key role of transport

Industrial Places face several challenges around encouraging inward business investment, particularly in their potential strengths in advanced manufacturing and encouraging greater labour market participation. Improved connectivity to employment centres and regenerating neighbourhoods is required to both attract investment where existing accessibility is poor (provided other, complementary investment is made in skills and training), and support labour supply effects where they better connect regions to areas with high employment densities and job vacancies.

These types of places generate significant volumes of business and freight traffic, largely due to a greater proportion of employment within the manufacturing, logistics and distribution sectors which rely on the highway network.

Tackling transport related social exclusion is a priority in this typology as 40.7% of the population lives in high-risk areas. This requires significant investment in local public transport to employment centres, education, and health services, including out of town locations. Public transport should operate sufficiently within evenings and weekends, enabling access to work with irregular hours, including shift work. This will ensure everyone, including non-car users and vulnerable groups, are able to access opportunities, which will have economic as well as social and wellbeing benefits.

Policies: *what needs to be true?*

1. Creating 15/20-minute neighbourhoods by improving sustainable transport connectivity increasing spatial proximity and enhancing digital connectivity.

1.1 Investment in housing and office developments with active travel facilities and improved local connectivity is key for creating 15/20-minute and liveable neighbourhoods. This should be complemented by road space reallocation to active travel infrastructure in local road, reduction of pavement parking and improvement of junction safety to minimise severance between communities and facilitate modal shift to active travel.

1.2 Industrial Places are typically well served by rail or are located near a large conurbation well served by rail. Rail services into large conurbations should be frequent and reliable to facilitate accessibility to opportunities and reduce TRSE. For Industrial Places with limited rail connectivity, or no possibility to improve the frequency (i.e.,

outside of peak commuter hours) 'hub and spoke' bus services should be implemented to provide the necessary accessibility to main employment areas and basic services. Public transport frequencies and timetables should be in line with peak times related to local industry. Seamless transfer with reliable information is expected at interchange options to encourage multimodal trips.

1.3 15/20-minute neighbourhoods should be complemented with multimodal hubs where feeder bus services that connect them to rail stations and/or hub and spoke services. Multi modal hubs can also support new commercial, leisure and social uses to create local centres or support district centres as increased footfall is attracted to these hubs, supporting wider regeneration opportunities for the area (focusing on essential community services and remote working hubs for improved digital connectivity), coupled with upgraded public realm infrastructure, and enhanced active travel linkage.

2. Supporting industries' freight necessities and transition to more sustainable patterns

2.1 Industrial places typically contain (or are near) strategic road and rail corridors, which therefore should be developed to support economic efficiency, reliability of goods movement and a greater resilience of the freight network. Industrial places also provide opportunities to support freight and logistics with the safeguarding and prioritisation of land to support freight activities such as lorry parks, refuelling, warehousing, and distribution centres, all of which can boost employment.

2.2 Focus for shifting to rail freight can reduce negative externalities of the Strategic Road Network (SRN) and support employment. Existing Strategic Rail Freight Interchanges, such as Tees, Selby, Wakefield, Ditton and Doncaster should be supported and enhanced. The switch to rail freight will help managing negative externalities of road freight transport. Opportunities for opening unused existing rail should be explored. There is a need for appropriate gauge clearance (W12) on the network to support the movement of deep sea and short sea shipping containers to grow the market for freight from port to port and inland terminals.

2.3 Electric Vehicle Charging Infrastructure should be implemented near the Major Road Network and consolidation centres to support main industrial employers' switch to Electric Vehicles and help further reduce the negative externalities of freight transport. This can be further complemented with e-cargo bikes where appropriate.

2.4 The transport network should be prepared to ensure the development of hydrogen and alternative fuels, as some of these industries are developing in these areas. For example, hydrogen could play in the North East and North West, and transport will be both a major customer and a supplier in this industry. There are several hydrogen fuel producers also located within these areas of the North.

3. Working with the main employers and industrial/business parks for more sustainable travel patterns

3.1 Industrial Places are often associated with one or two key organisations or with employment/industrial developments that employ a disproportionately large share of the working age population in the area. Local authorities should work with these employers to develop effective sustainable travel plans, including consideration of sustainable travel reward schemes, formalised car sharing schemes, and workplace parking levies (with proceeds invested back into facilitating sustainable travel schemes). I.e., Nottingham's workplace parking levy has funded the purchase of 15 electric buses, an expansion of the tram network, a station renovation, and grants for employers to support sustainable transport options.

3.2 Workplace provision of alternative shared transport options (i.e., coaches picking up from district centres or multimodal hubs) can be implemented through local authorities and employers' co-ordination.

Meeting: Scrutiny Committee
Subject: Transport and Health Policy Position
Author: Tom Jarvis, Senior Evidence & Analysis Officer
Sponsor: Tim Foster, Interim Strategy & Programme Director
Meeting Date: Wednesday 23 November 2022

1. Purpose of the Report:

- 1.1 To introduce TfN's draft Transport and Health Policy Position, provided in Appendix One.

2. Recommendations:

- 2.1 That Committee members consider and provide comments on the draft Transport and Health Policy Position (Appendix One). The final version of the policy due to be discussed at TfN Board in December 2022.

3. Main Issues:

Policy position background and context

- 3.1 In 2022/23, Transport for the North (TfN) undertook research with Cambridge Econometrics and Cavill Associates on the impacts of the transport system on health and wellbeing. This research brought together evidence on the range of impacts of the transport system on health and wellbeing, quantified these impacts, and facilitated analysis of variations in these impacts across the North. The research report produced from this is included as a background paper.
- 3.2 The research demonstrated a clear health inequality challenge in England. For example, the 2019 English Indices of Deprivation found that 23.9% of areas in the North fall in the most deprived decile for health, and 54.1% in the most deprived three deciles. This compares with 4.4% and 20.2% of the rest of England.
- 3.3 The causes of health and wellbeing inequalities in England are multiple and complex. However, both TfN's research and the wider body evidence on the determinants of health and wellbeing in England demonstrate that the transport system has a significant role. The five key impacts highlighted in TfN's research are: (1) Road traffic incidents and safety, (2) access to healthcare, (3) air pollution, (4) noise pollution, and (5) physical inactivity.
- 3.4 The draft policy position reflects and responds to a number of challenges. These include the complex and multi-dimensional relationship between transport and health, the fact that health impacts from transport often fall on non-users and are therefore not reflected in user costs, and the need to reduce levels of car-dominance and car-dependency if significant progress is to be made on reducing negative health externalities from the transport system.

TfN's role on transport and health

- 3.5 The draft policy position sets out the following actions for TfN to respond to the challenge evidenced by the research:
- (1) Vision zero for the major and strategic roads network: TfN will adopt a vision for zero deaths and serious injuries on the major and strategic roads network, and will consider this vision in developing future policy related to this network.

(2) Enhance links with OHID and local Directors of Public Health: TfN will enhance its links with the Office for Health Improvement and Disparities (OHID) and with local Directors of Public Health in the North. This will develop new arrangements for evidence sharing on the impacts of transport on health, and identify evidence gaps of mutual interest.

(3) Enhance evidence on access to healthcare and links to health inequality: Despite methodological development undertaken in 2021/22, it is not currently possible to quantify the link between changes in access and changes in health outcomes. Subject to available resources, TfN will undertake research to address this significant evidence gap.

(4) Develop a severance tool: In 2021/22, TfN developed a methodology to estimate severance effects caused by major road and rail infrastructure. However, the level of data required, and the methodological complexity of this approach, means that it is not easily transferable to other contexts. Subject to available resources, TfN will work to overcome these methodological challenges, and provide a transferable tool for Local Authorities to estimate the severance impacts of road and rail infrastructure.

(5) Develop a broader impacts costing tool and estimate for the North: TfN will collate existing evidence and, if required, conduct additional research, to establish the whole systems impacts of different transport modes in the North and carry out a comparative analysis against existing pricing models. This is with the intention of supporting policy-makers in decisions on road user charging, parking policy, public transport fares, and investment in active travel.

(6) Support partners in identifying areas with poor access to health services: TfN's transport-related social exclusion data tool allows Local Authorities and other stakeholders to access LSOA-level data on access to jobs, education, and key services – including healthcare. TfN will promote this tool and provide support to partners in using it to identify areas in where there is both poor access to healthcare and high levels of need.

(7) Measure progress towards health outcomes: TfN's Monitoring and Evaluation Framework includes several health-related metrics and provides a transparent means of monitoring progress towards the ambitions set out in Strategic Transport Plan.

Next steps

- 3.6 Following the consideration of the draft report by the Scrutiny Committee, the draft policy position will be recommended to TfN Board for adoption. The policy position and supporting research will be published by TfN and will inform the development of the second Strategic Transport Plan being prepared by the Executive.

4. Corporate Considerations

Financial Implications

- 4.1 There are no direct financial implications arising from this report. The financial implications of further work will be considered as part of the business planning and budgeting process for future years.

Resource Implications

- 4.2 Any resourcing implications to TfN as a result of this policy will be considered as part of TfN Business Planning Process for FY2023/24.

Legal Implications

- 4.3 There are no apparent legal implications arising as a result of this report.

Risk Management and Key Issues

- 4.4 There are no risk implications arising from this report.

Environmental Implications

- 4.5 This report does not constitute or influence a plan or programme which sets the framework for future development consents of projects listed in the EIA Directive and therefore does not stimulate the need for SEA or EIA. The protection and enhancement of health and wellbeing is an important objective within our existing STP and intrinsically linked with a fair decarbonisation transition within TfN's Decarbonisation Strategy. This policy position and the activities laid out within it, will support the objectives of both these documents.

Equality and Diversity

- 4.6 The draft policy position responds to evidence of significant health inequalities in England, and the concentration of poor health outcomes in the North. These health inequalities are known to disproportionately impact those on low incomes, people with disabilities, ethnic minority communities, and young people. The actions set out in the draft policy position are intended to develop evidence and support TfN's partners in addressing these inequalities, where they relate to transport.

Consultations

- 4.7 None

5. Background Papers

- 5.1 Transport, Health, and Wellbeing research report

6. Appendices

- 6.1 Draft Transport and Health Policy Position

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Transport for the North

Transport, health and wellbeing in the North of England



public health consultancy



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Contents

	Page
Executive summary	6
1 Introduction	9
2 Approach	10
3 Evidence review	14
4 Impact framework	24
5 Analysis	42
6 Conclusion	80
7 References	88
Appendices	97
Appendix A System maps	98
Appendix B Expert consultations	103
Appendix C Other tools for economic assessment	107

Tables and figures

Tables	Table 3.1: Summary of evidence	15
	Table 5.1: Increased average walking and cycling activity by proximity to route	43
	Table 5.2: Increased MVPA relative to the reference category (0 parks within 0.5 km)	46
	Table 5.3: Road incident statistics for selected areas	49
	Table 5.4: Factors affecting traffic incident occurrences	49
	Table 5.5: Air pollutants and their main sources	52
	Table 5.6: Increased health risks from air pollution (per 100,000)	53
	Table 5.7: Population affected by impacts tied to air pollution	53
	Table 5.8: Wellbeing benefits of green space	62
	Table 5.9: Reduced risk of type 2 diabetes relative to reference category (<40% within 1 km radius)	66
	Table 5.10: Reduced risk of psychosocial distress relative to reference category (<5% within 1-mile radius)	67
	Table 5.11: Reduced risk of self-rated fair or poor general health relative to reference category (<10% within 1-mile radius)	68
	Table 5.12: Population affected by impacts tied to proximity to green space	69
	Table 5.13: Increased physical health risks from road traffic noise	70
	Table 5.14: Increased mental health risks from road and rail traffic noise	71
	Table 6.1: Summary of the estimated number of people at risk, by transport-related health impact and geography	82
Figures	Figure 4.1: Causal chains of green space health impacts	32
	Figure 4.2: Logic of, and evidence for, health impacts of community severance	36
	Figure 4.3: Severance effects of a section of road	37
	Figure 5.1: Increase in physical activity associated with hypothetical mixed walking and cycling route relative to reference (>4 km away from mixed cycling and walking route)	43
	Figure 5.2: Areas within 1 km of mixed cycling and walking routes in Greater Manchester	44
	Figure 5.3: Access to walking and cycling routes by LSOA in Greater Manchester	45
	Figure 5.4: Daily increase in MVPA relative to reference (0 parks within 0.5 km), Manchester	46
	Figure 5.5: Daily increase in MVPA relative to reference (0 parks within 0.5 km), Sheffield	47
	Figure 5.6: Casualty rates in the North of England	48
	Figure 5.7: Traffic volume in Greater Manchester	51
	Figure 5.8: Traffic incidents in Greater Manchester	51
	Figure 5.9: Increased hospital annual admission risk from carbon monoxide	55
	Figure 5.10: Concentrations of SO ₂ around Manchester and Liverpool	57
	Figure 5.11: Increased health risks from nitrogen dioxide	58
	Figure 5.12: Increased mortality risk from PM ₁₀ (left) and PM _{2.5} (right)	59
	Figure 5.13: Areas of high annual ozone exposure	60

Figure 5.14: Green space around Manchester	63
Figure 5.15: Green space and median age around Manchester	63
Figure 5.16: Share of population in Manchester with green space within 300m of their homes	64
Figure 5.17: Share of population in Newcastle with green space within 300m of their homes	65
Figure 5.18: Reduced risk of type 2 diabetes from proximity to green space	66
Figure 5.19: Reduced risk of psychosocial distress from proximity to green space	67
Figure 5.20: Spatial risk of self-rated fair or poor general health from proximity to tree canopy in the North of England	68
Figure 5.21: Increased health risks from road traffic noise	72
Figure 5.22: Increased mental health risks from rail traffic noise	73
Figure 5.23: People impacted by road traffic noise in the North, by LSOA	74
Figure 5.24: Severance imposed by Road A580 on Postcode L11 7AS	76
Figure 5.25: Severance imposed by the A1 in Newcastle	79

Appendix tables

Appendix Table B.1: Transport and health expert consultations	103
---	-----

Appendix figures

Appendix Figure A.1: Complete system map	99
Appendix Figure A.2: System map for Tier 1 evidence	100
Appendix Figure A.3: System map for Tier 1 and 2 evidence	101
Appendix Figure A.4: System map for Tier 1, 2 and 3 evidence	102

Executive summary

This project looked at quantitative evidence on transport, health and wellbeing in the North of England

- Transport for the North (TfN) commissioned Cambridge Econometrics (CE), with Cavill Associates, to improve understanding of how transport affects health and wellbeing in the North of England.
- The purpose of this work was to shed light on the various transport impacts to inform: the further development of TfN's Strategic Transport Plan (STP), TfN's Decarbonisation Strategy, and TfN's capacity to analyse the impacts of transport in the North.
- The project considered ten areas (impacts) in which transport might affect health and wellbeing, with:
 - a review phase to: establish the state of the evidence base on each of those impacts, supported by expert consultations to augment the evidence base and our understanding of the causal relationships
 - the development of an impact framework with which to take the evidence and show whether and how it might be combined to inform quantitative assessment

A portion of the evidence base is amenable for quantitative analysis...

- The review phase identified three tiers of evidence:
 - 1 Evidence supported by a body of robust quantitative data permitting further analysis: these were taken forward into the quantitative analysis presented in this report – physical inactivity, incidents and safety, green space and noise pollution.
 - 2 Evidence supported by quantitative data but with weaker or less conclusive results, possibly with more complex causal chains and/or data limitations for analysis: one of these was taken forward for quantitative analysis and another, severance, was tested as a small example case to see if there might at least be some way to identify potential risk of social disconnectedness.
 - 3 Evidence on the likely direction and scale of the effects but little in the way of concrete evidence with which to carry out any quantitative analysis: user experience, access to healthcare, access to employment and environment quality.

...but other elements of the framework lack both evidence and data

- The impact framework sets out the evidence base as a whole but also a summary of the evidence most useful for quantification. In cases in which quantification is currently possible, we put forward recommendations and analysis to show how the framework can be applied. For impacts which cannot (currently) be assessed, the focus is more on limitations and how data gaps might need to be addressed.

Results

- Road transport is notable in its detrimental impacts on health, especially in the form of:¹
 - safety i.e. accidents, especially on A roads

¹ The analysis in this part of the report was only able to consider road transport as a whole, rather than isolating public from private transport.

- air pollution, especially in the form of nitrogen dioxide (NO₂) and particulate emissions, which raise the risk of hospitalisation and mortality much more than the other pollutants considered
- noise, as a source of stress that raises the risks of coronary heart disease, hypertension and depression
- Our analysis shows the availability of walking and cycling routes for exercise and of parks in urban areas, highlighting that these routes should be promoting activity for those in the vicinity and that the impacts of parks are positive small.
- In terms of green space more generally, lower availability in urban centres (here, with a focus on Manchester) may have distributional implications given the tendency for people living in those centres to be younger.
- Proximity to green space appears to confer relatively widespread benefits with respect to psychosocial distress. Green space also appears to help reduce the risk of type 2 diabetes though these benefits are much less likely to be in urban centres.

Future directions

- The analysis in this report shows what is currently possible given the available evidence (knowledge of how transport affects health and wellbeing) and the availability of data with which to carry out an assessment. There remain various areas TfN might wish to explore more deeply to expand their ability to analyse health impacts. This specifically concerns: more consideration of access/use rather than simply proximity; and the context-specific nature of traffic incidents (as below). Broader evidence gaps concern access to healthcare and employment, the effects of severance, and user experience.
- Distinguishing between proximity (access/use in principle) and actual access/use is a key challenge for better understanding physical inactivity and green space. Currently proximity is the typical surrogate for usage and exploration of usage and its determinants (or, put another way, barriers) would be valuable.
- The context-specific nature of traffic incidents also makes it challenging to say much in detail because identifying the upstream effects hinders downstream analysis. It is likely that this strand of work would require more detailed and sophisticated prior modelling to augment a health assessment.
- Otherwise, given the presence of impacts of interest but which are lacking evidence and/or data, there are various ways in which further research will be needed to generate more robust analyses and, in time, link them to (possibly new) datasets to shed light on issues of importance such as access to healthcare and employment, severance and user experience.

Executive Summary Table 1: Summary of the estimated number of people at risk, by transport-related health impact and geography

Impact category	Impact	Geography analysed	Estimated number of people at risk in geography ('000s)
Physical inactivity	Lower walking and cycling activity	Greater Manchester	163
Incidents and safety	Number of traffic casualties		33*
Air pollution	Higher risk of mortality from nitrogen dioxide	The North	5,880
	Higher risk of mortality from PM ₁₀		5,850
	Higher risk of mortality from PM _{2.5}		5,640
Limited access to green space, recreation and leisure	Higher risk of type 2 diabetes		9,720
	Higher risk of psychosocial distress		200
	Lower self-rated general health		5,750
Noise pollution	Higher risk of hypertension		2,500
	Higher risk of coronary heart disease		2,500
	Higher risk of depression		2,500

Note(s): * This number does not represent those at risk of traffic incidents but the number of traffic casualties in the North for 2019.
 We did not calculate the number of people at risk for physical activity and subjective wellbeing from proximity to parks and severance.
 For air pollution, only the three most harmful pollutants were considered.

Source(s): Cambridge Econometrics analysis.

1 Introduction

This project considered the impacts of transport on health and wellbeing in the North of England

Transport for the North (TfN) commissioned Cambridge Econometrics (CE), with Cavill Associates, to improve understanding of how transport affects health and wellbeing in the North of England.

The purpose of this work was to shed light on the various transport impacts to inform: the further development of TfN's Strategic Transport Plan (STP), TfN's Decarbonisation Strategy, and TfN's capacity to analyse the impacts of transport in the North.

The rest of this report is structured as follows:

- Chapter 2 sets out our approach to the project
- Chapter 3 summarises the findings of the evidence review on how transport affects health and wellbeing
- Chapter 4 explains the impact framework by which transport impacts can be related, quantitatively, to health and wellbeing
- Chapter 5 presents the results of quantitative analysis from applying the impact framework
- Chapter 6 offers concluding remarks about the work and directions for future analysis

As well as full references (in Chapter 7), the report has various appendices that provide further information from the evidence review including the system maps developed during the first part of the work (Appendix A), a summary of the expert consultations (Appendix B), and a listing of other economic assessment tools in use (Appendix C).

2 Approach

The work was divided into an evidence review phase, and then an impact framework / analysis phase

We divided the project into two phases:

- 4 an evidence review (led by Cavill Associates) to assemble system maps of the channels by which transport could affect health and wellbeing
- 5 the development of an impact framework to operationalise the causal chains (evidence-/data-permitting) and quantitative analysis to illustrate these impacts in the North of England (both led by CE)

These phases of the work correspond to the next three chapters of this report:

- Chapter 3 summarises the findings of the evidence review from Phase 1
- Chapter 4 sets out the impact framework subsequently developed, as the first part of Phase 2
- Chapter 5 goes on to present the results of the data analysis using the impact framework, as the second part of Phase 2

The following sections set out the approach to each part.

2.1 Evidence review (Chapter 3)

The evidence involved three tasks:

- 1 a literature review
- 2 a system mapping exercise
- 3 a series of expert interviews to augment the system maps and the literature assessed

The literature review (review of reviews) built on earlier work by TfN

TfN had previously conducted a high-level review of the main ways that transport influences health. This review identified ten impacts of transport on health and wellbeing. This prior review was taken as a starting point for a search for the best available and most up-to-date data and evidence on each impact. This search focused on reviews, synthesised evidence and high-level reports from authoritative sources (a review of reviews). Primary search engines were PubMed and Google Scholar, using search terms designed to identify as wide a range of relevant reviews as practicable (for example, including 'review' and 'health' in each search along with the specific topic). These searches were supplemented with data and evidence identified through expert consultation. This is an efficient search method that is able to identify key literature in ways that approach the sensitivity of formal systematic reviews, which were not possible given the time and resource constraints of this project.

Initial search results were screened to identify the reviews that provided direct quantitative evidence of the links between transport and the specified health outcome(s).

This literature review produced two main outputs:

- a detailed summary of the quantitative evidence and references

- a systems map showing the connections between aspects of transport and health outcomes (see Appendix A)

Expert consultation augmented and refined the evidence review

The outputs of the literature review were then used to frame interviews with thirteen leading transport and health experts identified by the team to cover the topics under consideration (see Appendix B). These interviews were 30-60 minutes long, conducted on Zoom, and attended by both Nick Cavill and Harry Rutter, and the expert consultee. These discussions were semi-structured and focused on two main tasks:

- 1 Reviewing and updating the systems map, adding in new issues and connections where appropriate. These were added to the map during the interview i.e. in real time (using Kumu mapping software and screen-sharing). In the first part of the discussion, any issue that could be considered to be associated with health outcomes was included, whatever the level of evidence.
- 2 Identifying evidence and data sources that support these transport-health connections, with a focus on quantitative evidence that might be used for an eventual assessment method.

It is important to note that this review did not consider the impacts of the transport system on carbon emissions and climate change more generally, as this issue is covered in other aspects of TfN's modelling. Acknowledging this, the importance of emissions and climate change as having an effect on health and wellbeing was highlighted through the consultation process.

Chapter 3 of the report provides a summary of the evidence reviewed during this first part of the work. As that chapter shows, not all evidence was considered robust enough to support further quantitative assessment.

2.2 Impact framework (Chapter 4)

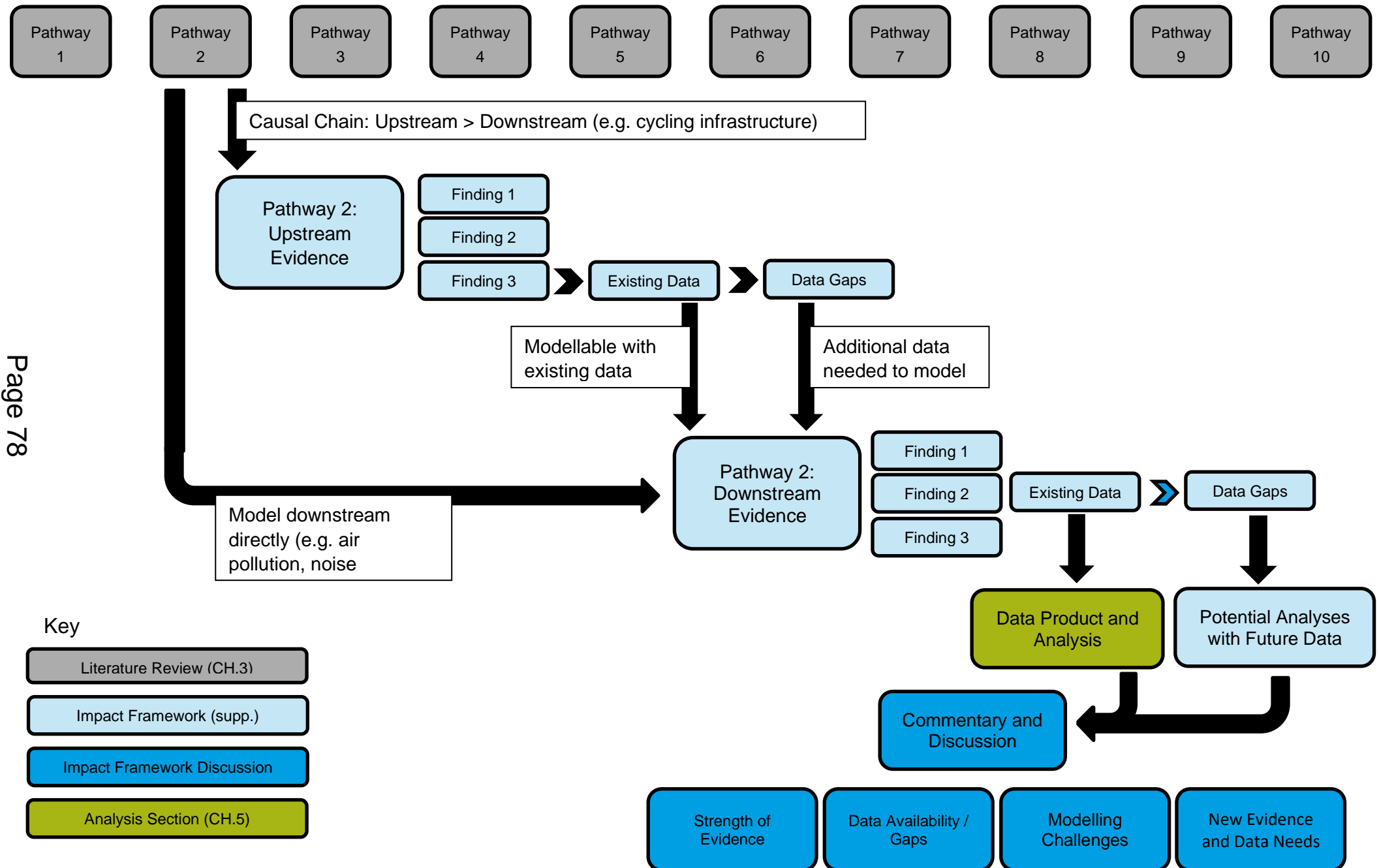
The impact framework uses the evidence base in a way that seeks to establish relevant causal links

While the focus of the evidence review was on what the available literature has to say about the links between transport and health/wellbeing, it is not necessarily the case that this leads immediately to a framework with which to assess the impacts of transport on health and wellbeing.

The purpose of the next step was to develop an impact framework that could operationalise the evidence in a way that could reasonably inform quantitative assessments for TfN's purposes. The focus was to develop the causal chains and evidence in a way that could more clearly establish an impact logic.

The starting point was the evidence base and thinking from the first phase, with the impact framework then assembled by situating that evidence in a causal chain with upstream (causes) and downstream (impacts) effects. From this, we could then consider the data requirements to assess these impacts. Comparisons to the availability of (good quality / appropriate) data then informed the final set of feasible impacts, with commentary/discussion about data gaps that might need to be filled to make other aspects of the impact framework viable.

Figure 2.1: Flow Chart from Evidence to Impact Framework



For each impact, the final impact framework consists of:

- an explanation of the impact logic, extending the causal chains from the evidence (by Chapter 3) and distinguishing upstream from downstream effects
- identification of data requirements to fill the impact framework, alongside an assessment of the extent to which the available data (as part of a data review) support such analysis
- discussion of challenges and data gaps for aspects of the impact framework that cannot (yet) be deployed

Chapter 4 sets out the impact framework with various tables that identify the effects and data requirements/availability. An accompanying spreadsheet consolidates this information, with further technical detail for reference.

2.3 Analysis (Chapter 5)

We also present the results of analysis that makes use of the impact framework

Having stepped through from evidence base to an impact framework, Chapter 5 of this report presents the results of applying that framework.

The principal outputs of this final part of the work are a set of datasets (GIS data layers / shapefiles) to inform future analyses of transport and health/wellbeing. As a demonstration of the approach, Chapter 5 presents elements of the GIS layers to show how they can be used to assess transport-related health and wellbeing effects across the North.

Details of each piece of analysis are covered in Chapter 5 but the general approach has been to:

- 1 use the evidence and available data to construct estimates of the 'footprint' (spatial distribution) of a health/wellbeing effect e.g. the health risks associated with certain air pollutants and how those risks vary across the North according to pollutant concentration
- 2 overlay this footprint of effects on to some spatial representation of the population that might be affected, to estimate the overall impacts

By making this distinction between *where the effects are*, and *how they have impacts on the population of the North*, the goal was to make, for example, the distinction between high-pollution zones with relatively small resident populations (high risk but low impact/burden) from medium-pollution zones but with very many people living there (medium risk but high impact/burden due to the number of people affected).

We note in some cases that certain kinds of effect can only be reasonably considered in certain parts of the North e.g. in cases in which the underlying literature only concerns cities, or certain impacts (e.g. of green space) in which largely rural areas may be saturated. In such situations we narrow the analysis to more meaningful areas/units of interest.

3 Evidence review

This chapter assesses the evidence on links between transport and health/wellbeing

This chapter summarises the findings from the evidence review of the connections between key aspects of transport and health outcomes. These are presented below on an impact-by-impact basis. This exercise also produced a system map connecting the various causes and effects across the piece. This can be found in Appendix A.

The evidence review focused on ten impacts, which were originally identified and assessed in earlier work by TfN. This original list set the constraints of the review and, while the expert consultation did identify other impacts, none of these additional effects were deemed to be supported by sufficient quantitative evidence to warrant extending the list from the original ten.

The results below summarise the findings from the literature review and expert interviews. They also incorporate helpful comments received from TfN colleagues and wider stakeholders on an earlier draft.

The results that follow are presented in priority order, according to the importance and scale of the health impacts for each topic, as well as the extent of evidence and availability of data for quantitative modelling purposes. This is also based on wider evidence of the health impacts of transport: for example Woodcock *et al.* (2013) found in their modelling study that ‘the pathways that produced the largest benefits were, in order, physical activity, road traffic injuries, and air pollution’.

The review identified three tiers of evidence that vary according to robustness of the quantitative findings and their amenability for further analysis

The prioritisation also divides the impacts into three tiers of evidence, that reflect the extent to the various impacts might be amenable to quantitative assessment and modelling. The three tiers, in descending order of amenability are:

- 1 Evidence from the literature and expert interviews is supported by sufficient quantitative data and robust analysis for it to be possible to characterise the identified relations with high levels of confidence (four impacts).
- 2 Evidence from the literature and expert interviews is supported by sufficient quantitative data to estimate the strength of the relationship. However, either the data were insufficiently comprehensive, or econometric results were not strong enough, for this to be characterised as a robust result (three impacts).
- 3 Evidence from the literature review and expert interviews provides insight as to the direction, approximate scale, and nature of the relationship between two or more variables; however no attempt to quantify this has yet been made (three impacts).

Table 3.1 summarises these tiers and the various impacts.

This part of the assessment only considered the quantitative evidence for relationships between transport and health/wellbeing as presented in the literature i.e., on its own terms. As such, the feasibility of translating the evidence into a useable set of causal chains and numerical values still depends on the availability of the necessary data for the North.

Table 3.1: Summary of evidence

Tier	Impact	Considerations	Main source(s) of evidence
1	Physical inactivity	Converting active travel into volume of physical activity Cycling and walking are directly correlated with all-cause mortality, when controlled for leisure time physical activity Detailed data on active mode networks	Kelly <i>et al.</i> (2014) Zheng <i>et al.</i> (2009) Goodman <i>et al.</i> (2014) Sallis <i>et al.</i> (2016)
	Incidents and safety	Measuring speed and volume of traffic Developing a multi-coefficient model for more accurate prediction (or using a single coefficient model with more limited power to explain)	Hussain <i>et al.</i> (2019) Roshandel <i>et al.</i> (2015)
	Air pollution	Measurements e.g. particulate matter, nitrogen oxides Isolating the emissions arising from traffic	Hoek <i>et al.</i> (2013) Requia <i>et al.</i> (2018)
	Limited access to green space, recreation and leisure	Modelling access, rather than proximity Translating access to use Measuring quality	Twohig-Bennett and Jones (2018) Houlden <i>et al.</i> (2018) Astell-Burt <i>et al.</i> (2014)
2	Noise pollution	Identifying the nature and distribution of exposure Upstream modelling: Forecasting noise	Münzel, Sørensen <i>et al.</i> (2018) Babisch (2014) van Kempen and Babisch (2012) Seidler <i>et al.</i> (2017)
	Severance	Quantifying severance Translating lost connections into health outcomes Quantifying severity of barriers such as roads based on their characteristics	Anciaes (2013)
	User experience	Quantifying active travel and public transport use	Kelly <i>et al.</i> (2017)
3	Limited access to healthcare facilities	Lack of evidence linking transport access and health outcomes	-
	Limited access to high-quality employment	Lack of evidence linking transport access and employment	-
	Environment quality	Lack of evidence linking transport access and environment quality	-

Note(s): Tier 1 - Evidence from the literature and expert interviews is supported by sufficient quantitative data and robust analysis for it to be possible to characterise the identified relations with high levels of confidence.

Tier 2 - Evidence from the literature and expert interviews is supported by sufficient quantitative data to estimate the strength of the relationship. However, either the data were insufficiently comprehensive, or econometric results were not strong enough, for this to be characterised as a robust result.

Tier 3 - Evidence from the literature review and expert interviews provides insight as to the direction, approximate scale, and nature of the relationship between two or more variables; however no attempt to quantify this has yet been made.

Expert consultations

Before presenting the summaries by individual impact, we first summarise more general feedback by consultees, which augmented the exercise below. A summary of points discussed by interviewee can be found in Appendix B. A few points of note:

- Internal reviewers (i.e. contacts of TfN, not the consulted experts) raised a number of very pertinent issues regarding additional evidence for the health impacts of transport. Where possible they have been considered here but many of these were supported only by single studies rather than review-level evidence, so have not been included.
- A number of consultees were uncomfortable with producing a system map of transport and health without considering the impact on carbon emissions and climate change (which do of course have very important health impacts). It is understood however that TfN addresses carbon impacts in other parts of its transport models.
- A similar issue arose with biodiversity: road transport is likely to be associated with reductions in biodiversity both as more land is taken up by roads and through surface contamination, run-off, and other forms of pollution. This will have long-term negative health impacts.
- One consultee thought it was inappropriate to separate out access to employment and healthcare and not to also include access to education. Travel to school has different patterns and determinants to other forms of travel; has a great deal of policy focus; and is likely to influence future travel patterns.
- One consultee had been co-author of a high quality review of 'Fourteen pathways between urban transportation and health'. This provided a valuable cross-check to the issues raised in this review. It did however raise some additional topics that may influence health:
 - urban heat islands: this is seen to be currently an issue of low importance in the UK (but may become increasingly important as the climate changes)
 - greenhouse gases: see above comment
 - contamination: this may be an issue worthy of consideration and relates to chemicals and pollutants that can be found on roadway surfaces due to motor vehicle traffic, as a result of road surface, brake, and tire wear – these chemicals and pollutants can contaminate water sources, soils, and air, which pose significant threats to humans and the environment. The consultation highlighted this issue's importance, leading to its inclusion in the system map, but there is currently insufficient evidence to allow it to be quantified and therefore included in the final impact framework.
- It was particularly encouraging that Dr Francesca Racioppi described a hierarchy that was almost identical to Table 3.1 (without having seen this draft report). She has been working closely on the WHO HEAT tool for over ten years, along with other economic models (see Appendix C) (World Health Organization, 2022). The HEAT covers physical activity, road traffic injuries, air quality and carbon. She considered the next 'candidates' for inclusion in the HEAT to be green space and traffic noise.

3.1 Physical inactivity

For physical activity, there is solid evidence on the health benefits of walking and cycling

There is a strong evidence base on the health benefits of physical activity. In adults, there is robust evidence to demonstrate the protective effect of physical activity on a range of chronic conditions, including coronary heart disease, obesity and type 2 diabetes, breast and colon cancer, mental health problems, and other health-related issues including social isolation and risk of falls (Department of Health and Social Care, 2019).

High levels of car use are linked with lower levels of physical activity and higher rates of obesity, especially where car use replaces short walking journeys. Walking and cycling for transport provides sufficient health benefits to achieve recommended physical activity levels in most people: for adults, 150 minutes per week of moderate intensity physical activity (MPA) or 75 minutes of vigorous intensity physical activity (VPA), for children and young people, at least 60 minutes of moderate-to-vigorous physical activity (MVPA) per day across the week (Department of Health and Social Care, 2019).

Incorporating physical activity into daily life – primarily through walking and cycling as transport (in contrast to promoting deliberate exercise or sport) – has been consistently recommended as a public health strategy and has been shown to be an effective intervention, recommended by NICE (National Institute for Health and Care Excellence) (2012). Infrastructure for cycling and walking has been shown to be associated with reduced health inequalities (National Institute for Health Research, 2022). A 2014 study evaluating the impacts of a newly-built walking and cycling path in the UK found that proximity to the path was associated with more minutes of physical activity per week (Goodman *et al.*, 2014).

Additionally, access to parks, especially within urban contexts, has a relationship to physical activity. A 2016 study of individuals across 14 different global cities found that the density of parks near residences in urban areas is linearly associated with an increase in daily minutes of moderate to vigorous physical activity (Sallis *et al.*, 2016).

Robust evidence for the quantitative relationship between physical activity and mortality is provided by Kelly *et al.* (2014). Most helpfully, this focuses specifically on walking and cycling, and controls for other forms of physical activity. This means that (in theory at least) their analysis isolates the contribution of walking and cycling to decreased mortality, making the evidence particularly useful for modelling. The study was conducted specifically to provide quantitative input to the World Health Organization's (WHO's) Health Economic Assessment Tool (HEAT) for walking and cycling (World Health Organization, 2022). Kelly *et al.* (2014) report that, for a standardised dose of 11.25 metabolic equivalent of task (MET)² hours per week (or 675 MET minutes per week), the reduction in risk for all-cause mortality was:

- 11% (95% CI: 4-17%) for walking

² The amount of energy expended in a task relative to sitting at rest, which has an MET of 1. Moderate intensity cycling as an MET of approximately 8, so uses 8 times the energy of sitting at rest. Walking at normal speed on a level surface has an MET of around 3.5

- 10% (95% CI: 6-13%) for cycling

3.2 Incidents and safety

Road traffic injuries are context-specific, with the clearest relationship being to traffic speed

The WHO reports that, every year, the lives of approximately 1.3m people are cut short globally as a result of a road traffic crash. Between 20m and 50m more people suffer non-fatal injuries, with many incurring a disability as a result of their injury (World Health Organization 2021).

Road traffic injuries cause considerable economic losses to individuals, their families, and to nations as a whole. These losses arise from the cost of treatment as well as lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured. Road traffic incidents cost most countries 3% of their GDP each year (World Health Organization, 2021a).

There is a wide variety of quantitative evidence to describe the nature, prevalence, and severity of road traffic injuries. For example Ang *et al.* (2017) report that 14% of older adults suffer from a road traffic incident, with mortality rates highest among the very elderly adults aged 74 years and above, and pedestrians. Risk to pedestrians is underlined by Charters *et al.* (2017) who report that pedestrians account for a high proportion of overall road traffic fatalities in high-income countries, with pedestrians admitted to hospital twice as likely to die of their injuries than vehicle occupants. There are significant inequalities in road traffic injuries in the UK with children and people from more deprived neighbourhoods disproportionately affected: The Killed or Seriously Injured (KSI) rate per 100,000 population for pedestrians aged 10-14 is approximately 2.6x higher in the most deprived quintile than in the least deprived (30 and 11 respectively). For pedestrians aged 5-9, the most deprived KSI rate is 6x higher than the least deprived rate (18.6 and 3.3 respectively). Among cyclists aged 10 to 14, the KSI rate between 2012-16 was 7.0 KSI in the most deprived quintile of areas compared to 4.2 in the least deprived (public Health England, 2018b).

Some areas of the UK have adopted the Vision Zero approach to road safety (Transport for London, 2021). This approach is common in much of Europe and involves encouraging safe behaviours and designing vehicle and infrastructure to reduce risks.

It is important to note that the risk of a road traffic crash is highly context-specific, making an input into modelling quite challenging. Multiple factors such as collision speed, speed difference, traffic volume and density predict the probability of a collision taking place (Roshandel *et al.*, 2015).

3.3 Air pollution

Air pollution is a major risk factor for premature mortality

In the WHO global burden of disease study, air pollution was ranked fourth as a risk factor for premature mortality, exceeded only by hypertension, smoking and dietary risks. Among environmental risk factors, ambient air pollution was the most important cause of disease, leading to more than 4m premature deaths and more than 100m disability-adjusted life years lost annually worldwide. In 2021, at the launch of new WHO global air quality guidelines, air pollution was called 'one of the biggest environmental threats to human health, alongside climate change' (World Health Organization, 2021b).

Transport-related air pollution contributes to an increased risk of death, particularly from cardiopulmonary causes, with significant social inequalities in the distribution of the impacts (Barnes *et al.*, 2019). It increases the risk of respiratory symptoms and diseases that are not related to allergies. While only a few studies have been conducted on the effects of transport-related air pollution on cardiovascular morbidity, they report a significant increase in the risk of myocardial infarction (heart attack) following exposure. Other studies and the experimental evidence indicate that exposure results in changes in autonomic nervous system regulation and increased inflammatory responses. The WHO International Agency for Research on Cancer has concluded that there is sufficient evidence that outdoor air pollution, including particulates, causes lung cancer to be classified as a carcinogen (Krzyzanowski *et al.*, 2005; IARC, 2013). Of particular concern is exposure to particulates, notably PM_{2.5} and PM₁₀³, especially in areas of housing or schools near busy roads.⁴

Particulates and nitrogen dioxide have the highest health risks

Quantitative evidence is provided by a number of reviews of epidemiological studies. Hoek *et al.* (2013) reports an excess risk per 10 µg/m³ increase in PM_{2.5} exposure of 6% (95% CI 4-8%) for all-cause and 11% (95% CI 5-16%) for cardiovascular mortality. Long-term exposure to PM_{2.5} was more associated with mortality from cardiovascular disease (particularly ischemic heart disease) than from non-malignant respiratory diseases (pooled estimate 3% (95% CI -6-13%).

Requia *et al.* (2018) report that people aged 65+ showed the highest mortality risk for PM₁₀, whereas the youngest age group demonstrated the highest risk for ozone (O₃). There are no studies reporting association between children (aged <5 years) and the pollutants PM_{2.5} and SO₂.

Hoek *et al.* (2013) found respiratory diseases to show the highest risk for:

- PM₁₀ (1.3%; 95% CI: 0.9-1.7%)
- PM_{2.5} (2.7%; 95% CI: 0.9-7.7%)
- O₃ (0.8%; 95% CI = 0.2%, 2.3%)

whereas cardiovascular diseases demonstrated highest risk for:

- SO₂ (1.1%; 95% CI: 0.8-1.6%)
- NO₂ (1.6%; 95% CI: 1.2-2.2%)

3.4 Limited access to green space, recreation and leisure

Evidence suggests that green space confers numerous health benefits

There is a strong and growing evidence base in support of the health benefits of green space. One direct pathway to health benefits comes from the extent to which natural and green areas promote health due to the opportunities for physical activity. In addition, there is evidence that exercising in a green environment may provide additional health benefits compared to exercising in an indoor gym environment. Public green spaces have also been associated with social interaction, which can contribute towards improved well-being, notably through improved mental health. Other benefits may come from

³ The subscripts of 2.5 and 10 refer to the fineness of these particulate matters – their diameters in micrometres (0.001 millimetres).

⁴ And this is in addition to any other effects of road transport in such areas, including perceptions of safety and risks of social exclusion/isolation.

exposure to sunlight (thought to counteract seasonal affective disorder, and by providing vitamin D); and exposure to a range of micro-organisms, including bacteria, protozoa and helminths, which are abundant in nature and may be important for the development of the immune system and for regulation of inflammatory responses.

Access to green space can be measured as either the proportion of green space within a certain distance of one's place of residence or as the number of parks or green spaces accessible nearby.

Quantitative evidence for the association between green space and health outcomes comes from a recent high-quality systematic review and meta-analysis (Twohig-Bennett and Jones, 2018). This provides strong evidence for a range of health outcomes due to green space exposure notably reduced risks of:

- all-cause mortality: 0.69 (95% CI: 0.55-0.87)
- type 2 diabetes: 0.72 (95% CI: 0.61-0.85)
- cardiovascular mortality: 0.84 (95% CI: 0.76-0.93)

as well as a range of cardiovascular and other risk factors.

A 2019 study from Australia found that the proportion of green space within a 1-mile (1.6-km) radius of one's place of residence is associated with significantly reduced risk of psychosocial distress (Astell-Burt & Fend, 2019). This same study also found that the proportion of tree canopy cover (a subset of green space) within a 1-mile radius of place of residence is associated with a lower risk of self-reporting fair or poor general health on a survey (*ibid*).

Additionally, a study in London found that living within 300m of green space has statistically significant wellbeing impacts. These are measured in 'Happiness', 'Life satisfaction' and 'Sense of worth', and depend on the area of accessible green space (Houlden *et al.*, 2018).

This strong evidence for the association between green space exposure and health outcomes can be used for modelling purposes if the challenge is overcome of finding measures for green space exposure and use that can be related to transport interventions (rather than simply green space proximity). We were unable to find such evidence, but we did find data that would support such analysis if the evidence were to be found (see Section 4.4 and the supplementary impact framework tables)

3.5 Noise pollution

Noise generates stress which can lead to both physical and mental ill-health

Traffic noise exposure is linked to cardiovascular diseases such as arterial hypertension, myocardial infarction, and stroke. Chronic low levels of noise can cause disturbances of activity, sleep, and communication, which can trigger a number of emotional responses, including annoyance and subsequent stress. In turn, chronic stress is associated with cardiovascular risk factors such as increased blood pressure and dyslipidaemia⁵, increased blood viscosity and blood glucose, and activation of blood clotting factors.

⁵ A broad term describing a number of conditions in which disturbances in fat metabolism lead to changes in the concentrations of lipids (e.g. triglycerides, cholesterol and/or fat phospholipids) in the blood and which is a risk factor for the development of cardiovascular disease.

Persistent chronic noise exposure increases the risk of cardiometabolic diseases, including arterial hypertension, coronary artery disease, diabetes mellitus type 2, and stroke (Münzel, Sørensen *et al.*, 2018).

Quantitative evidence is provided by a range of sources, many of which were associated with the 2018 WHO noise guidelines. Babisch (2018), in a meta-analysis on the relationship between road traffic noise and coronary heart disease, found that the risk of coronary heart disease increased by 8% for each additional increment of 10 decibels (dB) of road traffic noise between 55dB and 75dB. A similar meta-analysis on the relationship between road traffic noise and hypertension found the risk of hypertension increase by 3.4% for each additional 5dB of road traffic noise between 45dB to 75dB (van Kempen & Babisch, 2012). A 2017 study with data from Germany found a relationship between both road and rail traffic noise and depression, with the relationship being linear for road traffic noise and u-shaped for rail traffic noise, likely because of the small subset of sample households exposed to higher levels of rail traffic noise (Seidler *et al.*, 2017).

3.6 Severance

While the relationship between transport and severance is recognised, evidence on the precise health effects is less clear

Community severance occurs where speed and volume of road traffic inhibit access to goods, services, or people. This can occur directly (i.e. through an inability to cross busy roads) or due to reduced perceptions of safety. There is evidence that strong social networks are associated with healthy behaviours and improved health, with high levels of social integration associated with reduced mortality (with an effect size of similar magnitude to stopping smoking) (Mindell and Karlsen, 2012). However, the evidence for a direct quantifiable relationship between transport-related severance and outcomes in terms of either health or social networks has not been established. Vaughan *et al.* (2020) state that “Many publications assert that community severance affects health; while plausible, no study has examined this explicitly”. Mindell and Karlsen (2012) provide an excellent overview of the topic, concluding that ‘there is empirical evidence that traffic speed and volume reduces physical activity, social contacts, children’s play, and access to goods and services. However, no studies have investigated mental or physical health outcomes in relation to community severance. While not designed specifically to do so, recent developments in road design may also ameliorate community severance.’

There is little or no quantitative evidence to describe the relationship between severance and health outcomes. However, Anciaes *et al.* (2016) provide an interesting overview of how to value severance, which may be useful for modelling purposes. This includes ideas for measures of severance including ‘crossability’: how easy it is to cross a barrier (such as a road)?; ‘walkability’: Does the barrier reduce the ability to walk around an area?; ‘accessibility’: Does the barrier prevent people from reaching certain destinations?; and ‘quality’: Does the barrier reduce the quality of the walking experience?.

3.7 User experience

The evidence emphasises differences in experience by mode...

The primary function of transport is to reach a destination. However, the experience of the journey can differ between modes of transport: people in cars; on buses; or walking and cycling experience the same journey quite differently. There is good evidence linking travel mode choice to mental health and subjective wellbeing, particularly in the case of journeys for work, with car travel shown to be a significant contributor to user stress and anxiety, compared to active travel or public transport use. Shorter travel times in general improve wellbeing, with commutes lasting between 60 and 90 minutes having the biggest negative impact on wellbeing (Office for National Statistics, 2014).

The strongest quantitative evidence was found between active travel (walking and cycling) and psychological wellbeing. Martin *et al.* (2014) found significant associations between overall psychological wellbeing and:

- 1 active travel (0.185; 95% CI: 0.048-0.321) and public transport (0.195; 95% CI: 0.035-0.355) when compared to car travel
- 2 time spent (per 10-minute change) walking (0.083; 95% CI: 0.003-0.163) and driving (-0.033; 95% CI: -0.064 to -0.001)
- 3 switching from car travel to active travel (0.479; 95% CI: 0.199-0.758)

...but some conflict about a statistically significant relationship with depression

However, ascribing an economic value to overall psychological wellbeing is challenging. Incidence of depression is more amenable to valuation (as it is associated with high financial burden to the NHS and society) but quantitative evidence for an association with transport is conflicting: Marques *et al.* (2020) found two studies that related active travel to depression but five studies that found no significant association.

3.8 Limited access to healthcare facilities

Research has tended to focus on healthcare access, rather than outcomes

Variations in access to health services are clearly likely to be associated with health outcomes, particularly access to GPs, pharmacies, and hospitals. A number of studies explore variations in access to healthcare, but these are usually based on the assumption that this is associated with health outcomes i.e., the positive benefit is taken as given, rather than examined/quantified. Direct review-level evidence is rare: one review explored rates of heart disease and stroke mortality related to geographical location of healthcare services (in the USA) and found unequal access and unequal health outcomes for many priority populations (by ethnic origin; gender and geographical region). It is unclear if this can be applied to the UK's health system. Access to healthcare (and other services) is also likely to be related to socioeconomic status, especially due to socioeconomic patterning of car ownership (half of all people in the lowest income quintile do not have access to a car).

3.9 Limited access to high-quality employment

Similarly, employment is understood as beneficial for health but the link from transport to health is little explored

Access to high-quality employment raises similar issues to access to healthcare: there is evidence from a wide range of sources (including systematic reviews) that links employment to positive health outcomes. For example, van der Noordt *et al.* (2014) conclude that 'employment is beneficial for health, particularly for depression and general mental health' while Hergenrather *et al.* (2015) state that 'unemployment and job loss were associated with poorer physical health. Employment and re-employment were associated with better physical health.' Other studies investigate links between the transport system and access to employment, reporting socioeconomic inequalities in access. However, there are no reviews that look at the direct quantitative relations between transport-related access to employment and health outcomes.

3.10 Environment quality

Intuitively, environment quality should have some bearing on health and wellbeing, but the literature remains quite sparse

It could reasonably be assumed that the nature and quality of the built environment has an influence on health through a number of mechanisms, notably: improvements to mental health and wellbeing (as discussed in the green space section); loss of green space due to road (and car park) building; providing environments for social interaction; or enabling active travel. It is only the last of these aspects that has been studied extensively: there is strong evidence for the influence that the nature of the built and natural environment has on rates of walking and cycling. For example, Van Cauwenberg (2011) shows the impact on walking and cycling of a wide range of factors including: walkability; residential density; land-use mix; presence of shops; access to services; walking and cycling facilities. However, there is no review that relates these components to quantifiable health outcomes.

4 Impact framework

This section sets out the approach to operationalising the evidence from the previous chapter. Covering each of the ten impacts in turn, we first outline the main findings of the evidence, and to which health outcomes they pertain, then include a discussion on how these may be used in modelling, the methodological and operational challenges and considerations in doing so, and the data requirements and data gaps that a modeller would face.

For the impacts that we have modelled in Chapter 5, we outline the reasons for our choices here: why we favoured using particular parts of the evidence to exemplify analysis over others. Often this is linked to data availability but in some cases, relates to selecting evidence that better conveys a range of approaches. For the impacts that we did not model we outline the evidence and/or data gaps that prevented this.

4.1 Physical inactivity

Physical activity is beneficial for health and fitness

The evidence is comprehensive and strongly supportive of physical activity being beneficial for health. Limited opportunities to engage in physical activity as a consequence of transport impediments is therefore an area that planning policy can add value by addressing.

The impact framework table for physical inactivity is shown as a sheet in the supplementary workbook, and summarises the evidence on impacts from the literature distinguishing, respectively, upstream causes (here, factors that influence the amount of physical activity people engage in, or their likelihood of engaging) from downstream impacts (the health outcomes of physical activity). The tables also summarise the data that would be needed to model these impacts ('Data requirements') alongside our assessment of which data are currently available for the current purpose ('Available data'). Within the evidence shown, there are systematic reviews which cite multiple studies and coefficients that could be used for modelling.

There is strong evidence of physical activity's beneficial effects on a range of health outcomes

Physical inactivity is judged to have Tier 1 evidence by our assessment framework (from Chapter 3). As is apparent from the supplementary impact framework table, there is strong evidence of physical activity's positive effects on mortality, obesity, fitness, and cardiovascular risk factors. The upstream evidence for physical activity is of three main types: proximity – or in some cases access – to infrastructure or places where physical activity takes place, such as green space or cycling tracks; the qualities of such infrastructure, such as safety and comfort; and interventions to encourage use, such as bike-share programs. The downstream evidence could be described as quantifying the numerous health benefits that come about as a direct effect of exercise.

Modelling is a two-stage approach with upstream causes and downstream outcomes

The approach to modelling impacts of interventions to encourage physical activity depends on the intervention but in most cases should include:

For the upstream:

- A buffer zone around the intervention. This buffer zone may be a simple straight-line boundary (Sallis *et al.*, 2016), or may require modelling of

access to the infrastructure via roads or footpaths (Goodman *et al.*, 2014), or neighbourhoods included in a program (Fuller *et al.*, 2013).

- Incorporating measures of the quality of the intervention, such as safety and comfort.
- Controlling for factors such as existing similar infrastructure. For example, attempting to isolate the health impacts of a stretch of active mode infrastructure without capturing the effects of other nearby infrastructure. (this is not covered in the impact framework)
- Translating the coefficients of likelihood of use, and/or amount of use into a dose to align with the downstream impacts.

For the downstream:

- Selecting health outcomes of interest and determining metrics that both align with the upstream and downstream coefficients and for which there are data.
- Quantifying the impact by calculating the number of residents within the affected zone(s), perhaps tightening the focus by also including prevalence of health conditions of interest in the affected area.

Challenges arise in aligning upstream and downstream coefficients

The evidence is more robust for the downstream effects, with more systematic reviews and clearer dose-response coefficients. While the upstream evidence is amenable to modelling, the challenge lies in aligning the coefficients of the upstream and downstream. For example, an increased number of minutes of physical activity or a proportional increase in physical activity needs to be translated into the metric used for downstream impacts, such as MET hours of cycling. Where outcomes fall into discrete ranges, such as 11.25 MET hours cited in Kelly *et al.* (2014), these ranges may be too wide to capture variation in the upstream effect (a constraint of the available data), meaning the granularity of existing data make it difficult to apply the evidence (which is robust) to the available data. This is mentioned in the analysis in Section 5.1.

Data gaps and challenges

Existing data on cycling infrastructure supports the basics of the upstream approach, but only the Greater Manchester cycling data has sufficient detail to incorporate infrastructure qualities, such as degree of segregation of cycling paths, and this is not to the level of detail cited in the evidence. Data on health outcomes are available from Fingertips and, in some cases ONS, but only go to the level of geographical detail of local authorities. The ideal infrastructure data for modelling the upstream would be similar to the Greater Manchester cycling infrastructure data but cover the whole North of England and would go beyond it in showing degree of safety of the lanes: segregation, smoothness, indications to traffic of separateness, and how far this is enforced. Additional evidence would further focus on people's preferences to use cycling infrastructure based on these qualities.

Additional evidence that either expressed health outcomes in smaller bin widths (the bin width was 11.25 MET. Hours in Kelly *et al.* (2014)) or that incorporated a larger number of coefficients to predict more accurately a larger total amount of physical exercise (so the outcome size was large enough to span several bins) would also improve estimation.

Evidence for analysis

The strongest evidence on the health outcomes of physical activity can be found in:

- Kelly *et al.* (2014): Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship
- Zheng *et al.* (2009): A meta-analysis quantifying the dose-response of walking in reducing coronary heart disease risk
- Mueller *et al.* (2015): A systematic review - health impact assessment of active transportation

All of these studies have high methodological robustness and are amenable to modelling health outcome for a given amount/change in physical activity. However, these are downstream effects. For our analysis in Section 5.1, we also wanted to convey the upstream – the change in physical activity that would result from an environmental stimulus. For this we used:

- Goodman *et al.* (2014): A study measuring increased physical activity following the construction of active mode infrastructure in the UK
- Sallis *et al.* (2016), as cited in the systematic review by Gianfredi *et al.* (2021): A study assessing increased physical activity based on proximity to green space

These are not systematic reviews but have the advantage of quantifying upstream causal drivers of physical activity, which is useful for GIS modelling.

The first paper, Goodman *et al.* (2014), estimates the change in physical activity (walking and cycling) that results from newly-built infrastructure that pedestrians and cyclists can use for transport and leisure travel, and expresses its results in the form of coefficients that are amenable to spatial modelling against existing or planned infrastructure.

The second, Sallis *et al.* (2016), found that the density of parks near residences in urban areas is linearly associated with an increase in moderate to vigorous physical activity (MVPA).

We chose these two papers because of the availability of data and because they effectively convey some different approaches that have broader applicability for similar analysis: proximity to infrastructure and proportion of green space in a neighbourhood.

4.2 Incidents and safety

Road traffic incidents cause huge loss of life worldwide

The literature review cites statistics on how extensive are deaths and injuries globally from road traffic incidents (RTIs). The UK has one of the lowest rates of deaths from RTIs in the developed world. But variations exist between areas and, given the devastating impacts of RTAs, further insight into the causes and how to mitigate them is warranted.

The impact framework table for incidents and safety is shown as a sheet in the supplementary workbook and summarises the upstream and downstream evidence respectively. Here the upstream evidence concerns those factors affecting the risk of an RTI while the downstream evidence concerns the impacts of accidents in terms of mortality (including demographics) and physical and mental health impacts.

Speed, volume, density, and regulations affect crash likelihoods

The upstream evidence in the supplementary impact framework table includes systematic reviews and individual studies. The factors affecting the likelihood of a crash include traffic speed measures, traffic volume, and interventions such as speed cameras and traffic calming regulations. They also include coefficients that connect directly to outcomes, such as: speed increases the likelihood of a *fatal* crash (rather than increases the chances of a crash, combined with a separate coefficient for the chances of mortality from a crash). Downstream impacts in the supplementary impact framework table are not in the form of 'dose-response' coefficients as much as for the other impacts.⁶ They include the prevalence of incidents, baseline mortality rates, the proportion of pedestrians involved, and mental health impacts from crashes.

Crash prediction is complex and should be approached with caution.....

The upstream evidence on this impact includes coefficients on speed, density, and volume. But crash forecasting is complex and more involved than isolated coefficients might suggest. Causal factors in crashes are numerous and arise from factors including behavioural, vehicle-specific, traffic conditions, road geometry, and weather conditions. Of these, behavioural factors are thought to be most important but are least amenable to data collection (Roshandel *et al.*, 2015). Data are readily available on traffic conditions and a focus in the literature has been on which combination of traffic conditions are more crash prone (*ibid*). The traffic-based coefficients cited in this impact framework should therefore be contextualised as 'other things equal', and used to model changes in that upstream variable in isolation rather than as part of a multi-coefficient model with multiple and possibly interacting effects. Such a full prediction model would be more in the realm of specialists and beyond the scope of this work (to consider existing evidence as it might apply to the North).

...further research is needed for a comprehensive approach

Because the risks of road traffic crashes are highly context-specific, forecasting them using available evidence and data with any accuracy is quite challenging. A modeller would first need to be cognisant of the limits of any forecast. They might then proceed by forecasting likelihood of a crash perhaps using isolated upstream coefficients, such as traffic density, and frame estimations in the form of "Were density to reduce by x%, other things equal, we would expect the likelihood of a crash to reduce by y%". A more robust

⁶ That is, where the dependent variable changes by a number of units in response to a change in the independent variable.

approach would be to develop a multivariate crash forecasting model using multiple upstream coefficients, such as traffic speed combined with traffic volume, but further research would be needed to achieve this, as we did not find such a complete model in the evidence. Both approaches should note the previously stated caveats, that crashes are highly context-specific and traffic characteristics are only part of the picture.

With the isolated or a multivariate model, analysis could be done in a given population of traffic and based on upstream coefficients such as traffic characteristics (speed, volume etc). It could in principle forecast crash numbers in a given period. Some of the upstream evidence on traffic regulation, such as speed cameras or traffic calming zones, could enter this model since they affect speed, which is a crash predictor. The model could then forecast health outcomes by multiplying crash likelihood by a scalar such as the rate of mortality or injury, such coefficients being available in, for example, Ang *et al.* (2017) or the rates of mental health impacts, such as those in Craig *et al.* (2016), to estimate likely incidences of injury, mortality, and/or mental health impacts due to RTAs. The evidence from Hussain *et al.* (2019) would could be used here (since it relates to impact speed, which presupposes a crash has already occurred) as a predictor of the *severity* of a crash.

Evidence for analysis

The strongest evidence on incidents and safety can be found in:

- Hussain *et al.* (2019): A systematic review and meta-analysis on the relationship between impact speed and the probability of pedestrian fatality during a vehicle-pedestrian crash
- Charters *et al.* (2017): A systematic review on population incidence of pedestrian traffic injury in high-income countries
- Roshandel *et al.* (2015): A systematic review providing a summary impact of traffic characteristics on crash occurrence

The first two of these are rated as robust and useful. However, the nature of the evidence makes it difficult to relate the estimates to readily available data. For example, we could not obtain data on impact speed which could have been used in the first of these studies or pedestrian patterns which could have been used in the first two of these studies.

We subsequently identified the third study, which reported results relating to traffic volume, which is an input into crash likelihood estimation, though one of many, and not the most important one (which is thought to be behavioural characteristics).

Our approach then, by necessity, was to be more descriptive, and show accident data around traffic volume, to allow visual comparison, rather than demonstrating cause-effect quantification.

Data gaps and challenges

Data exist for traffic volume and speed throughout the UK, but these are point data, rather than area data for specific roads or sections of roads. It is challenging to obtain from these variables such as traffic density (which would

need volume to be combined with space, which is not possible for point data). Data which show the incidence and type incidents for a given area tend to cover fairly broad geographical areas, for example, number of fatal or serious incidents within Liverpool. There are some data at LSOA level, but only for London. We also located more detailed data for Greater Manchester for individual incidents. These are 'point' data – showing the location on a map of individual incidents, as opposed to area data that might show the average number of incidents in an area.

4.3 Air pollution

Air pollution is a major contributor to premature deaths and illnesses

Air pollution is a major contributor to mortality, hospitalisation, and health conditions such as asthma. Of particular danger are fine particulates such as PM_{2.5} and PM₁₀.

The impact framework table for air pollution is shown as a sheet in the supplementary workbook, and summarises the downstream evidence, the health impacts of pollutants. The evidence review did not uncover upstream causal drivers of air pollutants. Subsequent scoping (not being robust enough to be listed in the impact framework) suggests this includes such factors as traffic volume, weather conditions, and topography.

The downstream evidence is detailed and amenable to modelling

The evidence is more extensive, and amenable to modelling because it is in dose-response form, in the downstream impacts in the impact framework table. Here the increased risks of mortality, hospitalisation, or health conditions are expressed for individual pollutants and as continuous coefficients.

Modelling impacts is straightforward for the downstream

The downstream health impacts are well documented and robust, including reviews and epidemiological studies, while spatial data exist for each of the most important pollutants covering the whole UK. A straightforward methodology is to clip these spatial data to areas of interest and overlay onto population data, translating likelihoods of impacts of interest into headcounts i.e. areas in which large number of people coincide with areas of high pollution (health risk). At its most detailed, the approach could use finely-grained population data (well below typical area-based datasets) to account for how populations are distributed around pollutant hotspots. A further refinement might display the prevalence of the health outcomes caused by pollutants in affected populations, such as asthma or cardio-respiratory diseases. The most detailed population data available from TfN is in point form and combining this with the point data on pollutants would shed (detailed) light on the burden of transport-related health impacts.

It would be more challenging to predict the upstream causes of air pollution, for example to assess the effects of a transport intervention on pollution. Our systematic evidence review did not uncover upstream causes, but subsequent searches suggest this is more of a specialist field, where modelling would necessitate controls such as weather, vehicle type, geometry of the area, and thus require data and evidence beyond the scope of this project (but which may be possible in TfN's existing models and other programmes of work).

Data gaps and challenges

Point data on emissions from Defra in vector format are available for all of the pollutants discussed in the supplementary table and have sufficiently detailed coverage to resemble area data when formatted appropriately. But, and as the

principal limitation, these are total emissions (including from non-transport sources) and do not identify the source of these emissions. That is, the available data do not clearly identify which emissions are from transport and which are not. As an alternative, coarser data are available from BEIS which do identify sources of emissions, but these are either in raster files, which do not have the geographical resolution of the aforementioned point data, or in shapefiles which show emissions only from single site sources, such as factories, rather than as emissions covering an area. This would, however, come at a loss of resolution that may not be so desirable given the location-specific nature of air pollutants and the importance of understanding them at a localised level.

Evidence for analysis

The strongest evidence on the health impacts of air pollution can be found in:

- Requia *et al.* (2018): a meta analysis of increased hospitalisation and mortality risks from six pollutants (CO, NO₂, O₃, PM₁₀, PM_{2.5}, and SO₂)
- Hoek *et al.* (2013): a systematic review and meta-analysis of increased risk of cardiovascular and cardio-respiratory diseases from five pollutants (PM₁₀, PM_{2.5}, O₃, SO₂ and NO₂)

Both studies carry out meta-analyses with robust methodologies, expressing the results as dose-response coefficients which are amenable to quantitative analysis. Both studies emphasise especially particulates as a source of heightened health risk.

As well as being robust sources of evidence in themselves, the results are readily combined with available data (from Defra) on modelled point estimates of the above pollutants. These can be directly applied to the evidence above. Given the slightly greater number of pollutants covered, we opt to use the Requia *et al.* (2018) estimates in the analysis in Section 5.3.

Other evidence (mostly about increased mortality) was judged of lower usefulness owing to either weaker methodological rigour (on the evidence side) or a stronger need for source-specific data (e.g. tailpipe emissions).

4.4 Limited access to green space, recreation and leisure

Green space is beneficial for physical and mental health

A number of hypotheses exist for the relationship between health and natural spaces, including the opportunities for physical exercise which, as already noted, provide health benefits, which are increased when exercise is undertaken in natural spaces; through the opportunities for social interaction, which improve wellbeing; through exposure to sunlight and vitamin D; and the 'old friends' hypothesis of exposure to bacteria, protozoa and helminths which boost the immune system and regulate inflammation (Twohig-Bennett & Jones, 2018).

The impact framework table for limited access to green space is shown as a sheet in the supplementary workbook, and summarises the evidence on impacts from the literature distinguishing, respectively, upstream causes

(here, factors that affect access to green space) from downstream impacts (the consequences of changes in access. The tables also summarise the data that would be needed to model these impacts ('Data requirements') alongside our assessment of which data are currently available for the current purpose ('Available data'). Within the evidence shown, there are systematic reviews which cite multiple studies and coefficients that could be used for modelling.

The evidence largely concerns the link between usage and health/wellbeing

As the supplementary impact framework table shows, the downstream impacts of green space are extensive. As a health and wellbeing impact judged to have Tier 1 evidence (by our assessment framework), the stronger associations between green space exposure and health outcomes are suitable for quantitative modelling.

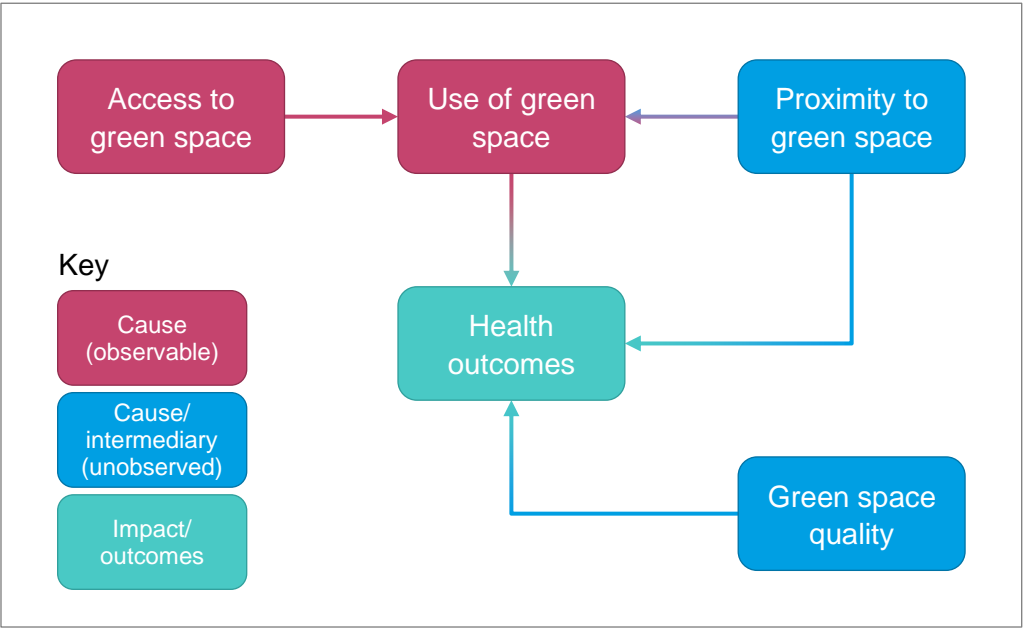
The evidence of health benefits from green space concerns three main channels: health outcomes derived from direct use, i.e. the benefits to people being in that green space; outcomes which are more passive, and which derive from proximity; and outcomes based on quality, such as 'greenness' or improvements to the green space. For transport interventions, which are likely to be more focused on improving access, modelling will mainly focus on benefits resulting from use, which will in turn be a function of access.

In some cases, proximity could serve as a surrogate for usage

The process of modelling the impacts depends on the causal channel (see Figure 4.1). Modelling proximity to health outcomes is simplest and, based on the evidence, can take one of two approaches:

- **Distance to green space:** For those measuring health impacts caused by green space being within a specified range of a dwelling, spatial data on green space combined with spatial data on household characteristics could be used. For example, a boundary representing the distance within which health impacts operate could be mapped around each green space polygon to assess health impacts of residences within that range.
- **Proportion of green space:** Some health outcomes arise due to proportions of nearby green space, for example, a quantified reduction in the risk of diabetes per percentage-point increase in green space within 1km of subjects' residences.

Figure 4.1: Causal chains of green space health impacts



The upstream data from Ordnance Survey on green space, combined with the data TfN provided on households at the MSOA level would in principle support both approaches.

Access could be inferred...

To model outcomes based on use of green space - for example, by using coefficients that show a larger impact of exercising in green space than in a gym – the focus would need to switch to modelling access to green space. This is likely to be a concern in modelling transport interventions. The Ordnance Survey green space spatial data include access points to the green space. This could be combined with TfN data both on major road networks and on household access to cars to get a picture of viable transport links to nearby green space at the household level.

Similarly, data on active mode networks, such as the cycle route network data (e.g. from Sustrans or Transport for Greater Manchester), would permit modelling of households' access to green space either on foot or by bicycle. The impact framework includes coefficients on people's relative likelihoods of walking, cycling, or driving to get to green space which could enrich such analysis.

...but converting this to usage remains challenging

After modelling access, however, a challenge will be in quantifying (or finding ways to proxy) usage. From our data assessment, there is no obvious dataset that measures such usage of green space. By extension, there are also no data on how usage might change in response to a transport or other intervention designed to improve access.

Appropriate quality measures represent a data gap at this time

Modelling quality-based impacts would require data on green space quality (however defined). Measurements used in the literature include the Normalised Difference Vegetation Index (NDVI) and proximity to greening interventions. However, we were unable to find such data as part of this exercise and this represents a data gap that TfN may wish to investigate further in the future.

Other challenges in relating the literature to factors of interest concern:

- finding measures of green space exposure and use that can be related to transport interventions, rather than simply proximity to green space
 - in the literature, such access metrics would ideally cover indicators such as walkable or drivable distance to green space
- the availability of corresponding data on health outcomes at a sufficiently detailed spatial level

Evidence for analysis

The strongest evidence on the health impacts of green space can be found in:

- Twohig-Bennett and Jones (2018): A systematic review and meta-analysis of green space exposure and health outcomes
- Yang (2021): An umbrella review - review of 40 systematic reviews – of green space and human health
- Public Health England (2020): A systematic review on improving access to green space.

There are several more strong pieces of evidence. Yet the challenge is noted in the initial evidence review of modelling, of assessing access to green space. There is also a challenge of translating access into use, for which we could not find any appropriate data.

Given these challenges, and the available data, we considered the options for GIS analysis to be related to proximity to green space (distance to green space) and green space in a neighbourhood (number of parks nearby, for example, or proportion of area that is green space).

The studies that were either in the evidence review or cited in the systematic reviews, and which both covered health outcomes of interest and which were amenable to this type of analysis were:

- Houlden *et al.* (2018): A systematic review of the positive association between green space and life satisfaction
- Astell-Burt *et al.* (2014): A study examining how the proportion of green space within 1 km of residents of an area is associated with diabetes
- Astell-Burt and Feng (2019): A study examining how the amount of green space within 1 km of an area's residents is associated with psychosocial distress

We chose Houlden *et al.* (2018) because it allowed a simple proximity measure to be used, and has the advantage of putting to the test UK and EU guidelines that individuals should have access to a green space within 300m of their home.

We chose the two Astell-Burt studies (2014 and 2019) because they relate to the proportion of nearby green space and because they cover both a well-known physical health outcome and a mental health outcome.

4.5 Noise pollution

Noise pollution can have an array of physical and mental health impacts

Noise pollution arising from traffic has been associated with a range of adverse physical health outcomes, such as hypertension, heart disease, breast cancer, and diabetes.

The impact framework table for noise pollution is shown as a sheet in the supplementary workbook, and summarises the evidence on impacts from the literature. Upstream impacts cover the factors likely to increase noise, whereas downstream impacts cover the effects on health of noise. The upstream table is much more sparsely populated which reflects the greater focus of the literature on the downstream. Upstream causes include volume and speed of local traffic, and proximity to rail lines and air routes, but predicting noise volumes from these is a specialist field – noise propagation modelling, which is a field of acoustics.

Noise beyond a threshold is associated with increasingly adverse health outcomes

The downstream impacts outlined in the supplementary tables all come from systematic reviews. They cover noise exposure from rail, road, and air noise and the aforementioned health impacts. One of the impacts considers the combination of noise from multiple sources. The evidence in this part of the impact framework is strong, with only mental health impacts seeming to still lack a strong body of evidence. The different pieces of evidence mostly share the same independent variable, decibels of noise exposure, and are thus amenable to mapping against data showing the spatial distribution of noise pollution. Most of the coefficients are continuous, describing increasingly adverse health outcomes with rising decibels, but some are discrete.

Modelling health outcomes is relatively straightforward

As with air pollution, the process of modelling impacts is relatively straightforward and would involve clipping spatial data to areas of interest and overlaying onto population data. Decibels can be translated into likelihoods of health outcomes using the coefficients from the impact framework, and population data could be overlaid onto the map to assess where these impacts fall most on the population of the North. The UK government provides data both on spatial mapping of noise, measured in decibels, and noise exposure data, with numbers of people affected by decibel levels of > 55db, > 60db, > 65db etc.

While the focus of the operational impact framework is on the effect that runs from noise (in decibels) to health impacts, we note that predicting the effects of interventions to manage noise would be more challenging e.g. a diversion of traffic intended to reduced traffic volume in noise hotspots. Specialist modelling (perhaps adapted from TfN's existing tools) would be needed to accurately forecast such effects before applying the downstream analysis here.

Aligning timespans of evidence and data is a consideration

The outcomes of this analysis are the heightened risk (i.e. the change in relation to the pre-existing risk). Were there more detailed data on pre-existing risks, it would be possible to see the overall impact on health risks.

We were unable to find data on noise pollution caused by aircraft, only that caused by road and rail. Further data searches could focus on this to be able to utilise some of the coefficients we found in the evidence. Another consideration in modelling noise impacts on health is aligning the timespans covered by the data with those used by researchers in the evidence. For

example, finding data that is the average noise over 24 hours, if that is how the coefficient is measured in the literature.

Evidence for analysis

The strongest evidence on the health impacts of noise pollution can be found in:

- Van Kempen *et al.* (2018): A systematic review and meta-analysis of the effects of environmental noise and Cardiovascular and Metabolic Effects
- Basner and McGuire (2018): A Systematic Review on Environmental Noise and Effects on Sleep
- Munzel *et al.* (2018): A comprehensive review of the effects of noise exposure on oxidative stress and cardiovascular risk

All three pieces provide evidence amenable to modelling, and may be operationalised using the road and rail noise data from the UK government, which is detailed and comprehensive.

Given the broader coverage of health outcomes, and inclusion of coefficients for combined rail and road noise, we decided to use coefficients cited in the Munzel *et al.* (2018) study in the noise pollution analysis in Section 0, to better convey the range of modelling approaches that may be used. Of these, we found Babisch (2014), covering coronary heart disease from road noise; van Kempen *et al.* (2018) and Babisch (2012), covering hypertension from road noise; and Seidler *et al.* (2017), covering depression from road and rail noise, to be most useful in exemplifying the different approaches one might take to modelling noise pollution.

But the other studies are robust and highly amenable to modelling, and with scalable approaches being now demonstrated in the analysis section, could be used in analysis in the same way as we have done for these three studies.

4.6 Severance

Transport infrastructure can sever people from friends and family

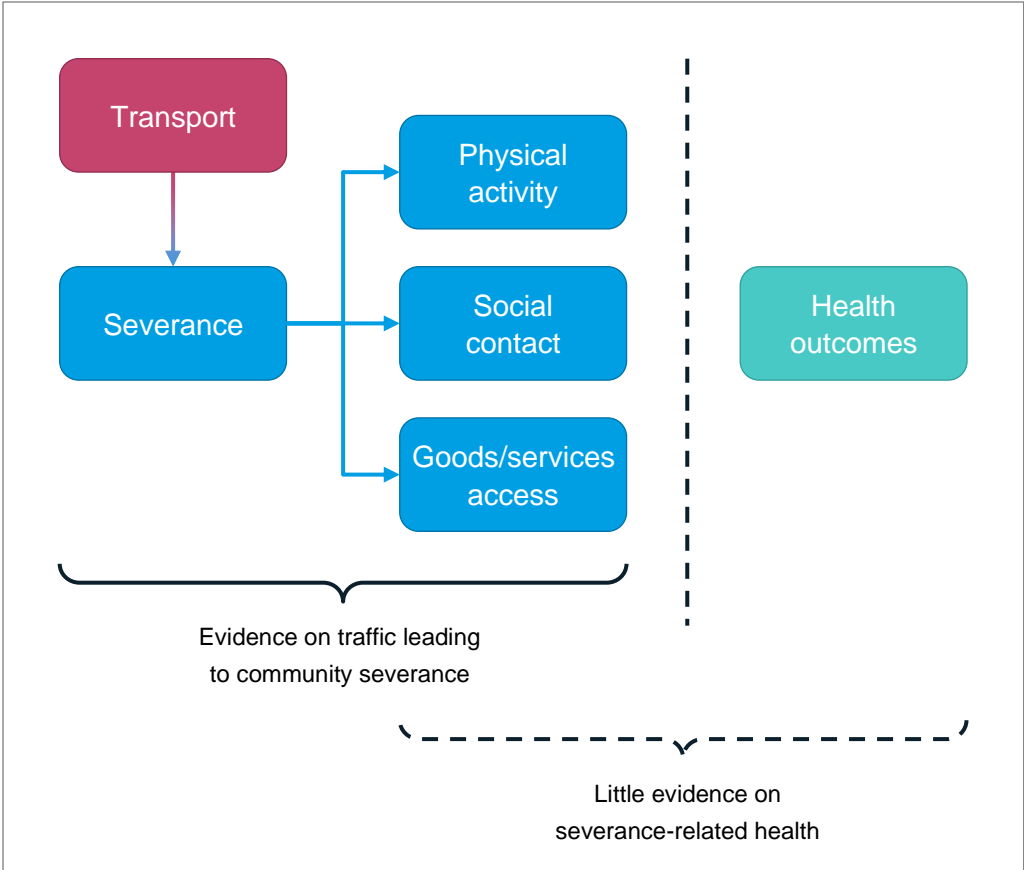
Severance concerns a range of effects and, following Mindell and Karlsen (2012), community severance describes barriers that can impede access to active travel or free movement of people to visit friends and family in their nearby areas. The barriers in question result from transport infrastructure, such as large motorways. Especially for older people or children, such barriers can be very challenging to cross and, if they lie across the routes between people, can disrupt people's social connections.

There is a lack of evidence linking transport to health outcomes due to severance

The impact framework table for severance is shown as a sheet in the supplementary workbook, and summarises, respectively, evidence for the upstream causes and downstream impacts of severance. The upstream coefficients outline the ways that social connections and green space visitation may be affected by walkability, traffic volume, and perceptions of safety. The downstream impacts outline the ways in which social capital or social isolation can affect physical and mental health outcomes.

As an impact with tier 2 evidence by our assessment framework, there is some quantitative information on the effects of severance. However, there are also one or more gaps/limitations that limit the degree to which a robust quantitative assessment can be made. In this case, the problem is one of linking upstream (factors leading to severance) to downstream (health outcomes caused by such severance) (see Figure 4.2).

Figure 4.2: Logic of, and evidence for, health impacts of community severance



The evidence suggests that traffic volume and speed interfere with normal activities while other evidence suggests that reduced access to social contact and goods and services is detrimental to health. The link that has not been formally established (however likely it seems), is between community severance by roads and traffic directly and adversely affecting health and wellbeing in a direct manner (Mindell & Karlsen, 2012).

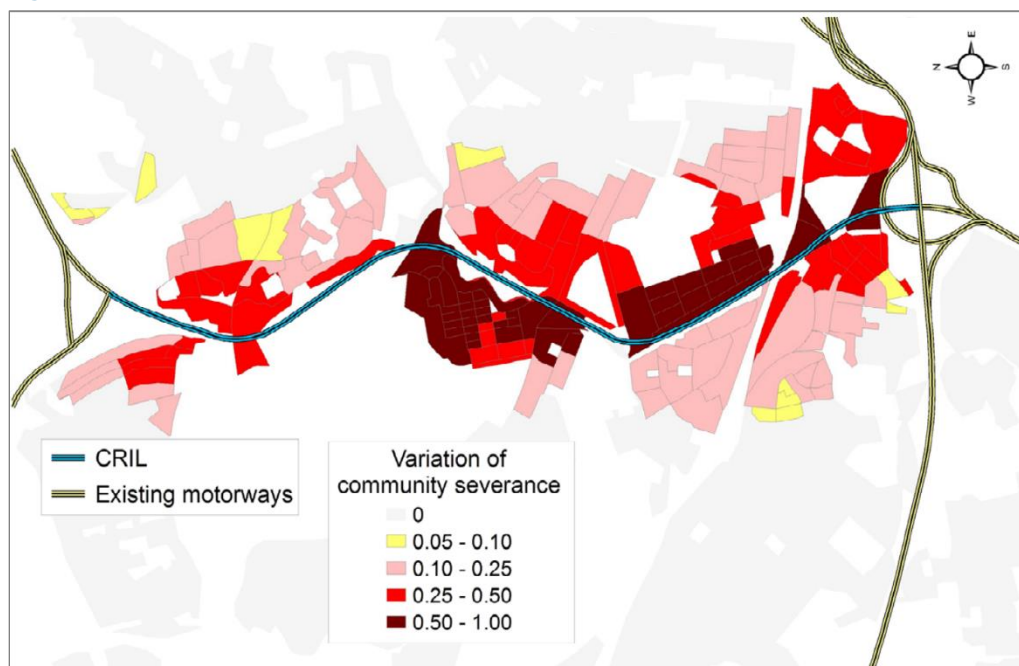
Modelling severance remains a challenge but there may be ways to infer social connectedness

While there is an evidence gap between transport and severance-related health impacts, TfN was keen to explore options for advancing the analysis all the same. One option for doing so would be to follow a method put forward by Anciaes (2013).⁷ In that paper, Anciaes (2013) identifies all potential destinations in walking distance of a neighbourhood, assigning an attractiveness score to each weighted by population. Severance can then be assessed by identifying the destinations that lie beyond (are severed by) a road. Extensions of the method could then adjust for the severity of the barrier e.g. availability of crossing point, traffic speed, traffic volume etc. Carried out on a neighbourhood-by-neighbourhood basis would yield a map such as

⁷ This paper uses the example of a ring road in Lisbon to demonstrate the approach.

Figure 4.3, showing how access to (in principle) walkable destinations may be impeded by a road.

Figure 4.3: Severance effects of a section of road



Source(s): (Anciaes, 2013).

Data gaps and challenges

The challenge of Anciaes's (2013) method is that it requires values for attractiveness (with population proposed as a proxy) and, in principle, methods for (numerically) specifying the severity of a barrier represented by a road. Currently, there seems to be relatively little in the way of evidence with which to derive such values e.g. to feature in a quantitative (maybe even cost-benefit) analysis. This would typically require new research to quantify non-monetary benefits e.g. from stated preference surveys to develop willingness-to-pay metrics.⁸ Also, the problem would still remain of then translating that lost access to physical and mental health outcomes. Linking the outputs of such a method to the literature requires a common unit which is not straightforward or settled, as the supplementary impact framework table shows (in part because of the challenges of measuring the phenomena of interest).

A tentative approach

Nevertheless, and subject to various caveats, the style of analysis put forward by Anciaes (2013) may be possible in a simpler form, based purely on population data.

Using detailed population data (e.g. postcode-level data), and interpreting a postcode as a neighbourhood, it is possible to identify the population in walking distance of said postcode as a group of potential (rather than actual/observed) social connections. If a road passes through this walkable area, the population can then be divided into two, giving a percentage of

⁸ Anciaes (2016) does, however, cite a few other studies that show, for example, that land prices tend to be lower in areas next to elevated railways than areas next to underground ones (Lee and Sohn, 2014); and that land value premiums rose following the tearing down of a freeway and replacing it with a linear park (Kang and Cervero, 2009). However, another study found speed bumps to not significantly affect property prices (Bretherton et al, 2000). There is thus some suggestion of monetisable effects but this was beyond the scope of this current study.

potential social connections severed. Were one willing to interpret these potential social connections as some crude measure of social capital, such higher severance could be thought of as being a risk factor for worse health outcomes.

We apply this method to a test case in Section 5.6, where we also discuss the relative merits in more detail.

Evidence for analysis

A recurring finding in the literature is that community severance cannot yet be effectively quantified. Boniface *et al.* (2015) also find that 'There are relations between severance and both social capital and social cohesion, but no quantifiable relations were identified'.

Nor did the initial evidence review uncover quantitative evidence that is of direct use for modelling. As such, it was not possible to perform analysis for severance in the same way as was done for the preceding impacts.

But, since this is an area of interest, we proceeded with testing an experimental approach outlined in Anciaes (2013), which articulates a methodology that transport planners might seek to develop. This approach was supported by data obtained on population and on local area geographical features (roads, neighbourhoods).

A strong caveat should be noted that this approach is nascent, and would require substantial additional research and development before being ready to be operationalised in a meaningful way.

4.7 User experience

The experience of a mode of travel can have mental health impacts

The experience of travel can differ depending on the mode, and this in turn can affect the traveller's health and wellbeing.

User experience is classed as Tier 2 for its amenability for quantitative modelling, meaning either the data were insufficiently comprehensive, or econometric results were not strong enough, for this to be characterised as a robust result. In this case, evidence is sparse. The distinction between upstream and downstream for the obtained evidence is less clear, with stress shown as both a cause and effect of improved user experience in the system map in Appendix A.

The strongest quantitative evidence was found for active travel (walking and cycling) and psychological wellbeing. Data on mode of travel and wellbeing may be challenging to obtain

The downstream impacts include positive associations between active travel and wellbeing indicators. The strongest quantitative association was found between active travel and psychological wellbeing. Impacts on depression have conflicting evidence: in the systematic review cited, some studies found an effect and others did not, while in another systematic review, the strongest evidence was for effects on depression. Associations between travel by car and wellbeing were negative in one panel study.

The challenges in modelling user experience are manyfold. Firstly, the data we found on model of travel is at a fairly broad geographical level and does not have continuous data on time spent in particular forms, but rather discrete bins of travel time by type. Data on the outcome variables may be available from Fingertips or ONS but metrics such as wellbeing, the outcome for which

the strongest associations were found, may be harder to find, particularly at a fine level of geographical detail.

Data requirements for future analysis

The literature found during the evidence review and the available data did not suggest that this impact would be conducive to modelling at this time: the evidence was weak to moderate in strength and the data on modes of transport was at an overly broad geographical scale.

Were stronger evidence to emerge, data acquisition efforts should focus on access to public transport, on modes of travel at a detailed (LSOA or lower) level, and on time spent in particular modes of travel.

4.8 Limited access to healthcare facilities

Variations in access to healthcare are likely to be associated with varying health outcomes

Variations exist in people's ability to access healthcare services, and this is likely to affect health outcomes. Access to healthcare is classed as tier 3 for its amenability for quantitative modelling, meaning that although evidence may exist, quantification is limited. The impact framework table for limited access to healthcare is shown as a sheet in the supplementary workbook, and summarises the evidence on impacts from the literature. Car availability and public transport provision are the two upstream causes for which we have evidence, but these are single studies, one of which is descriptive and of little use in modelling. These are included more to demonstrate the paucity of evidence than for their usefulness. The downstream evidence covers the differential access to health services and its estimated impact on heart disease and stroke mortality but does not contain usable coefficients.

Evidence and data are limited

Modelling access to healthcare will be challenging. The evidence does not link access to health services with health outcomes. A modeller could make the very reasonable assumption that access improves outcomes but could not quantify this based on the available evidence. Furthermore, modelling access could be challenging. Data is available on access to cars but we found less on public transport provision. Data on access to healthcare services are limited. The upstream evidence has only one quantitative coefficient, and this from a single study. The downstream evidence has none.

Data requirements for future analysis

The literature found during the evidence review and the available data did not suggest that this impact would be conducive to modelling at this time.

The single piece of evidence found was weak and thus not suitable for modelling. We did not find useable data on access to healthcare facilities.

Were stronger evidence to emerge along the lines of the existing evidence, data acquisition should focus on geographically detailed data on access to GP services, including distance, accessibility by different modes of transport, and ease of using the services. To assess differences in accessing services for particular ethnic groups, as in this study, or to compare differences in access along such lines, the population data would need to include information about ethnicity. This is not available at a very detailed geographical level.

4.9 Limited access to high-quality employment

Variations in access to employment are thought to have health outcomes, but this is not quantified

Evidence is insufficient for modelling

The evidence suggests that employment is beneficial for health. And where access to employment is limited by transport, this is a potential policy issue. However, at present, the evidence is insufficient to inform such interventions. Access to employment is classed as Tier 3 for its amenability for quantitative modelling, meaning that although evidence may exist, quantification is limited. Single study results are available for the upstream discussing how access to car or public transport can affect access to employment. While downstream evidence links employment to depression and mental health.

As already noted in the literature review, there are no reviews that look at the direct quantitative relations between transport-related access to employment and health outcomes. Robust, usable coefficients are thus unavailable.

Data requirements for future analysis

The literature found during the evidence review and the available data did not suggest that this impact would be conducive to modelling at this time: the supplementary tables show that evidence found during the review was rejected.

To model access to employment by car or public transport, data would be needed on access to cars, public transport availability, as well as, for a given neighbourhood of interest, the nearest locations of employment, which would include spatial data on business locations, the size of their workforces, and rates of hiring.

This could give a picture of the state of nearby labour markets and the strength of access. However, one should be aware of endogeneity issues in this approach: hiring activity is likely to be influenced by available applicants, and this will be influenced by access, if the hypothesis is correct. So comparisons with areas that have similar economies, but improved access, might be employed to overcome this.

If this were combined with data on unemployment and on the underlying health outcomes these (rejected) papers suggest are linked to employment, then a detailed picture could be drawn of where public transport interventions might have the most impact in increasing employment access and by addressing health problems in doing so.

4.10 Environment quality

There are good reasons to think the built environment affects health and wellbeing but the available evidence does not (currently) support quantification

It is reasonable to assume that features of the built environment, such as walkability residential density; land-use mix; presence of shops; access to services; walking and cycling facilities would influence health outcomes. Yet as noted in the literature review, this has not been quantified. Environment quality is thus classed as Tier 3 for its amenability for quantitative modelling. We did not find upstream evidence for environment quality. Downstream impacts of the built environment concern in particular how it encourages physical activity. This is a separate issue, discussed earlier in this impact framework, and for which plentiful evidence and data exists. But not health outcomes are quantified. Given this, it would not be possible to model health outcomes due to environment quality using currently available evidence.

Data requirements for future analysis

The combination of the evidence uncovered in the systematic review of evidence and the available data did not show itself to be conducive to modelling. The two pieces of evidence were rated as 1 out of 5 for usefulness in modelling. The evidence did not cite quantitative coefficients that one could link to a particular data requirement.

Stronger evidence would be needed on this impact to support modelling and would need to have clear quantitative coefficients to identify a data requirement.

5 Analysis

This chapter presents the analysis and results of the geospatial modelling

This chapter presents the analysis and the results of the geospatial modelling, considering both the upstream and downstream health impacts set out in the previous chapters.

The analysis focuses the six impacts considered feasible for further quantitative analysis:

- 1 physical inactivity
- 2 incidents and safety
- 3 air pollution
- 4 limited access to green space, recreation and leisure
- 5 noise pollution
- 6 severance

In approach, the analysis takes upstream factors identified in the impact framework (where there are suitable data) and applies coefficients from the available evidence to first assess the spatial distribution of health effects e.g. areas in which air pollution is high, translating to heightened health risks. As appropriate, health impacts are then estimated by overlaying the above with data on the spatial distribution of the population. For example, while there may be equally high air pollution in two areas (a similar *effect*), the *impact* will be greater in whichever area has the greater population.

Population impacts for noise pollution, greenspace (wellbeing) and physical inactivity are calculated using the LSOA population in 2019. In cases in which the effects are defined by area, the analysis tries to estimate the portions of the area (and thus population) affected under the assumption of a uniformly distributed population within an LSOA. For air pollution, severance and greenspace (other health outcomes), more detailed postcode-level population impacts are assessed, tied to data ultimately rooted in the 2011 census.

5.1 Physical inactivity

Our analysis of physical inactivity concerns proximity to walking and cycling routes, and parks (for exercise)

In this section, we present our analysis of the impacts of transport infrastructure on the health risk of physical inactivity. This analysis models the upstream segments of the theorised causal chain, linking transport to physical activity (which is itself a determinant of health outcomes, not a health outcome). We had insufficient data to model the downstream impacts because the increases in physical activity associated with walking and cycling routes and urban parks are relatively modest. This increase in physical activity is too modest to link to most health outcomes, which depend on receiving a sufficiently high dose of physical activity to change.

Proximity to walking and cycling paths

A 2014 study of residents in three municipalities of the UK found that living within 1 km of a newly-built mixed walking and cycling route was associated with greater levels of physical activity two years after the route was built (Goodman *et al.*, 2014). Table 5.1 lists the increased average level of

combined walking and cycling activity per resident associated with living near such a development, by distance from the route.

Table 5.1: Increased average walking and cycling activity by proximity to route

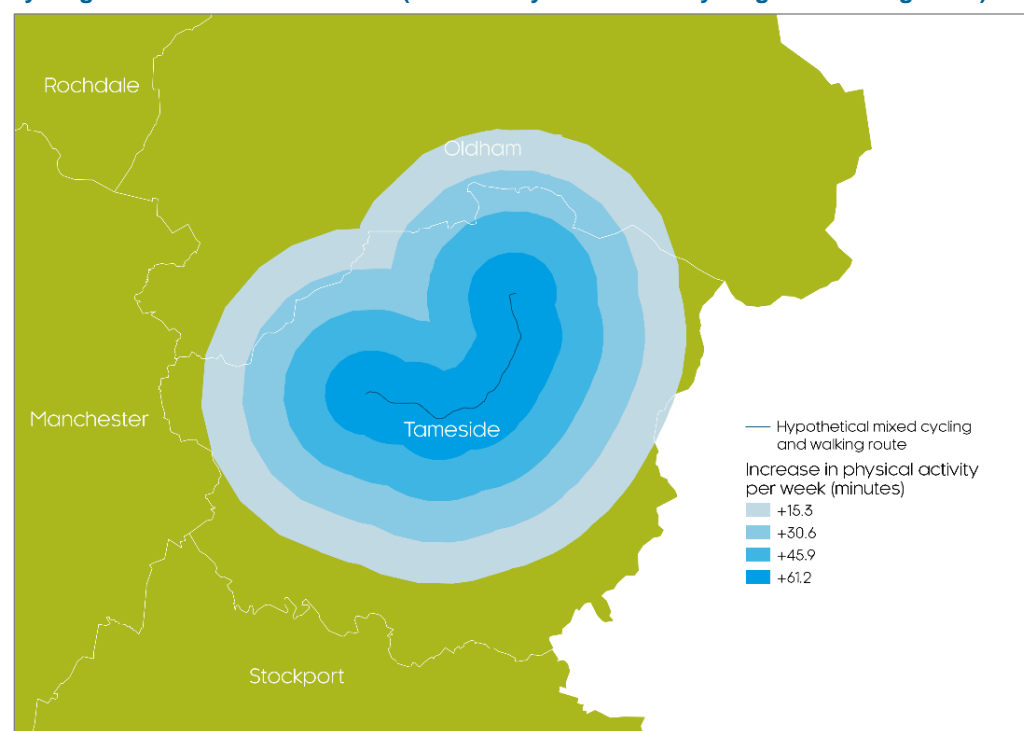
Distance of residence from route (km)	Increased average walking and cycling activity per week (minutes)
0-1	61.2
1-2	45.9
2-3	30.6
3-4	15.3

Note(s): Only routes within 4 km are considered

Source(s): Goodman *et al.* (2014).

As an illustration of the approach before applying it to actual data for the North, Figure 5.1 depicts these physical activity benefits on a map with a hypothetical newly-built mixed walking and cycling route in the Tameside borough of Greater Manchester.

Figure 5.1: Increase in physical activity associated with hypothetical mixed walking and cycling route relative to reference (>4 km away from mixed cycling and walking route)

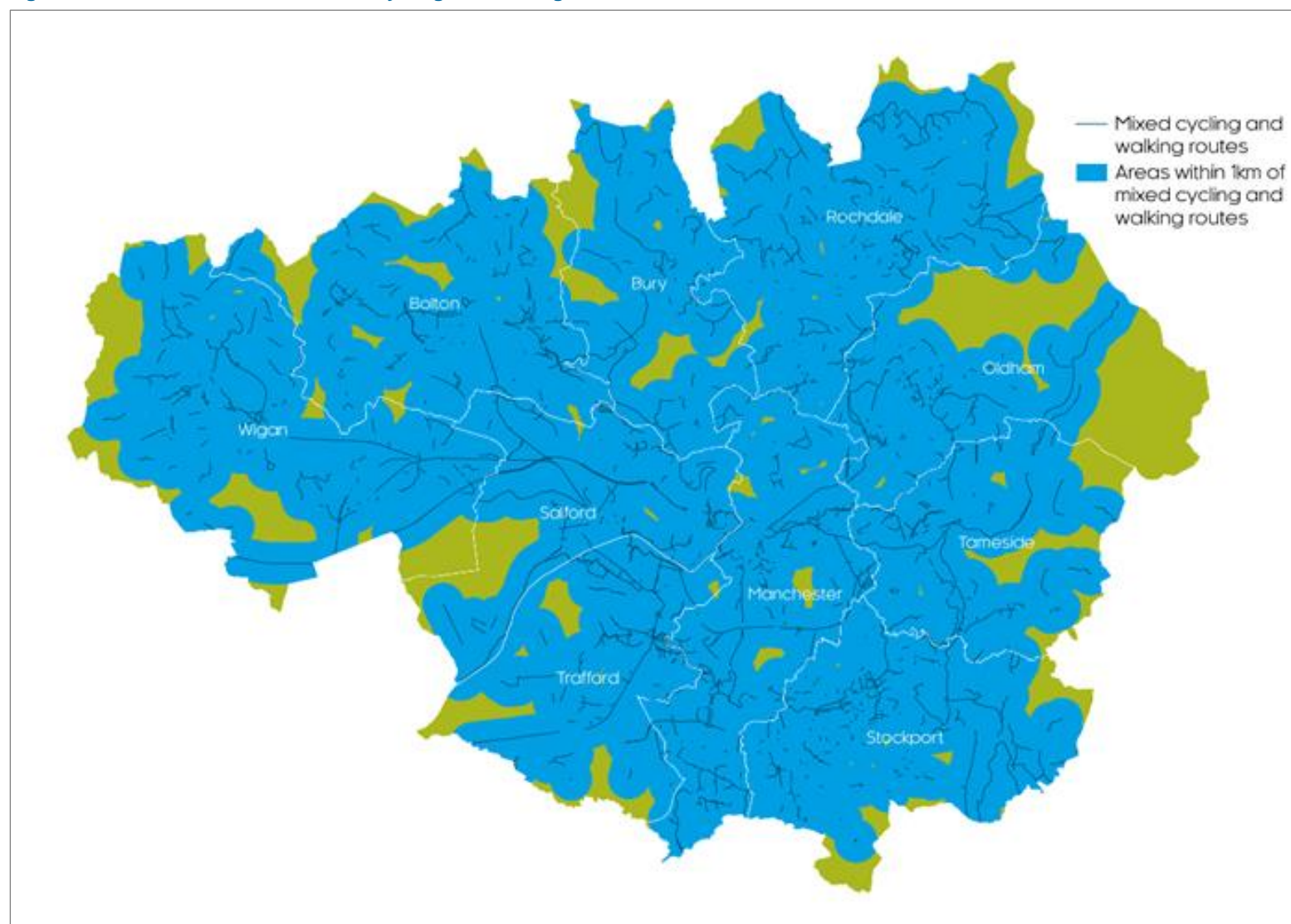


Source(s): Goodman *et al.* (2014); Cambridge Econometrics analysis.

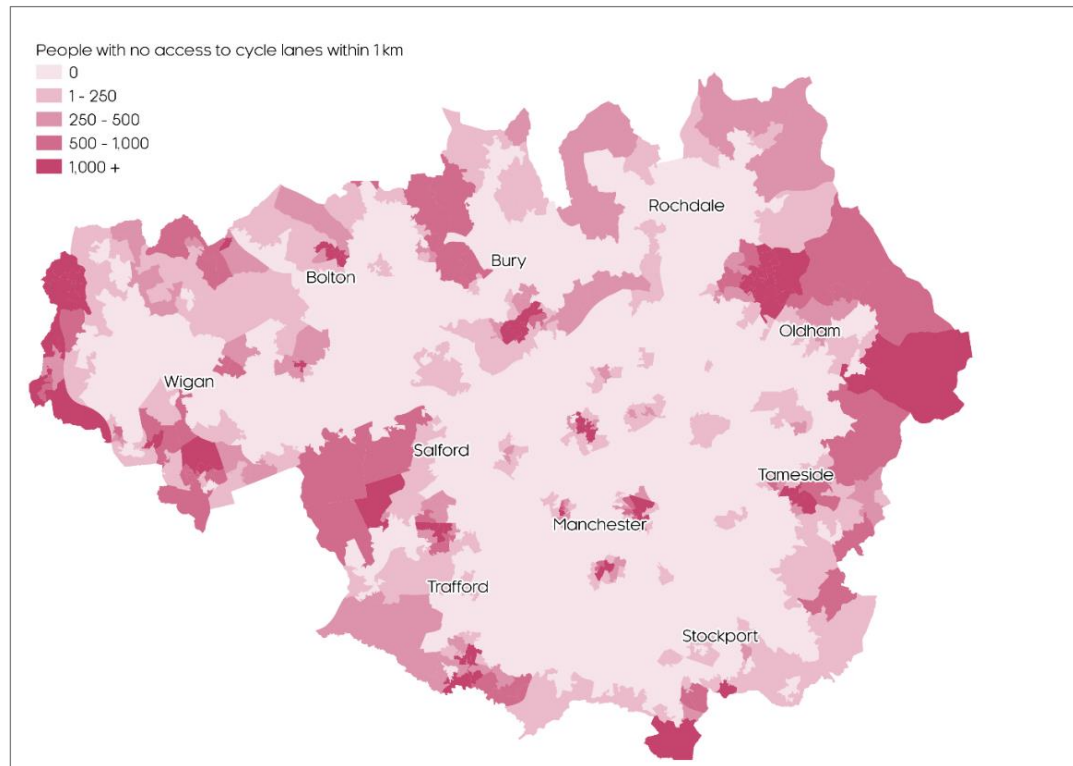
The majority of land area in Greater Manchester is within 1 km of existing cycling infrastructure

However, a relatively large urban centre like Greater Manchester has an existing network of walking and cycling routes that extends throughout the region. Thus, the marginal benefits of building new cycling infrastructure are harder to know, given the spread of existing infrastructure. Figure 5.2 displays the walking and cycling route network for Greater Manchester and the geographic area that lies within 1 km of any given section of this network. This map shows that a large majority of land area within Greater Manchester is within 1 km of existing cycling infrastructure.

Figure 5.2: Areas within 1 km of mixed cycling and walking routes in Greater Manchester



Source(s): Goodman *et al.* (2014); Cambridge Econometrics analysis.

Figure 5.3: Access to walking and cycling routes by LSOA in Greater Manchester

Source(s): Goodman *et al.* (2014); Office for National Statistics; Cambridge econometrics analysis.

Figure 5.3 shows the population of Greater Manchester by Lower Layer Super Output Area (LSOA) that does not live within 1 km of an existing mixed walking and cycling route. Over Greater Manchester, over 2.6m people have access to a cycle lane within 1 km of their home. Nevertheless, the map below also identifies 163,000 people with no nearby access (on distance alone). These areas are concentrated on the edges of the region, particularly around Bolton and Wigan. There are also a series of pockets with little or no access to cycling routes in the centre of the area. For example, over 5,000 people are more than 1 km from a cycling route in the Manchester 058B, Manchester 058D and Salford 016D LSOAs.

Our analysis of cycling and walking routes and their relationship to physical activity presumes that all infrastructure is of the same quality. However, the quality of existing routes in a city like Manchester varies depending on the type, age, location, etc. of the route. These details were not available in the geospatial data used in this analysis and are not well addressed by the literature linking built environment infrastructure to physical activity. Further information on quality and infrastructure usage could provide additional nuance to this analysis.

Proximity to parks

A 2016 study of individuals across 14 different global cities found that the density of parks near residences in urban areas is linearly associated with an increase in moderate to vigorous physical activity (MVPA) (Sallis *et al.*, 2016). Table 5.2 lists the increased physical activity associated with the number of parks within 0.5 km of a place of residence. Sallis *et al.* (2016) found this relationship to hold regardless of the size or quality of park(s).

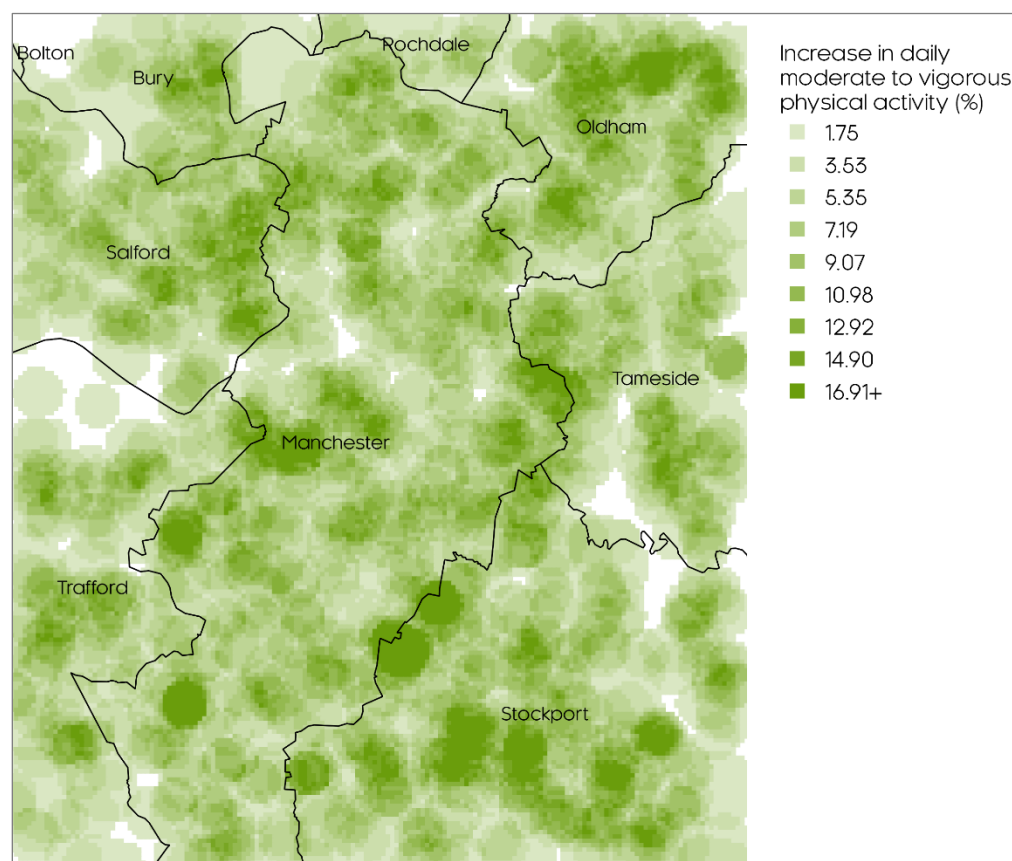
Table 5.2: Increased MVPA relative to the reference category (0 parks within 0.5 km)

Number of parks within 0.5 km buffer	Increase in daily MVPA (%)
1	1.75
2	3.53
3	5.35
4	7.19
5	9.07
6	10.98
7	12.92
8	14.90
9+	16.91+

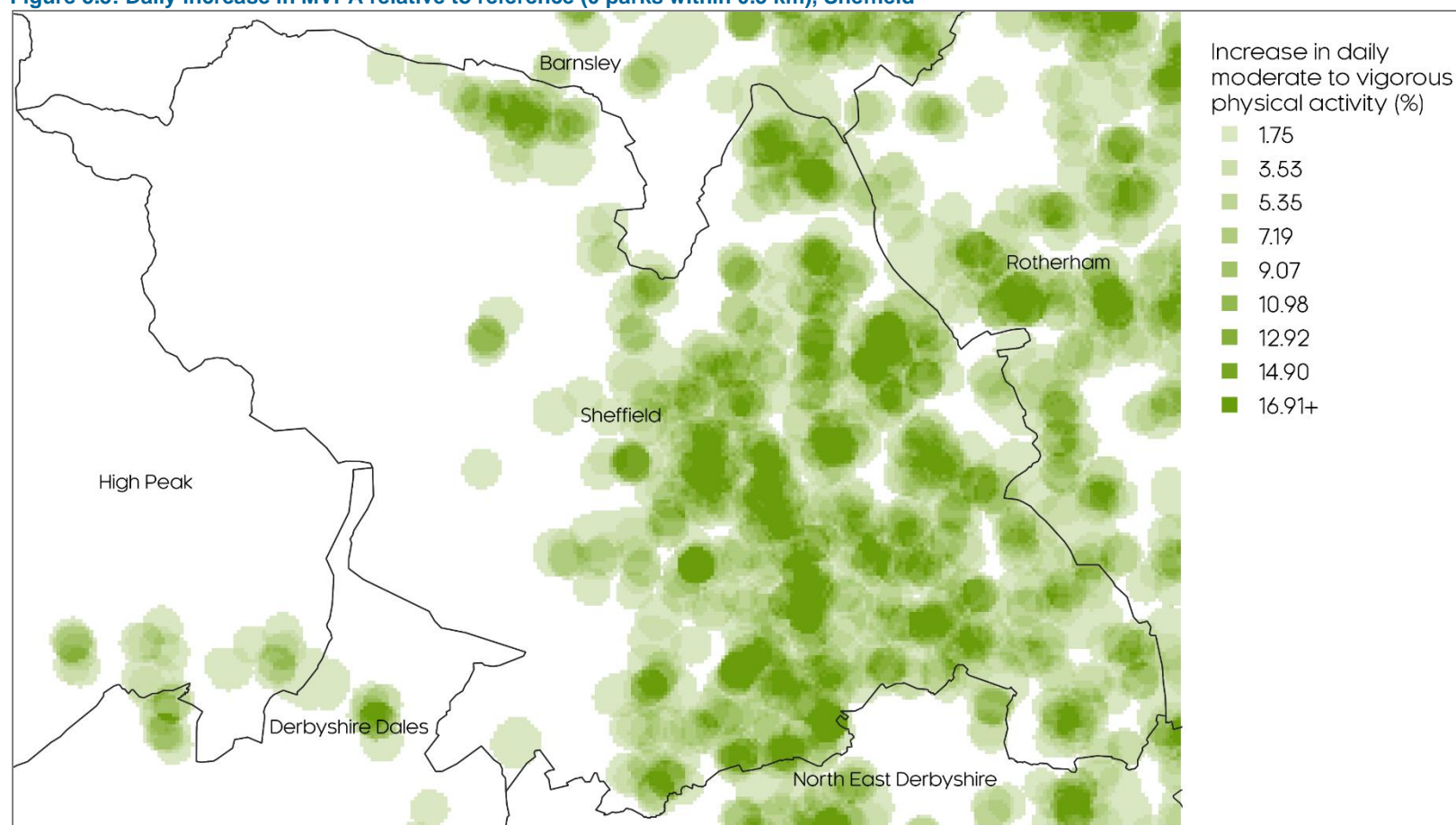
Source(s): Sallis *et al.* (2016); Cambridge Econometrics analysis.

Using the values above, Figure 5.4 (Manchester) and Figure 5.5 (Sheffield) show, for two urban areas, how proximity to parks could increase daily MVPA. This is relative to areas with no parks within 0.5 km of the place of residence.

Figure 5.4: Daily increase in MVPA relative to reference (0 parks within 0.5 km), Manchester



Source(s): Sallis *et al.* (2016); Cambridge Econometrics analysis.

Figure 5.5: Daily increase in MVPA relative to reference (0 parks within 0.5 km), Sheffield

Source(s): Sallis *et al.* (2016); Cambridge Econometrics analysis.

In both maps, white spaces represent areas that are more than 0.5 km from any park and thus not expected to benefit (on the basis of the evidence used). Relative to Sheffield, Manchester has a higher density of urban parks, though there are certain parts of Sheffield area with access to many nearby parks. Note that Sallis *et al.* (2016) focused on parks in urban areas but that the white area to the west of Sheffield includes the Peak District, which would also be expected to confer health benefits. These are not assessed in this current piece of analysis.

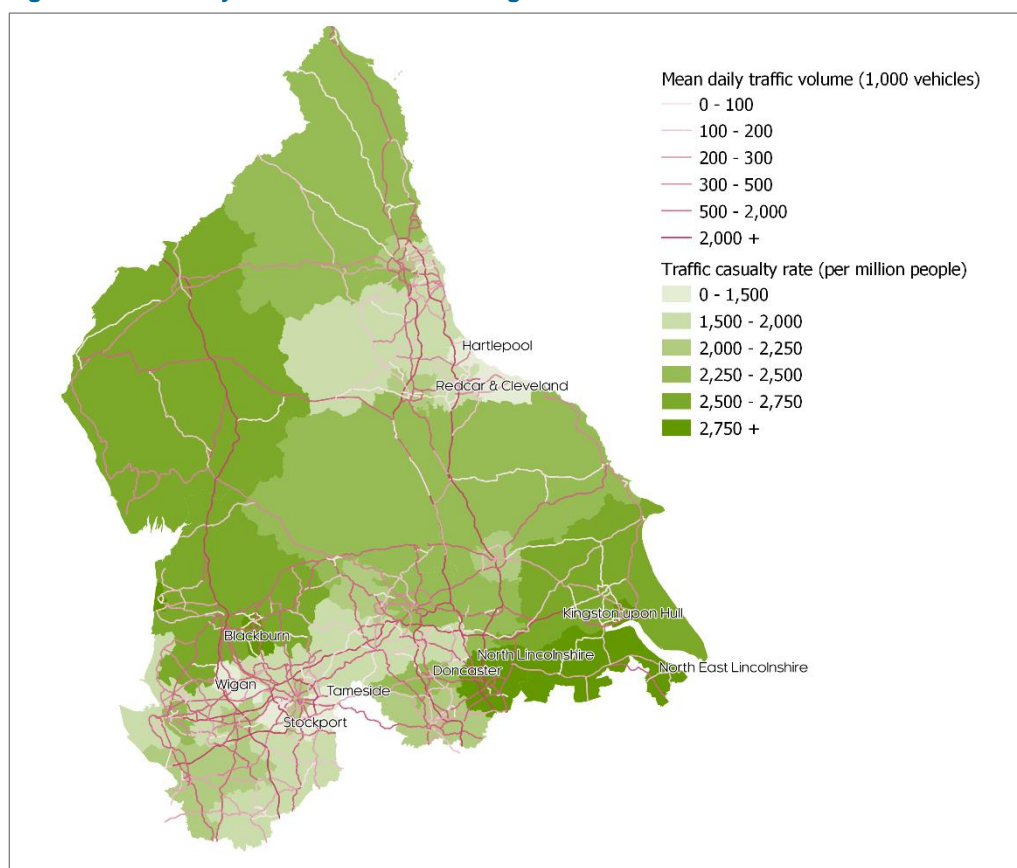
5.2 Incidents and safety

There were 1,752 road deaths recorded in the UK in 2019. At 26.4 deaths per million people, the UK's road death rate that year was 4 times lower than that of the US (36,096 deaths in a population of 332m people), and 2.5 times lower than New Zealand's (318 deaths; 5m people). This rate was slightly higher than that of Switzerland and the Nordic countries. Despite the UK's low rate by international standards, there is room for improvement, and there can be differences between regions.

There is great variation in the incidence rate across countries and, as the evidence below suggests, the occurrence of road traffic incidents is likely highly context specific.

In 2019, the North of England recorded 459 of the above deaths. This is proportionally more than the North's share of the UK population, implying a slightly higher death rate, of 30.8 per million people. Traffic incident and casualty data are available at the local authority level from the Department for Transport. Figure 5.6 presents the casualty rate per million inhabitants and shows areas of high/low traffic incident rates.

Figure 5.6: Casualty rates in the North of England



Note(s): The same rate is applied to all LADs where the data are only available at county level (Cumbria, Lancashire and North Yorkshire).

Source(s): Department for Transport 'Road traffic statistics' and 'Accidents by local authority'; Cambridge Econometrics analysis.

Table 5.3 presents road incident statistics for the four areas with the highest and lowest casualty rates. The highest casualty rate is found in Kingston upon Hull, followed by North East, and then North, Lincolnshire.

Table 5.3: Road incident statistics for selected areas

Geography	Casualty rate (per million people)	Casualties	KSI	Fatalities
Kingston upon Hull (highest)	3,603	936	149	7
North East Lincolnshire	3,259	520	77	3
North Lincolnshire	3,152	543	90	13
Blackburn	3,013	451	116	4
Hartlepool	1,377	129	30	1
Stockport	1,346	395	59	8
Redcar & Cleveland	1,342	184	51	5
Wigan (lowest)	1,244	409	112	15

Note(s): KSI - Killed or Seriously Injured.

Source(s): Department for Transport 'Accidents by local authority'.

Serious incidents (not shown), follow the population distribution, with Leeds, Sheffield and Liverpool on top.⁹ The high traffic volume in those three areas is in line with the evidence of a link between traffic volume and incident occurrence. Figure 5.6 also suggests some relationship between traffic volume and the casualty rate, with areas like Cumbria and Lancashire having heavy traffic and high casualty rates. On the other hand there are notable exceptions with Wigan, Stockport, Kirklees and Calderdale all showing high traffic volume but low casualty rates. More granular incident data would be needed for further analysis.

Roshandel et al. (2015) discuss the factors that matter in the probability of an incident taking place. Table 5.4 below shows the statistically significant factors affecting the odds ratio of a traffic incident taking place.

Table 5.4: Factors affecting traffic incident occurrences

	Change in odds ratio of a traffic incident per unit increase (%)
Average speed	-4.8
Traffic volume	0.1
Speed variation	22.5
Speed difference	3.2

Source(s): Roshandel *et al.* (2015).

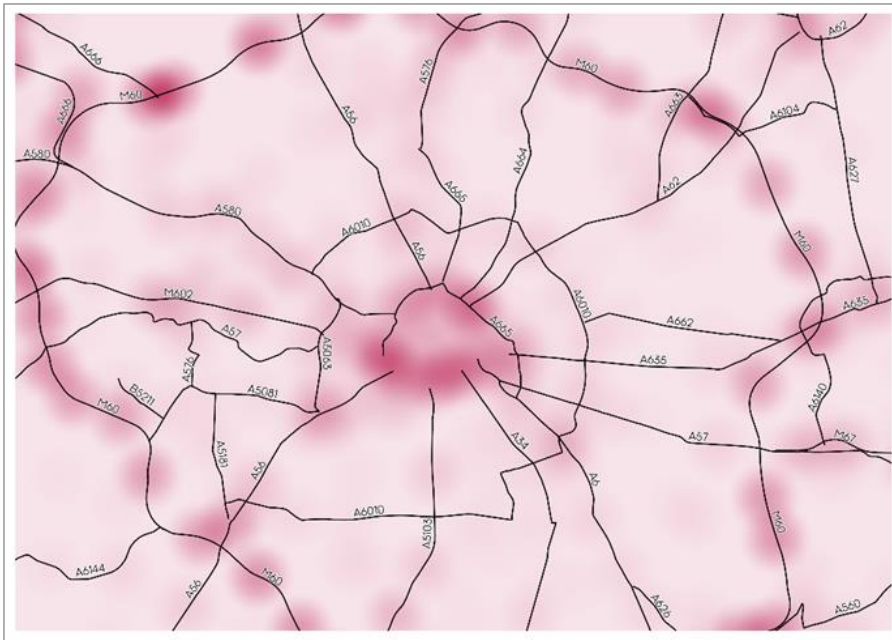
Average speed is the only factor with a negative impact on the probability of an incident. As Roshandel *et al.* (2015) point out, 'this result is not surprising because stop and go driving conditions are associated with lower average speeds, and the outcome being assessed is crash occurrence and not severity'.

- then highlight locations and coincidence or otherwise with traffic volumes

⁹ These figures exclude the three counties analysed – North Yorkshire, Lancashire and Cumbria.

To examine the hypothetical coincidence of traffic incidents with volumes, data for the exact location of traffic incidents is available for Greater Manchester (see Figure 5.7 and Figure 5.8).

Figure 5.7: Traffic volume in Greater Manchester



Note(s): Individual traffic counts are weighted by their volume before creating the heatmap.
Source(s): Department for Transport 'Road traffic statistics'; Department for Transport; Cambridge Econometrics analysis.

Figure 5.8: Traffic incidents in Greater Manchester



Note(s): Individual incidents are weighted by the severity index that accompanies the dataset.
Contains Transport for Greater Manchester data. Contains OS data © Crown copyright and database right 2021.
Source(s): Transport for Greater Manchester 'GM Road Casualty Accidents'; Department for Transport; Cambridge Econometrics analysis.

Figure 5.8 shows how casualties are concentrated around junctions and roads with lower speed limits in city centres. This highlights how low- and medium-speed roads have higher casualty rates and are thus incident hotspots. This is also reflected in the casualty rate per road, which is ten times lower for motorways when compared to A roads (as shown in the DfT data). This may explain the relatively low number of incidents around the M60 in Manchester, despite high traffic volume.

As data are available at relatively limited geographical detail, any relationship between traffic volume and the casualty rate in the North is not clearly visible. This may also be partly because varying incident rates by road type can cloud this relationship. The analysis shows the lowest incident rates on Motorways , at 58 per billion miles. This is followed by ‘A Roads’ (347) and ‘Other Roads’ (440). Smaller roads can therefore lead to more accidents, even when they have less traffic. This is supported by the literature, which suggests that speed (which is related to the road type) is negatively correlated with the probability of a traffic incident. Other variables that have significant explanatory power in the literature include speed variation, which would be interesting to gather data on.

5.3 Air pollution

Air pollution increases the risk of hospitalisation and mortality

Our analysis of air pollution concerns the health effects of six pollutants (see Table 5.5) for which (modelled) data are available from Defra as annual means. By Requia, Adams, *et al* (2018), these pollutants can be translated from measured concentrations into the following (increases in) health risk:

- hospital admissions
- mortality

Table 5.5: Air pollutants and their main sources

Pollutant	Main source(s)
Carbon monoxide (CO)	Cars, industrial furnaces
Nitrogen dioxide (NO ₂)	Fossil fuels, cars
Sulphur dioxide (SO ₂)	Fossil fuels, mineral ore smelting
Particles <10 µm in diameter (PM ₁₀)	Dust, pollen, mould, tire and brake wear
Particles <2.5 µm in diameter (PM _{2.5})	Combustion, organic compounds, metals
Ozone (O ₃)	Indirectly from NOx

The analysis that follows presents figures for 2019, as the last year of pre-pandemic data i.e. before movement restrictions.

Table 5.6 summarises the range of (increased) health risks across the North for five of the six pollutants, calculated from the Defra emissions data for 2019.¹⁰

¹⁰ Because the Defra data report ozone different, as number of days on which a threshold was passed (120 µg/m³), we treat this separately in the analysis that follows.

Table 5.6: Increased health risks from air pollution (per 100,000)

	Hospital admissions		Mortality	
	Mean	Maximum	Mean	Maximum
Carbon monoxide (CO)	4	5	-	-
Nitrogen dioxide (NO ₂)	1,325	6,445	1,115	5,427
Sulphur dioxide (SO ₂)	202	1,935	61	589
Particles <10 µm in diameter (PM ₁₀)	1,713	3,447	1,178	2,370
Particles <2.5 µm in diameter (PM _{2.5})	1,051	1,937	1,511	2,784

Note(s): Risk estimates calculated from Requia, Adams *et al.* (2018), who did not find a link between carbon monoxide and mortality.

Source(s): Defra 'Modelled background pollution data', Requia, Adams *et al.* (2018); Cambridge Econometrics analysis.

All prevalence observed in 2019 is below the UK government guidance for mean annual concentrations. These limits are 40 µg/m³ for NO₂ and PM₁₀, and 25 µg/m³ for PM_{2.5}, while the maximum prevalence observed is 34, 22 and 12 µg/m³ respectively.¹¹ Table 5.7 below shows the distribution of the impacts of the three most harmful pollutants across the population of the north.

Table 5.7: Population affected by impacts tied to air pollution

Health impact: increased risk of mortality	Population affected ('000s)	Proportion of affected population in lowest IMD decile (%)
Nitrogen dioxide		
High impact (over 2.33%)	5,880	30
Medium impact	5,540	14
Low impact (up to 1.58%)	4,411	6
Particulate Matter 2.5		
High impact (over 2.0%)	5,850	28
Medium impact	5,150	14
Low impact (up to 1.68%)	4,540	10
Particulate Matter 10		
High impact (over 1.50%)	5,640	26
Medium impact	5,320	16
Low impact (up to 1.27%)	4,570	10

Note(s): Totals may not be equal across impacts due to rounding error.
Risk brackets for 'low', 'medium' and 'high' divide the population into equal thirds.
Across the north, 18% of the population find themselves in the lowest IMD decile.
Population impacts are calculated at a postcode level and then grouped by IMD LSOA when reporting deprivation.

Source(s): UK Data Service 'UK 2011 census Postcode Headcounts'; Cambridge Econometrics analysis.

A clear pattern emerges from the table above, with the areas of 'high' increase risk of mortality from air pollution having a larger proportion of population in the lowest IMD decile (26 – 30%). For reference, an average of 18% of the population of the north find themselves in the lowest IMD decile so this 26-30% means worse-off people are disproportionately represented in these high impact areas. On the other hand, in areas of 'low' risk only 6 - 10% of the

¹¹ Defra, 'UK Air Quality Limits' [Air Quality Objectives Update.pdf \(defra.gov.uk\)](https://www.defra.gov.uk/air-quality/objectives/updates/2018/uk-air-quality-objectives-update.pdf), Cambridge Econometrics Analysis

population are within the lowest IMD decile. This suggests a strong association between pollution and deprivation. We also note the tendency for people living in these deprived areas to be younger. It was beyond the scope of this work to consider causal factors.

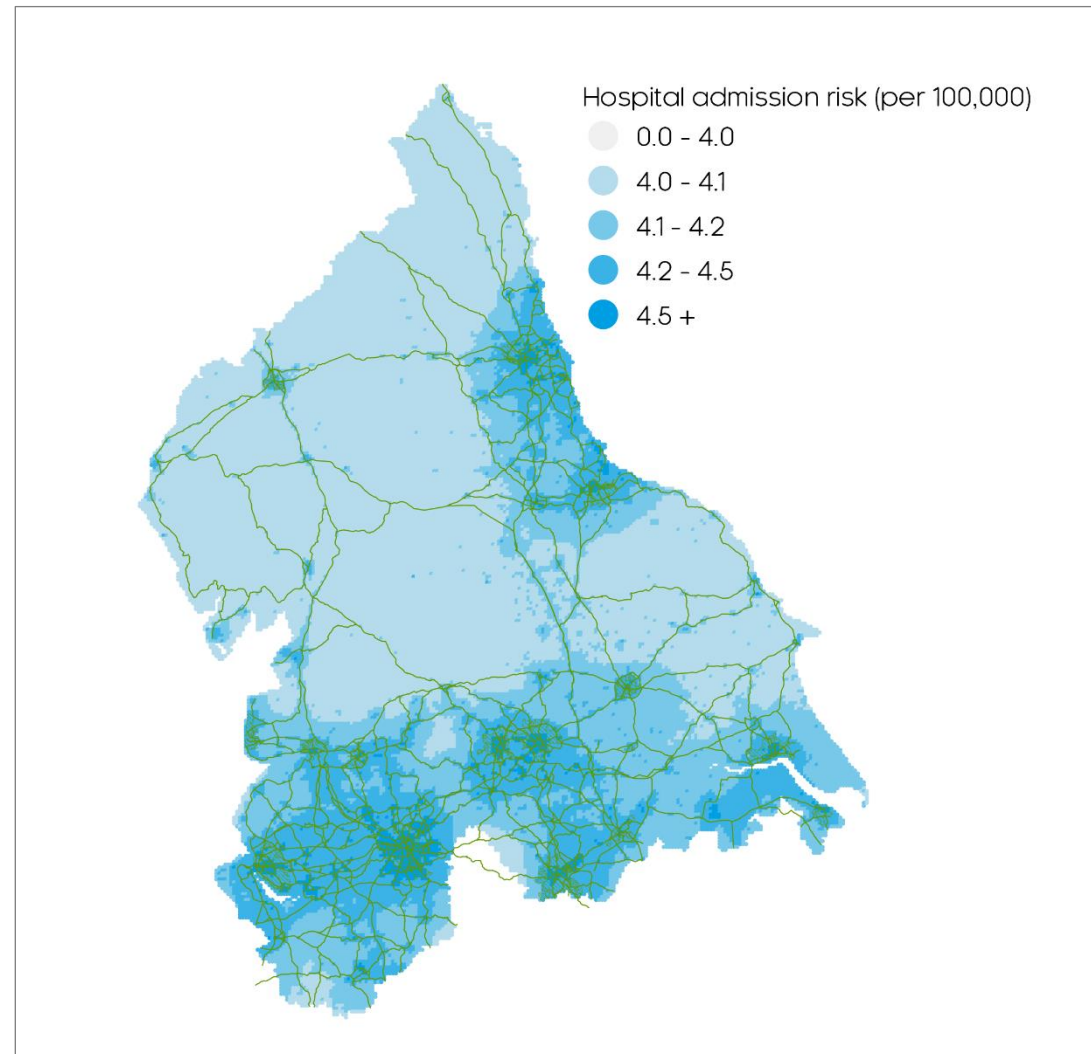
Carbon monoxide

Carbon monoxide arises mainly from internal combustion of fossil fuels (most commonly road transport) and industrial processes. Higher concentrations are thus found around residential areas and major roads; and industrial zones. Consequently, heightened risks of hospital admissions are in these same places, and especially the more densely populated residential areas (see Figure 5.9).

When compared to the other pollutants considered, the risk of such admissions is relatively low for carbon monoxide. Even in areas with high concentrations, the annual estimated admissions risk rises by, at most, 5 people per 100,000 in the most built-up urban areas. This rate is three orders of magnitude smaller than, for example, nitrogen dioxide (as below).

Requia, Adams, *et al* (2018) did not find any clear relationship between carbon monoxide exposure and mortality.

Figure 5.9: Increased hospital annual admission risk from carbon monoxide



Note(s): Risk estimates calculated from Requia, Adams *et al* (2018).

Source(s): Defra 'Modelled background pollution data', Requia, Adams *et al* (2018); Cambridge Econometrics analysis.

Nitrogen dioxide

Nitrogen dioxide exposure substantially increases hospitalisation and mortality risk

Nitrogen dioxide (NO₂) is mainly formed from cars and combustion of fossil fuels. We therefore see a similar spatial distribution as for carbon monoxide (see Figure 5.11).

However, the associated health risks are significantly higher for NO₂ than carbon monoxide, increasing the risk of hospital admission by as much as 6,445 people per 100,000. This compares to a rate of 36 people per 100,000 for carbon monoxide (as above).

The associated risk of mortality is also high from NO₂ exposure, increasing the risk by as much as 5,427 people per 100,000 in the highest-emissions areas.

Given the source of these emissions, the health risks are concentrated in densely populated areas and therefore have significant public health implications.

PM₁₀ and PM_{2.5}

Health impacts arise more from PM_{2.5} (in residential areas) than PM₁₀ (along major roads)

Particulate matter refers to any non-gas substance in the air and so can come from a variety of sources. From transport, coarser PM₁₀ is associated with trace metals emitted during vehicle motion as well as tire and brake wear (Defra, 2005). Finer particulate matter (PM_{2.5}) is associated with exhaust emissions from diesel vehicles, and also tire and brake wear (Defra, 2012). However, there is no data available on the emissions by source and pollutant, therefore the analysis cannot isolate pollution linked exclusively to transport.

Increased risk of mortality associated with PM_{2.5} is concentrated in densely populated areas. In contrast, heightened mortality risk associated with PM₁₀ is more clearly concentrated around major roads (see Figure 5.12). The health impacts of particulates are thus more consequential for PM_{2.5} given the location of the population of the north.

Although both sizes of particle arise from road traffic, the evidence suggests that, while PM_{2.5} concentrations are high within 1 metre of the kerb, these particulates are quick to disperse, with limited concentrations past that distance (Defra, 2012). PM₁₀ is slower to disperse, leading to a wider spread around the road network. This is visible in Figure 5.12.

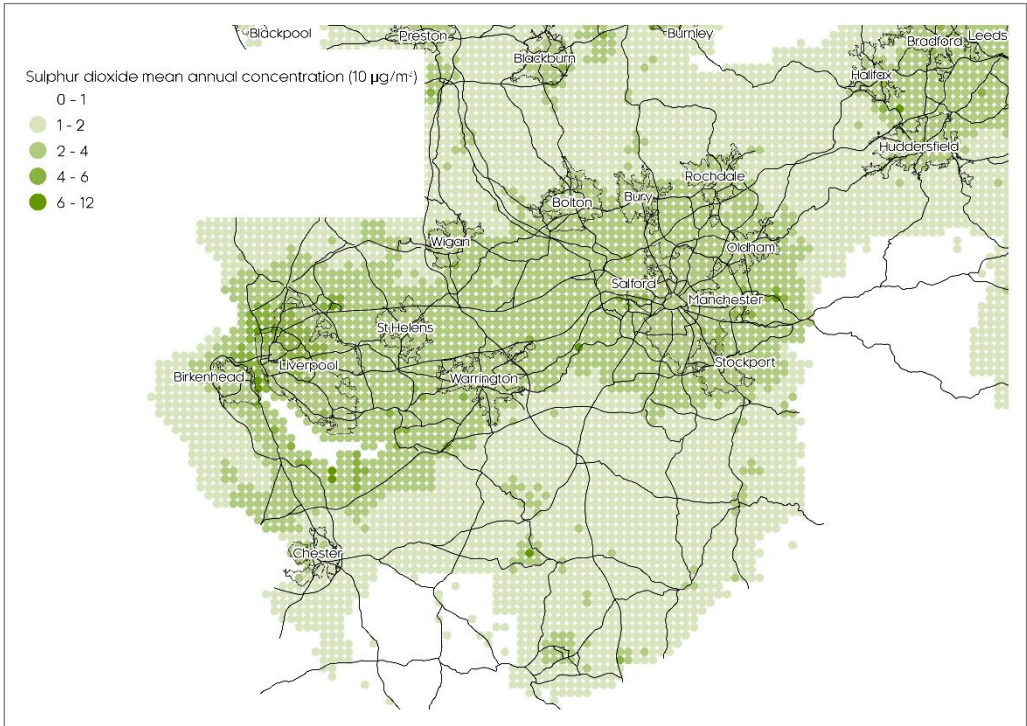
Sulphur dioxide

Health impacts from sulphur dioxide also cluster around population centres

The main source of sulphur dioxide emissions is fossil fuel combustion. Again, this leads to the pollutant concentrating around population centres and industrial areas. Sulphur dioxide is more of an industrial than a transport pollutant. As such, concentrations of sulphur dioxide follow the road network less clearly compared with carbon monoxide and nitrogen dioxide. The estimated increase in mortality risk ranges from 61 to 589 per 100,000 people, and is concentrated around densely populated areas.

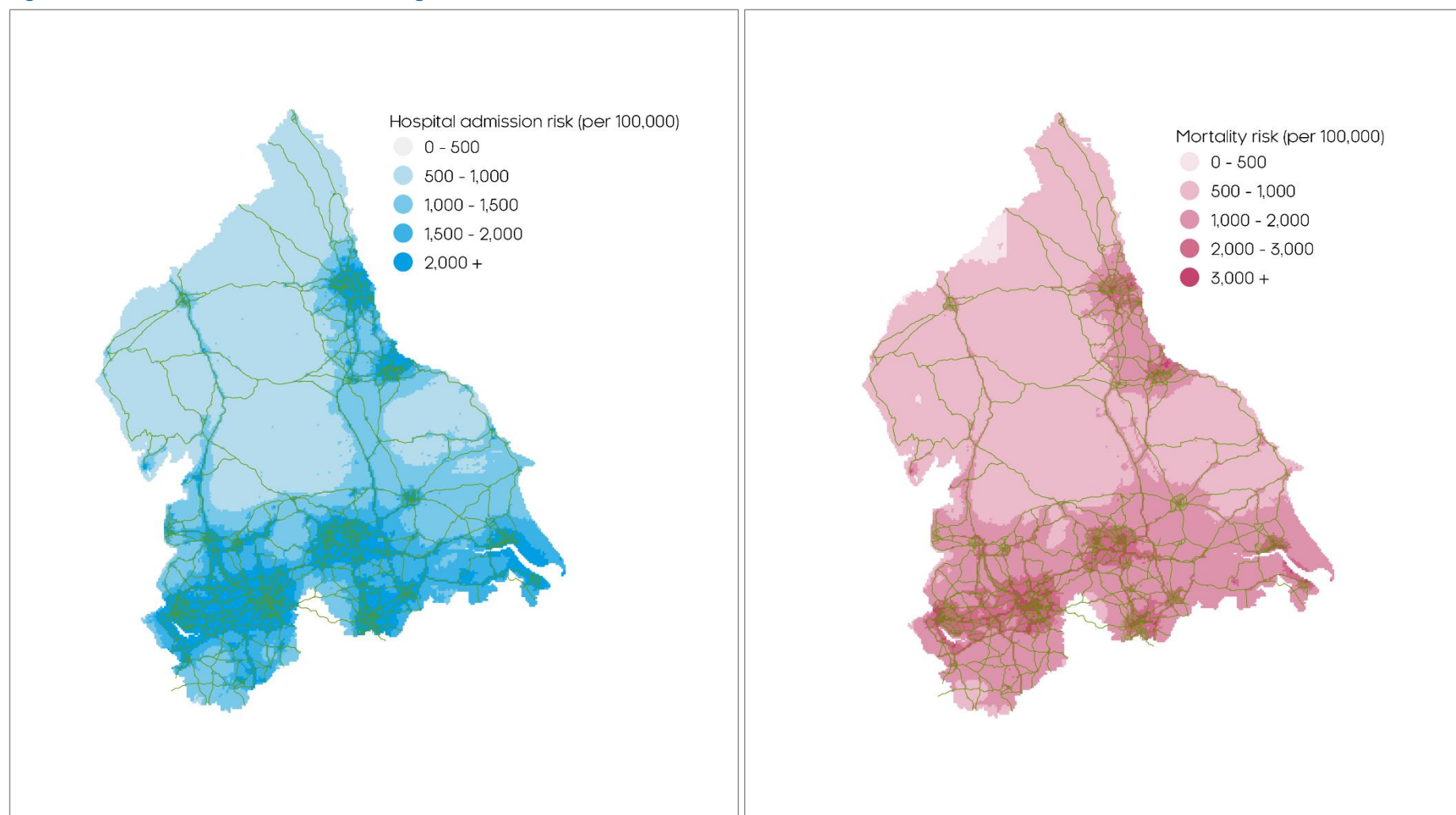
The associated increases in hospital admission risk are wider, ranging from 202 to 1,935 people per 100,000, by virtue of the larger coefficients. The highest concentrations are not clustered around major road networks and thus are more likely to be industry- rather than transport-related.

Figure 5.10: Concentrations of SO₂ around Manchester and Liverpool



Source(s): Defra 'Modelled background pollution data'.

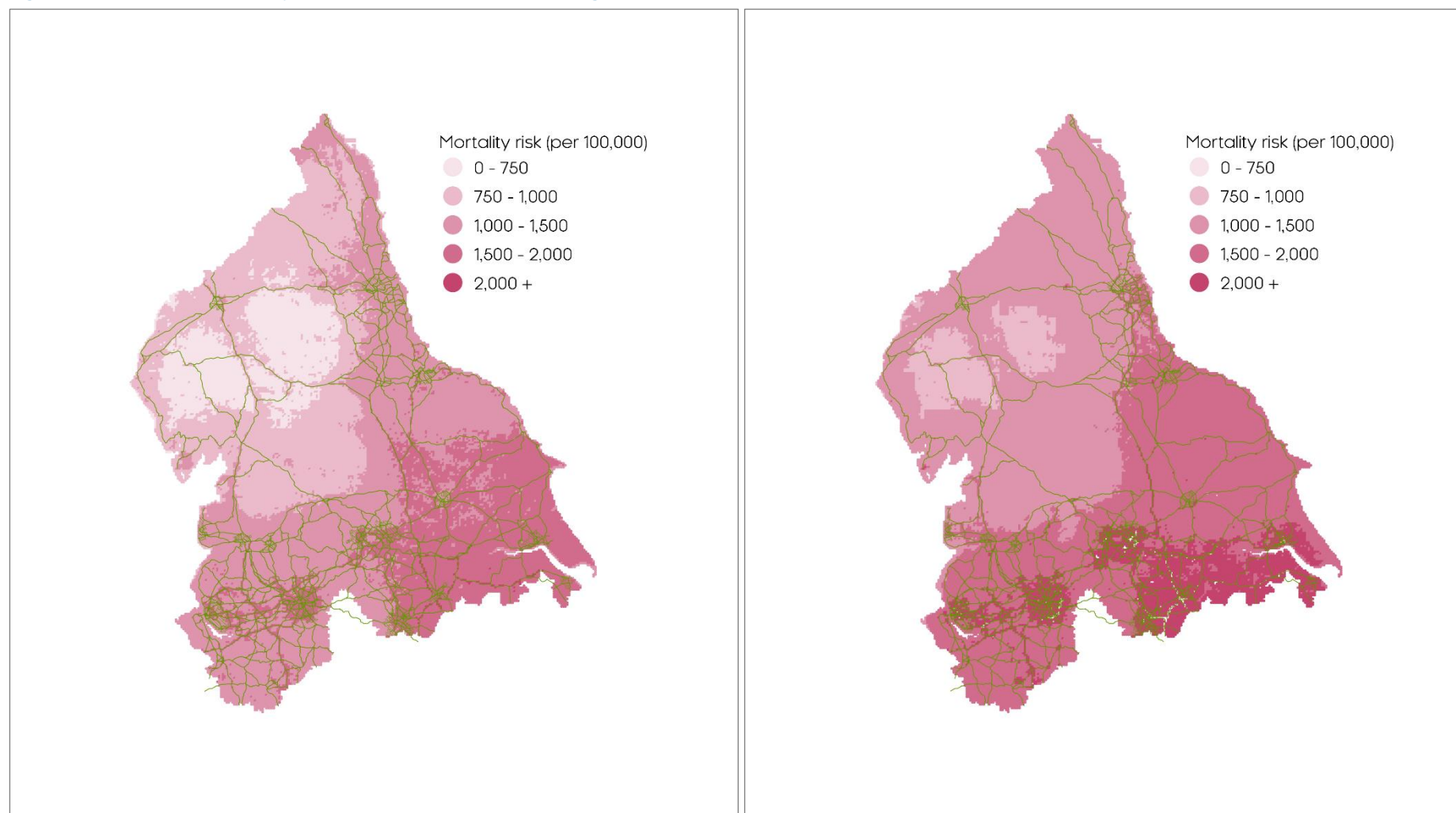
Figure 5.11: Increased health risks from nitrogen dioxide



Note(s): Risk estimates calculated from Requia, Adams *et al* (2018).

Source(s): Defra 'Modelled background pollution data', Requia, Adams *et al* (2018); Cambridge Econometrics analysis.

Figure 5.12: Increased mortality risk from PM₁₀ (left) and PM_{2.5} (right)



Note(s): Risk estimates calculated from Requia, Adams *et al* (2018).

Source(s): Defra 'Modelled background pollution data', Requia, Adams *et al* (2018); Cambridge Econometrics analysis.

Ozone

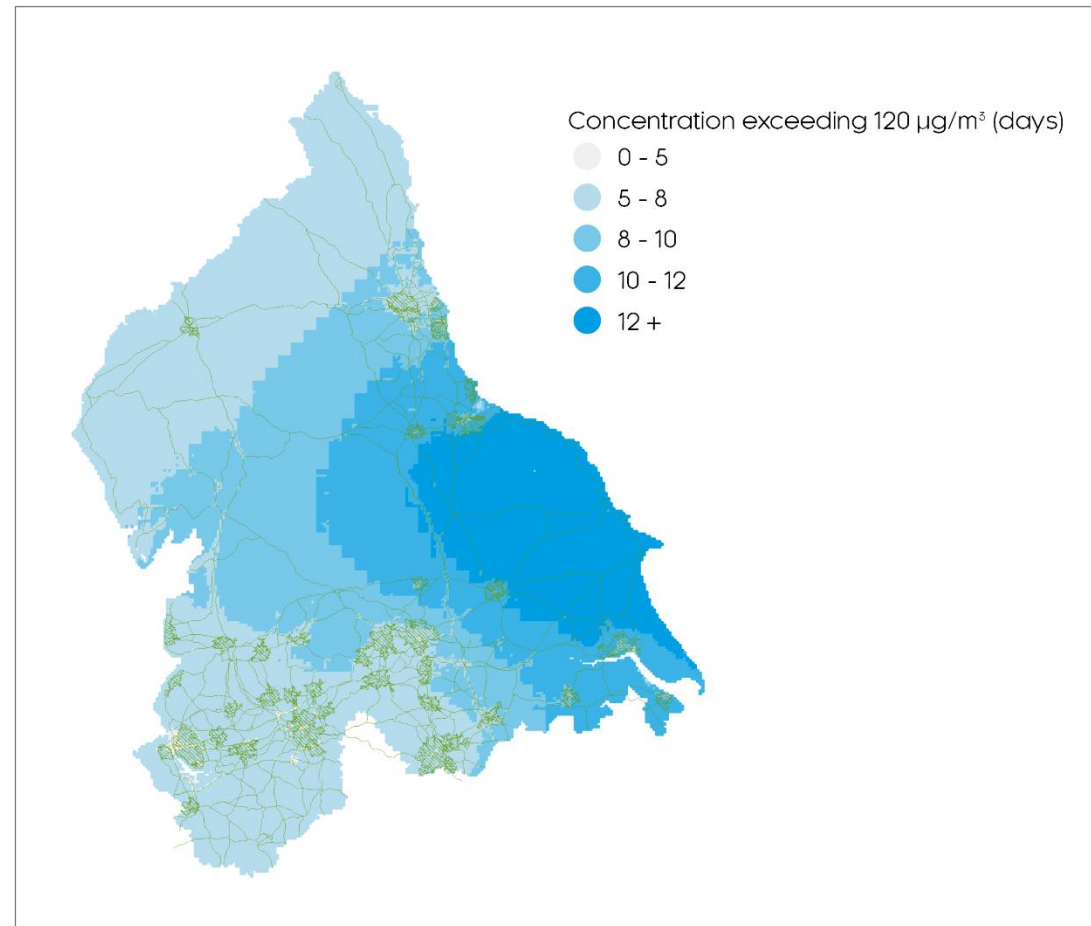
Ozone is a powerful oxidant that causes damage to mucous and respiratory tissues in animals, as well as plant tissues. Low level (tropospheric) ozone is the product of two anthropogenic pollutants, forming when nitrogen oxides react with volatile organic compounds (VOCs). Sources of VOCs include chemical plants and oil-based paints. Ozone can take hours or days to form and may reach maximum concentrations many miles downwind of these original sources.¹²

European guidance sets an air quality standard for ozone by which concentrations should not exceed $120 \mu\text{g}/\text{m}^3$ (the maximum daily eight-hour mean) on more than 25 days each year (averaged over three years).¹³

Compared to other pollutants considered in this analysis, the health risks from ozone exposure are relatively low. Even if an area were to exceed these concentrations every day of the year, hospitalisation and mortality risks would increase by just 19 and 8 people per 100,000, respectively.

Figure 5.13 shows the number of days on which ozone concentrations exceeded the above threshold in 2019. The map shows the highest exposure is quite far from population centres in the north, suggesting quite limited impacts (especially given the comparatively smaller increases in health risks).

Figure 5.13: Areas of high annual ozone exposure



Note(s): Risk estimates calculated from Requia, Adams *et al* (2018).

Source(s): Defra 'Modelled background pollution data', Requia, Adams *et al* (2018); Cambridge Econometrics analysis.

¹² UK Air Pollution Information System: Ozone:
http://www.apis.ac.uk/overview/pollutants/overview_o3.htm

¹³ European Commission 'Air quality standards':
<https://ec.europa.eu/environment/air/quality/standards.htm>

5.4 Limited access to green space, recreation and leisure

The association between proximity to green space and human health has been long established by the literature. With increasing urbanisation, the lack of green space in cities has been noted as a risk factor for a range of physiological and psychological conditions. Green space is thought to affect health in many indirect ways, such as by increasing opportunities for physical activity, social interaction, cleaner air, sun exposure, and exposure to micro-organisms within the natural environment. All of these can be linked to better health outcomes.

The North of England is filled with broadly-defined green space, especially in more remote or rural areas of the region. Our analysis examines the relationship between residential proximity to green space (including areas with tree cover, open green/grassy areas [excluding farmland], and areas with other low-lying vegetation) and the following health outcomes:¹⁴

- wellbeing, focusing on Manchester and Newcastle, owing to the urban focus of the underlying evidence
- diabetes
- psychosocial distress
- self-rated general health

The wellbeing analysis suggests that around half of the population of Manchester does not live within 300 metres of green space of sufficient size to confer wellbeing benefits. The benefits for those in proximity to green space are relatively mild, though, increasing wellbeing scores by no more than 0.5%.

The reduced risk of type 2 diabetes due to proximity to green space is most concentrated in areas that are less populated, with urban areas, especially those in the corridor from Sheffield and Leeds to Newcastle and the southeast area around Lincolnshire, most at risk from type 2 diabetes as a result of limited access to green space.

The reduced risk of psychosocial distress is most widespread across the region, as this health outcome is dependent upon a lower threshold of proximate green space as well as a broader definition of green space compared to self-report general health (as below; by including tree canopy coverage).

The risk reduction in self-reported fair or poor general health (a negative health outcome) is the most diffuse, as this health outcome is dependent on tree canopy coverage, which makes up a smaller proportion of the green space in the North of England.

Overall, the region could be defined as one in which the health risks due to lack of green space are most acute in urban areas, though there are many rural/remote areas with green space near those major cities.

¹⁴ For the purposes of our analysis, green space is defined as deciduous woodland, coniferous woodland, improved grassland, neutral grassland, calcareous grassland, acid grassland, heather, and heather grassland, as per the UK Centre for Ecology and Hydrology (UKCEH) land use categorisation.

Tree canopy is defined as deciduous or coniferous woodland, per the UKCEH land use categorisation.

Wellbeing

Our analysis of the wellbeing benefits of green space uses the indicators defined in the Annual Population Survey (APS). Looking at green space in terms of its wellbeing impacts is only applicable in urban settings, as most rural places will have access to abundant natural green space or fields within 300 metres. The results of a study by Houlden *et al.* (2018) for London are applied to the Manchester area, as the largest urban area in the North and thus closest to London in size. Given the city focus of the evidence we do not apply the approach to the entire North. The paper's results could be applied to other large urban areas but not in towns or rural areas because of the nature of the underlying evidence and the greater abundance of green space.

Table 5.8 shows that the benefits of being near green space (within 300 metres: around a five-minute walk) depend on the size (area) of that green space. The analysis maps proximity to such green space and the associated wellbeing benefits by area.

Table 5.8: Wellbeing benefits of green space

	Increase in the wellbeing indicator per km ² of green space within 300 metres (%)	p-value
Life satisfaction	0.8034	< 0.001
Worthwhile	0.7398	< 0.001
Happiness	0.5208	< 0.001

Note(s): Life satisfaction - Very high rating of satisfaction with their lives overall.
Worthwhile - Very high rating of how worthwhile the things they do are.
Happiness - Rated their happiness yesterday as very high.
The percentages above refer to the change in the score, measured on a five-point scale.

Source(s): Houlden *et al.* (2018).

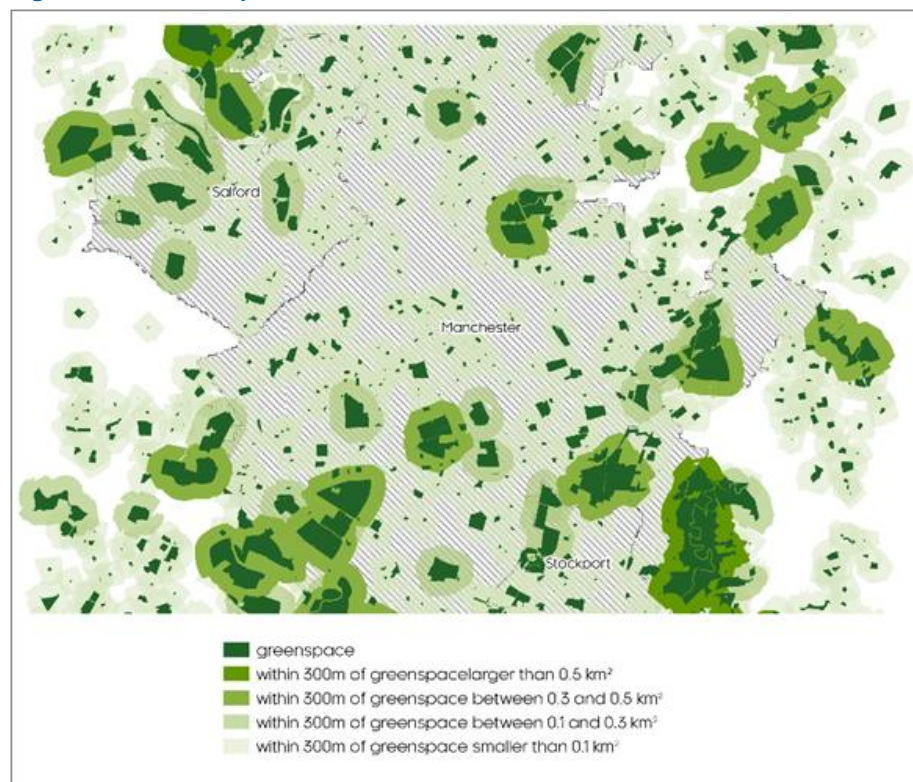
Figure 5.14 shows green space for the Manchester area. Each green space area is surrounded by a 300-metre buffer to proxy access. The buffers are coloured according to the size of the green space, to show the size of the associated wellbeing benefits.

Visibly grey areas are not within 300 metres of any (identified) green space and, by our approach, do not benefit from increased wellbeing. People living within 300 metres of parks larger than 0.5 km² are estimated to have improved life satisfaction by at least 0.4%, with their sense of how worthwhile their activities are, and happiness also increasing by at least 0.37% and 0.26%, respectively. Those near parks with an area of 0.3 km² would benefit from increased life satisfaction, sense of worth and happiness by 0.24%, 0.22% and 0.16%, respectively.

Young people in Manchester benefit the least from existing green space

Of note is that the least green LSOAs also have the lowest median age (see Figure 5.15). This suggests that, in terms of wellbeing, younger people benefit the least from existing green space.

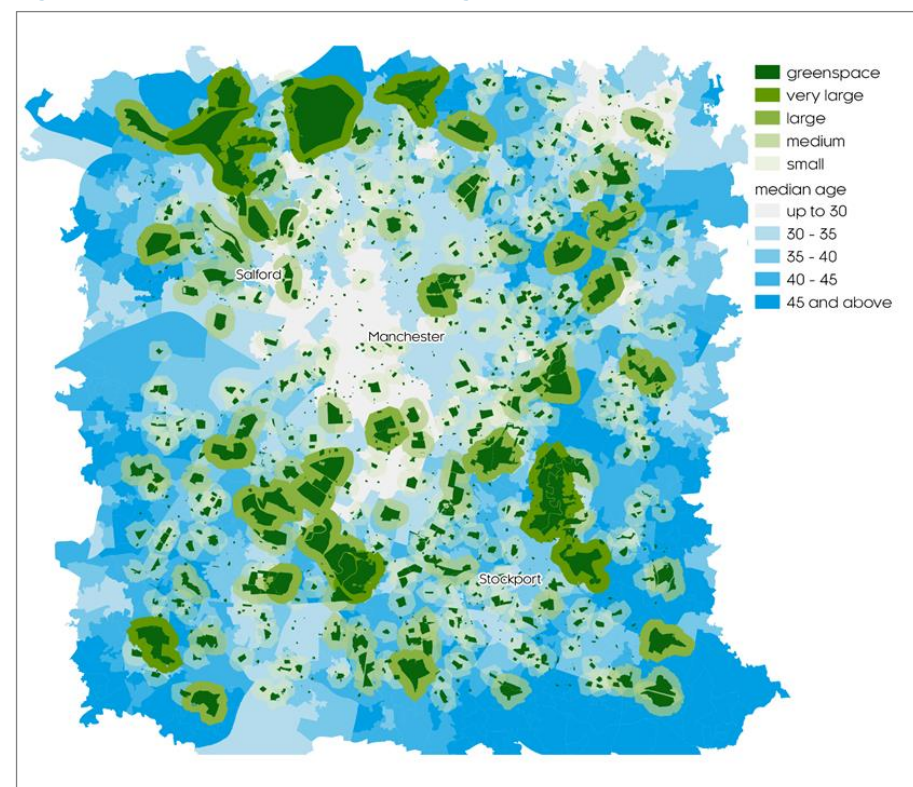
Figure 5.14: Green space around Manchester



Note(s): Some parks appear as multiple areas (rather than a single area), reflecting their representation in the underlying data.

Source(s): Ordnance Survey 'Open Greenspace'; Cambridge Econometrics analysis.

Figure 5.15: Green space and median age around Manchester



Note(s): Some parks appear as multiple areas (rather than a single area), reflecting their representation in the underlying data. Green spaces are classified as very large (larger than 0.5 km²), large (between 0.3 and 0.5 km²), medium (between 0.1 and 0.3 km²) and small (between 0.01 and 0.1 km²). Very small green space (smaller than 0.01 km² or 1 hectare) is excluded because of its minimal estimated wellbeing impacts.

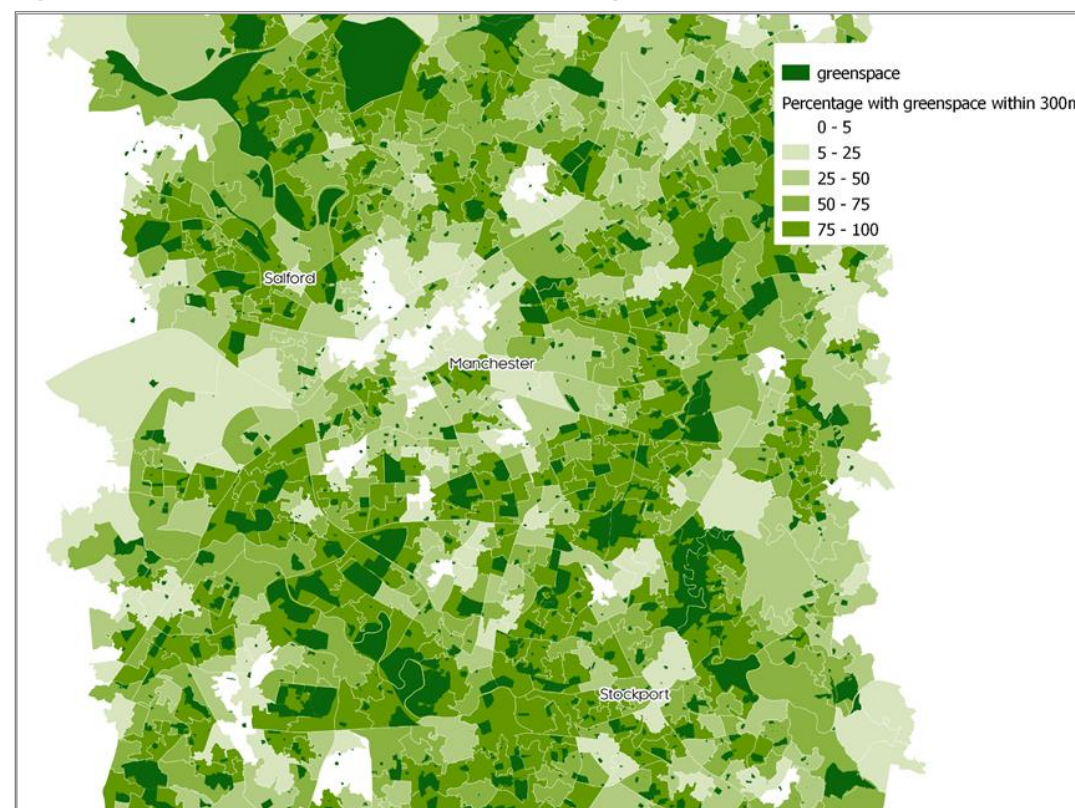
Source(s): Ordnance Survey 'Open Greenspace', ONS 'Lower layer Super Output Area population estimates'; Cambridge Econometrics analysis.

The magnitude of the wellbeing impacts quickly diminishes with decreasing park size. Densely populated areas in the centre of Manchester do not have easy access to large green space. This means that the potential wellbeing benefits of creating a new green space there would be significant and reach a large part of the population.

Assuming constant population density within each LSOA, we estimate that 800,000 people in the Manchester area have no green space larger than a hectare within 300 metres of their home. That is equivalent to 51% of the area's population.

Figure 5.16 identifies the percentage of people in each LSOA who have access to green space within 300 metres of their homes. In white and light-green areas, less than 25% of the population has access to green space larger than a hectare within 300 metres of their home.

Figure 5.16: Share of population in Manchester with green space within 300m of their homes



Note(s): Very small green space (smaller than 0.01 km² or 1 hectare) is excluded because of its minimal estimated wellbeing impacts.

Source(s): Ordnance Survey 'Open Greenspace', ONS 'Lower layer Super Output Area population estimates'; Cambridge Econometrics analysis.

Applying the same method to Newcastle shows quite different results. In the area examined, 324,645 people (69% of the population) are estimated to have access to green space within 300 metres of their home, whereas 146,631 (the remaining 31%) have not. In 20 LSOAs, **less than a quarter of the population** has nearby access to green space. In contrast, in 211 LSOAs, **more than half the population** is estimated to have access to greenspace. Two LSOAs (totalling 5,835 people) have no nearby access to greenspace: 006F (Salters Road, north of Nuns Moor) and 023H (near Newcastle train station).

Figure 5.17: Share of population in Newcastle with green space within 300m of their homes



Note(s): Very small green space (smaller than 0.01 km² or 1 hectare) is excluded because of its minimal estimated wellbeing impacts.

Source(s): Ordnance Survey 'Open Greenspace', ONS 'Lower layer Super Output Area population estimates'; Cambridge Econometrics analysis.

Diabetes

A study (Astall-Burt *et al.*, 2014) of more than 250,000 people in Australia found that living in an area where more than 40% of the land in a 1 km radius is green space is associated with a significantly reduced risk of developing type 2 diabetes. Table 5.9 lists the reduced risk of developing type 2 diabetes associated with living in an area with specific increments of green space within a 1 km radius.

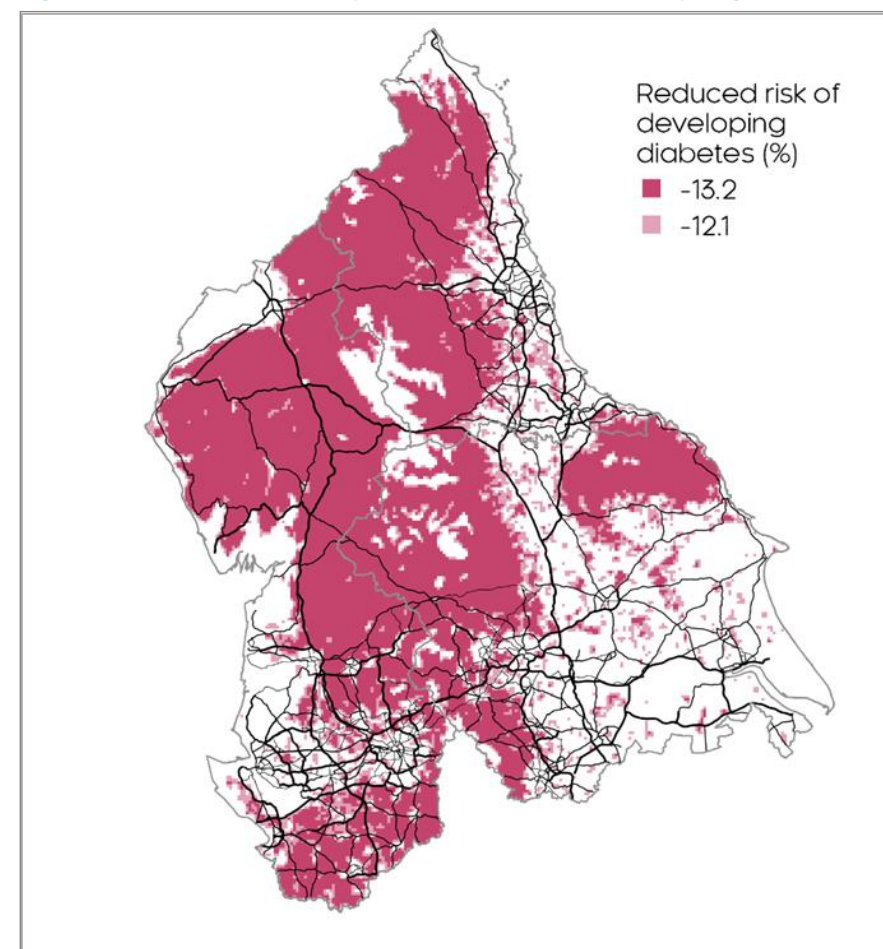
Figure 5.18 shows the spatial distribution of that reduced risk, highlighting the areas away from / around major cities. White areas on the map correspond to areas that have a lower density of green space within a 1 km radius (less than 40% of the surrounding area is covered by health-enhancing green space). The predominant land use in these areas is mostly urban, suburban, and farmland as well as rock- or sand-covered spaces in coastal areas.

Table 5.9: Reduced risk of type 2 diabetes relative to reference category (<40% within 1 km radius)

Green space increment (% within 1km radius)	Change in risk (%)
41-60	-12.1
60+	-13.2

Source(s): Astall-Burt *et al.* (2014).

Figure 5.18: Reduced risk of type 2 diabetes from proximity to green space



Source(s): Astall-Burt *et al.* (2014); Department for Transport (2020); UK Centre for Ecology & Hydrology; Cambridge Econometrics analysis.

Psychosocial distress

A study (Astell-Burt and Feng, 2019) of more than 45,000 people in Australia found that living in an area where more than 5% of the land in a 1-mile (1.6 km) radius is green space is associated with a significantly reduced risk of psychosocial distress. Table 5.10 reports the reduced risk of psychosocial distress associated with living in an area with specific increments of green space within a 1-mile radius.

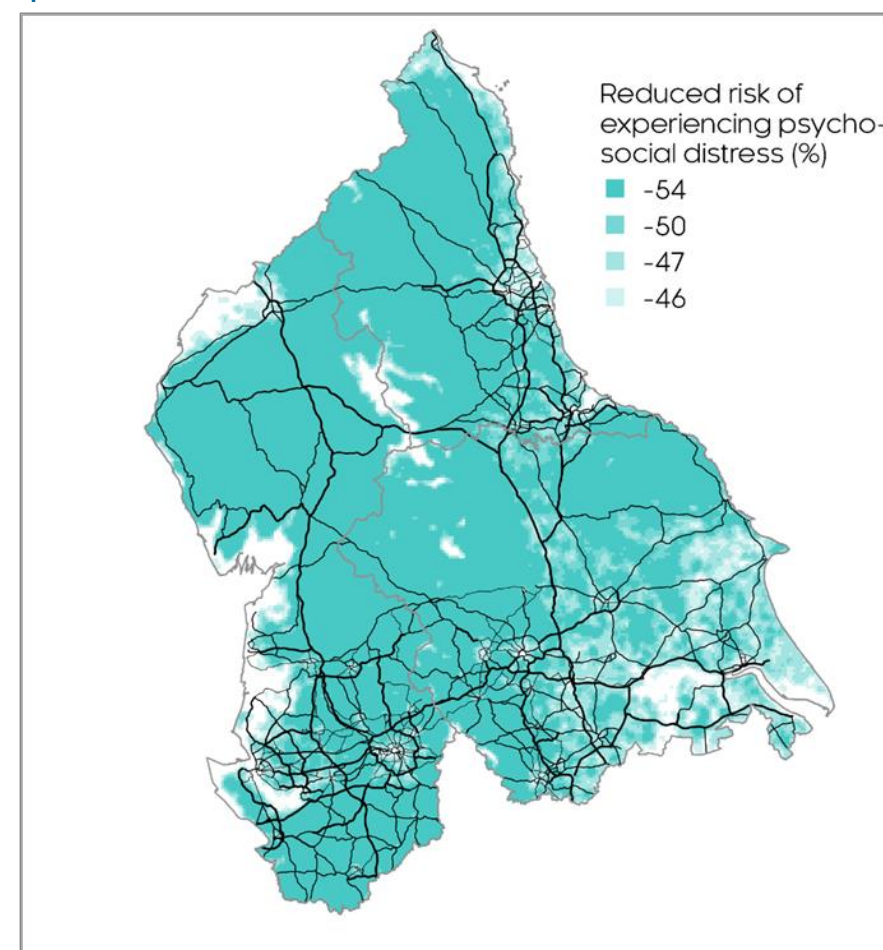
Figure 5.18 shows the spatial distribution of that risk reduction to be much more wide-ranging than for type 2 diabetes risk (as above) owing to the lower threshold identified for health benefits. The white space on this map corresponds to areas that have less than 5% of land within a 1-mile radius as green space. This lower threshold (especially compared with the diabetes analysis) translates to a large impact area across the region of the North.

Table 5.10: Reduced risk of psychosocial distress relative to reference category (<5% within 1-mile radius)

Green space increment (% within 1-mile radius)	Change in risk (%)
5-9	-46
10-19	-47
20-29	-50
30+	-54

Source(s): Astell-Burt and Feng (2019).

Figure 5.19: Reduced risk of psychosocial distress from proximity to green space



Source(s): Astell-Burt and Feng (2019); Department for Transport (2020); UK Centre for Ecology & Hydrology; Cambridge Econometrics analysis.

Self-rated general health

A study (Astell-Burt and Feng, 2019; as for psychosocial distress) of more than 45,000 people in Australia found that living in an area where more than 10% of the land in a 1-mile (1.6km) radius is tree canopy is associated with a significantly reduced risk of self-rated fair or poor general health. Table 5.11 lists the reduced risk of self-rated fair or poor general health associated with living in an area with specific increments of tree canopy within a 1-mile radius.

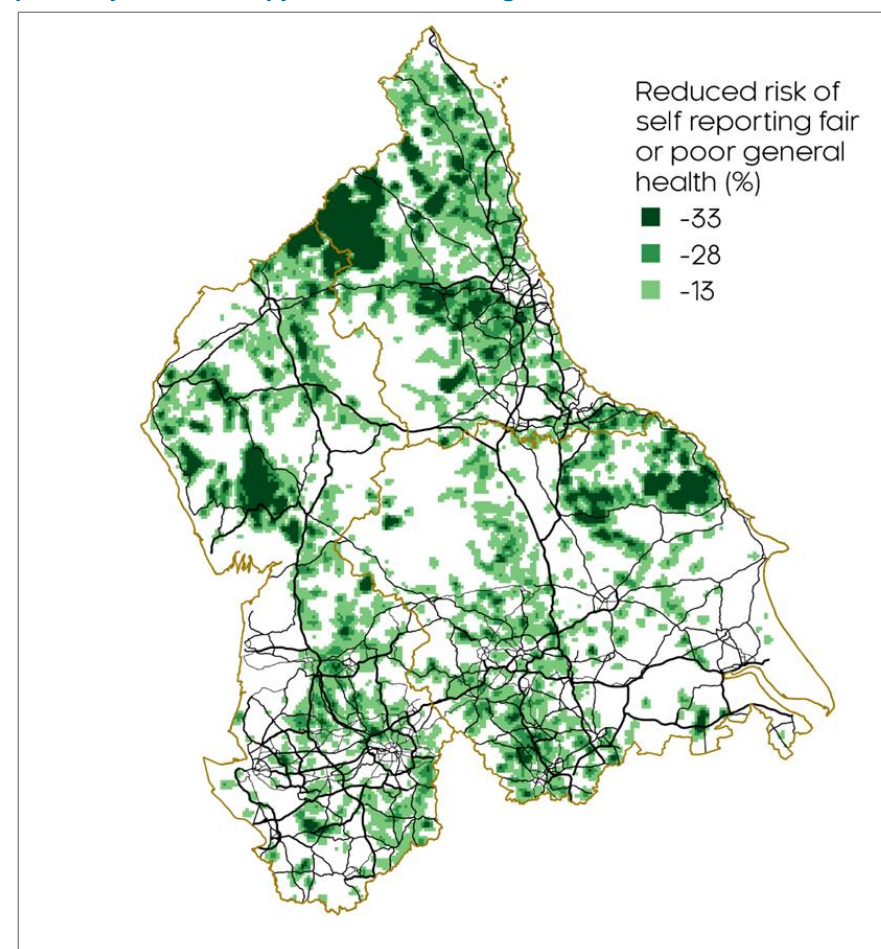
Figure 5.20 shows the spatial distribution of that risk reduction, with at least some areas in and around cities in the North. White spaces on this map correspond to areas with less than 10% of land within a 1-mile radius covered by tree canopy. According to Astell-Burth and Feng, people living there would be more likely to report poor general health, all other things constant. Relative to more broadly-defined green space, areas with sufficiently dense tree canopy are rarer in the North. The areas enjoying the greatest benefits of proximity to tree canopy are more concentrated in the northern half of the region, around Northumberland and Lake District National Parks. The North York Moors near Scarborough also offer good tree coverage.

Table 5.11: Reduced risk of self-rated fair or poor general health relative to reference category (<10% within 1-mile radius)

Tree canopy increment (% within 1-mile radius)	Reduced risk (%)
10-19	-13
20-29	-28
30+	-33

Source(s): Astell-Burt and Feng (2019).

Figure 5.20: Spatial risk of self-rated fair or poor general health from proximity to tree canopy in the North of England



Source(s): Astell-Burt and Feng (2019); Department for Transport (2020); UK Centre for Ecology & Hydrology; Cambridge Econometrics analysis.

Areas with the greatest health benefits from proximity to green space are less likely to be deprived areas

The 2011 census (the basis for our postcode-level analysis) reports 14.9m people living in the North of England, with the 2020 population estimates from Nomis reporting a more recent figure of 15.6m. From our (2011-based) analysis, some 5.2m people live in areas that benefit from lower risk of diabetes, 14.7m people live in areas that benefit from lower risk of psychosocial distress, and 9.1m people live in areas that benefit from a lower risk of self-rated fair to poor general health in the North. Table 5.12 lists the numbers of people in the North affected by each of these impacts. For diabetes and self-rated general health, those that live in the areas of highest risk were also more likely to be in the lowest decile of the 2015 English Indices of Multiple Deprivation (IMD). For psychosocial distress, few people (around 200,000) live in areas with the highest risk (receiving no estimated benefit from green space).

There is evidence of a steeper social gradient, with over one-third of people receiving the smallest benefit also living in the most deprived areas; while the rate falls to just over one in eight for areas seeing the highest benefit. In all cases, the areas enjoying the greatest health benefits from proximity to green space were least likely to have populations in the lowest IMD decile. This finding suggests that the health benefits of green space are unevenly distributed in the North, favouring wealthier or less deprived areas.

Table 5.12: Population affected by impacts tied to proximity to green space

Impact	Population affected ('000s)	Proportion of affected population in lowest IMD decile (%)
Diabetes		
Highest risk (0% risk reduction)	9,720	23.6
12.1% risk reduction	2,900	13.2
13.2% risk reduction	2,270	5.0
Psychosocial distress		
Highest risk (0% risk reduction)	200	16.7
46% risk reduction	490	34.9
47% risk reduction	1,920	30.9
50% risk reduction	2,970	23.8
54% risk reduction	9,310	13.8
Fair to poor general health		
Highest risk (0% risk reduction)	5,750	22.8
13% risk reduction	6,230	18.1
28% risk reduction	2,310	13.3
33% risk reduction	600	7.0

Note(s): Population totals (middle column) may not be equal across impacts due to rounding.

Source(s): Cambridge Econometrics analysis.

5.5 Noise pollution

Traffic noise has both physical and mental health impacts

Noise in the environment is a stressor that can trigger physiological and psychological responses in the body. Chronic noise exposure is a risk factor

for a range of non-communicable health conditions, including heart disease (Münzel *et al.*, 2018) and depression (Seidler *et al.*, 2017).

This analysis focuses on the relationships between:

- road traffic noise and physical health: coronary heart disease (drawing on a meta-analysis by Babisch, 2014) and hypertension (van Kempen and Babisch, 2012)
- road and rail traffic noise, and mental health: depression (Seidler *et al.*, 2017)

A meta-analysis by Babisch (2014) considered 24 studies on the relationship between road traffic noise and coronary heart disease and found an odds ratio of 1.08 for each increment of 10 decibels (dB) from 55 to 75 dB.

For hypertension, van Kempen and Babisch (2012) considered 27 studies in their meta-analysis of the relationship with road traffic noise and found an odds ratio of 1.034 for each increment of 5 dB from 45 to 75dB.

Table 5.13 lists the increases in the risks of coronary heart disease and hypertension associated with living in an area with road traffic noise.¹⁵ The table begins at 55 dB to match the measurements in the accompanying traffic noise data from Defra.

Table 5.13: Increased physical health risks from road traffic noise

Increase in noise (dB)	Increase in health risk (%)	
	Coronary heart disease	Hypertension
55.0 - 59.9	8.0	6.9
60.0 - 64.9	8.0	10.6
65.0 - 69.9	16.6	14.3
70.0 - 74.9	16.6	18.2
75.0+	26.0	22.2

Source(s): Coronary heart disease: Babisch (2014).
Hypertension: van Kempen and Babisch (2012).

Both road and rail traffic noise increase depression risk, but rail impacts are less certain at high noise levels

Seidler *et al.* (2017) considered the association, in Germany, between both road and rail traffic noise, and depression. This study found a strong, positive relationship between road traffic noise in one's place of residence and the risk of experiencing depression. The authors also found that rail traffic noise does increase the risk of experiencing depression, but this effect was not significant at higher levels of noise, likely because of fewer observations at close proximity to the rail network. Table 5.14 lists the increase in risk of depression associated with living in an area with road and rail traffic noise.

¹⁵ Measured as the average noise level in decibels over a 16-hour period between 07:00 and 23:00.

Table 5.14: Increased mental health risks from road and rail traffic noise

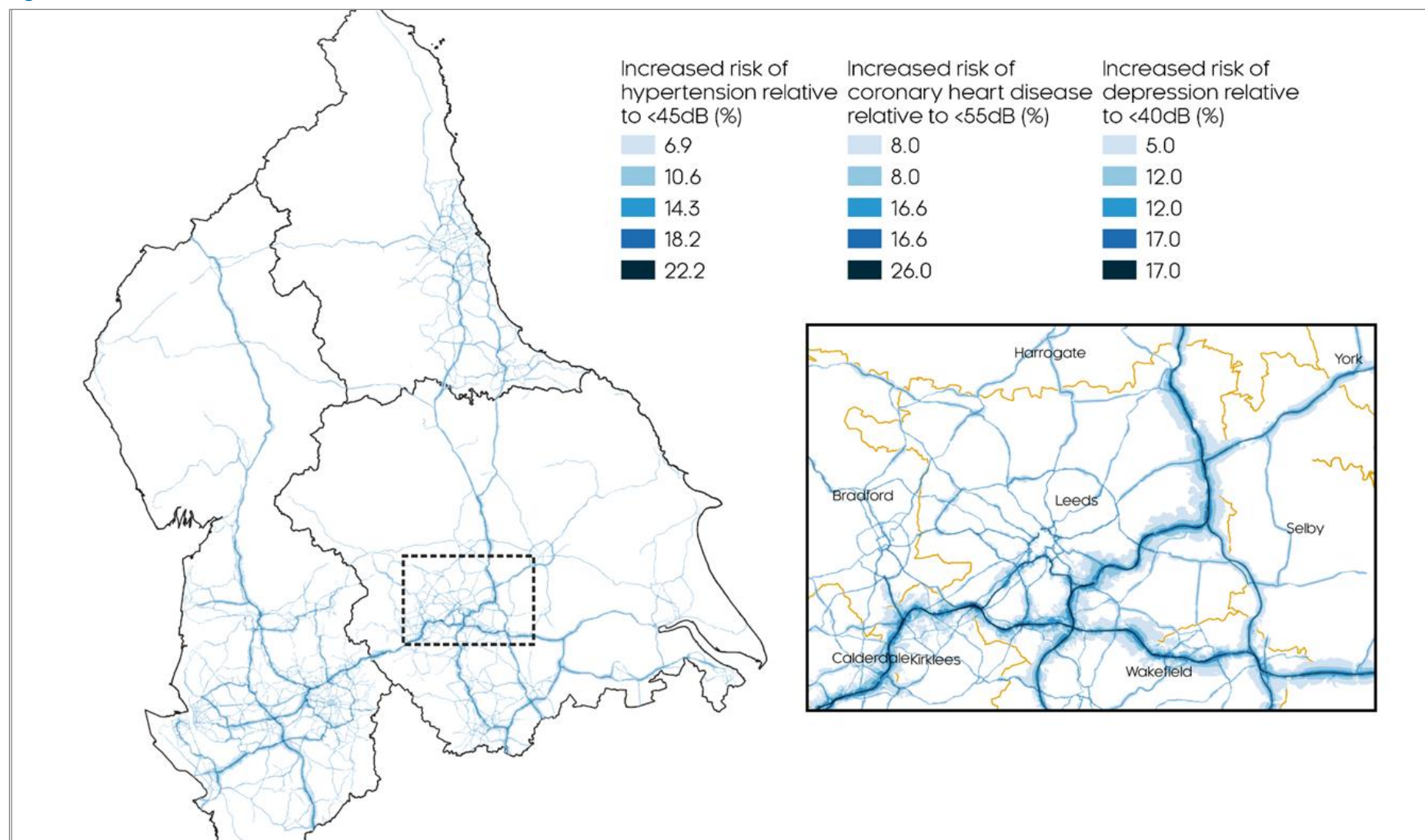
Increase in noise (dB)	Increase in depression risk (%)	
	Road	Rail
55.0 - 59.9	5.0	6.0
60.0 - 64.9	12.0	15.0
65.0 - 69.9	12.0	7.0*
70.0 - 74.9	17.0	-7.0*
75.0+	17.0	-7.0*

Note(s): * denotes estimates that are uncertain and not statistically significant at the 5% level. This is likely due to small sample sizes in close proximity to rail

Source(s): Seidler *et al.* (2017).

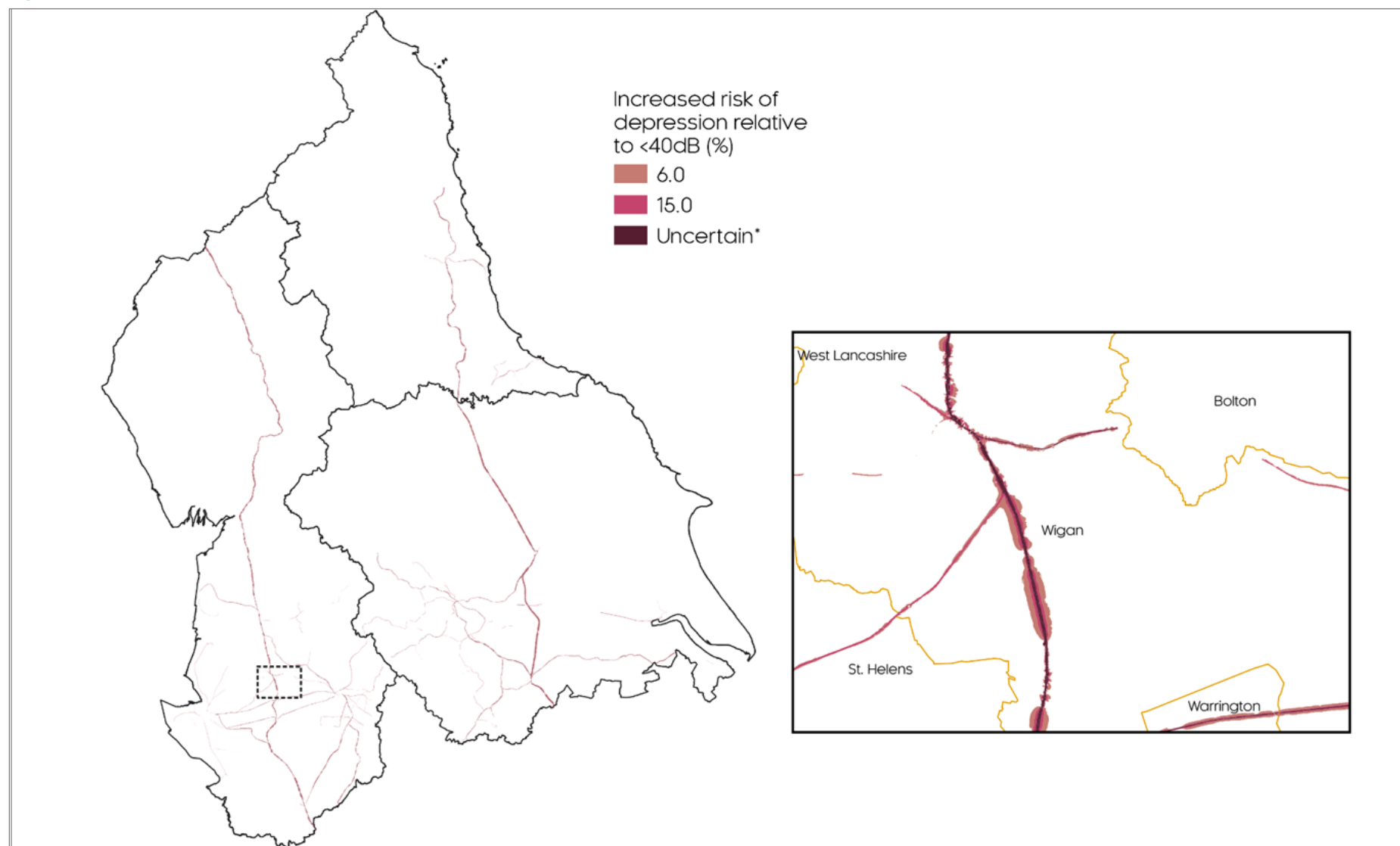
Figure 5.21 shows that the areas with the highest risk of health impacts due to road traffic noise are concentrated around major motorways, including more densely-populated urban areas around Manchester, Liverpool, Leeds, and Newcastle. The risk of depression due to rail traffic noise is much more diffuse, though there are areas of higher risk concentrated around two major north-south rail lines: one leading to Glasgow in the west and the other heading to Edinburgh in the east (see Figure 5.22). Both are electric, therefore noise differences may be due to the frequency rather than type of service. Generally, areas of high rail traffic noise do not extend as far from rail tracks as road traffic noise does from major roads and even more so for motorways, suggesting rail transport contributes much less to the burden of disease than does road transport.

Figure 5.21: Increased health risks from road traffic noise



Source(s): Babisch (2014), van Kempen and Babisch (2012), Seidler et al. (2017); Defra; Cambridge Econometrics analysis.

Figure 5.22: Increased mental health risks from rail traffic noise



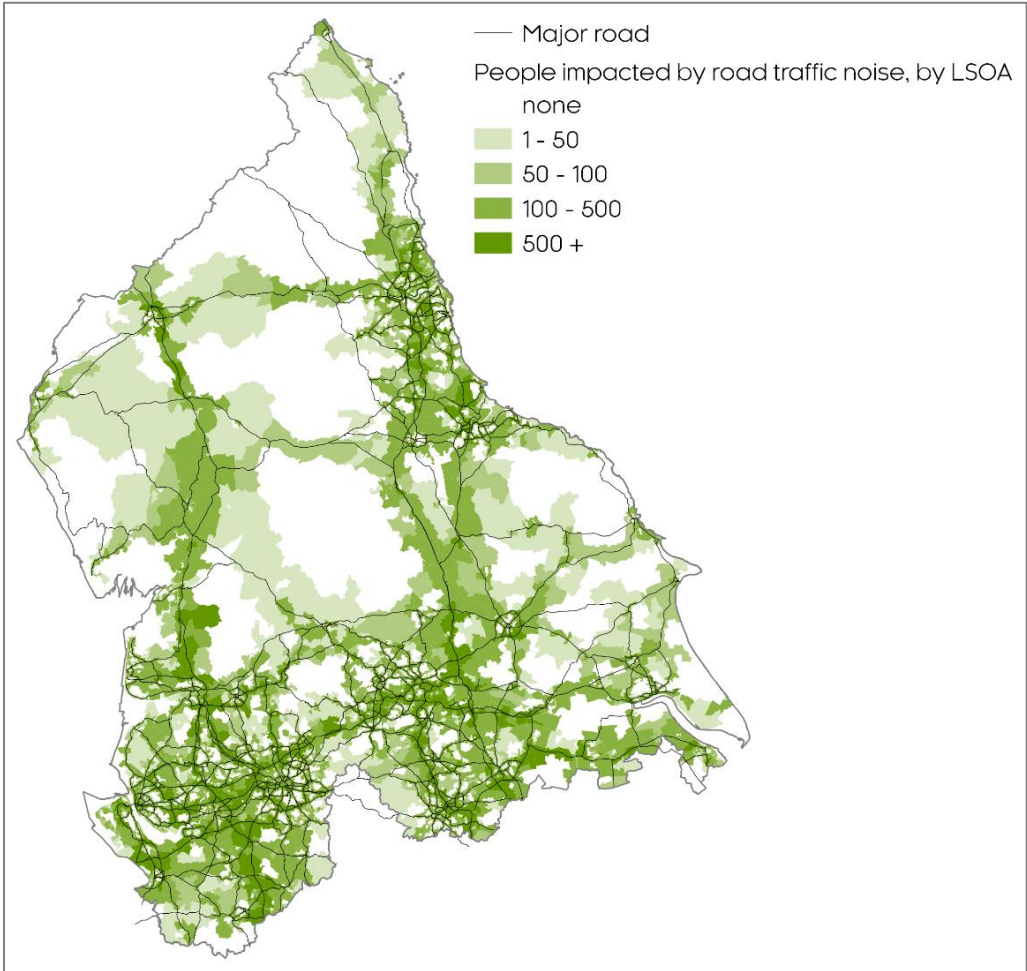
Source(s): Seidler *et al.* (2017); Defra; Cambridge Econometrics analysis.

Over 2.5m people are affected by road traffic noise in the North

Figure 5.23 illustrates the estimated impact that road traffic noise has on the population of the North, by LSOA. Over 2.5m people are affected by traffic noise from roads in the North. In percentage terms, this represents 18% of people in the North West, 15% in Yorkshire and the Humber, and just under 15% in the North East. The high percentage affected in the North West is likely to be linked to large urban centres such as Manchester and Liverpool. The impacts are most concentrated in and near the most densely-populated cities and towns. The human impact of road traffic noise in sparsely populated areas is minimal.

One caveat of the analysis is that impacts on sparsely-populated LSOAs is likely underestimated. This is because the method assumes that people are evenly spread within an LSOA. In reality, LSOAs have an uneven population distribution and residences are likely to be concentrated near major roads. Our estimate is therefore likely smaller than the real figure.

Figure 5.23: People impacted by road traffic noise in the North, by LSOA



Source(s): Seidler *et al.* (2017); Defra; Office for National Statistics; Cambridge Econometrics analysis.

5.6 Severance

This section presents an example application of a method proposed by Anciaes (2013)

Approaches to modelling community severance in relation to transport are still not fully developed. This is because community severance cannot yet be quantified effectively (Mindell & Karlsen, 2012). Nevertheless, impacts resulting from what can be identified as severance are outlined as part of the impact framework (see Section 4.6).

This section presents an application of the method put forward by Anciaes (2013) to measure (potential) severance caused by a road. We present it as a proof-of-concept which TfN may wish to explore further.

Anciaes's (2013) proposed method considers how destinations are separated by a road and how this restricts a neighbourhood's access to those destinations.¹⁶ A resident's potential destinations are all other population centres within walking distance of their neighbourhood. This captures both households where friends and family reside, and facilities and services, such as shops and town centres, which are also population centres.

Severance can be thought of as separating populations ('connections') in walking distance of each other

The calculation of severance involves:

- the number of people affected: the population of the neighbourhood in question
- the attractiveness of each candidate destination: proxied by the population of that destination i.e. as a weight
- the severance value of the road: how difficult it is to cross and how much of a detour must be taken to reach its crossings

Destinations are classed as population centres within straight line walking distance, and two walking distance bands are chosen based on the 'Streets for Life' urban design concept by Oxford Brookes University (Burton & Mitchell, 2006), at 0-500 and 500-800 metres. Destinations between 500-800m have their attractiveness score halved.

The severance value of the road depends on how significant a barrier it represents to those wishing to cross it, which is discussed in more detail below.

Adapting Anciaes (2013), the severance effect of a road on all neighbourhoods can then be calculated as:¹⁷

$$Total\ Severance = \sum_{n \in N} Pop_n \cdot \sum_{d \in D} A \cdot I_d \cdot RSI$$

where:

- n = a neighbourhood within 800m of the road
- N = all such neighbourhoods
- Pop = The population of a neighbourhood

¹⁶ The method could feasibly be used for rail or any other infrastructure that imposes a barrier between two places.

¹⁷ Anciaes (2013) does not articulate a formula, but sets out, descriptively, the input variables.

- A.I = Attractiveness index of a destination, proxied by its population
- d = a destination of neighbourhood n that has been severed by the road
- D = all such destinations
- RSI = Road Severance Index

As mentioned in Section 4.6, the unknowns (which must be defined and then measured) are the attractiveness index and the road severance index. Ancaes (2013) proposes population density as a convenient (and real-world) proxy for attractiveness and, as we suggest above, this could be interpreted as a measure of potential social connections. However, the road severance index remains problematic as a concept. We revisit this below, after presenting our example analysis.

Example: A dual carriageway in Liverpool

The A580 is a dual carriageway that goes through densely populated areas of Liverpool, including Norris Green, northwest of Liverpool city centre. A section of it is shown in Figure 5.24.

Figure 5.24: Severance imposed by Road A580 on Postcode L11 7AS



Source(s): Ordnance Survey 'OpenMap Local', UK Data Service 'UK 2011 census Postcode Headcounts'; Cambridge Econometrics analysis.

Walkable distance both defines and weights the neighbourhoods of interest

Figure 5.24 shows the severance impact of the A580 on the people living in a single neighbourhood, as measured by a postcode, L11 7AS, shown as the red dot at the centre of the concentric rings. The impact on this neighbourhood of the A580 road is measured in terms of lost connections, adjusted for distance.¹⁸ The 62 people living in L11 7AS now have to cross a road to get to any of the pink highlighted neighbourhoods (north of the road). The total

¹⁸ Following Ancaes (2013), people living between 500m and 800m from the origin are given half the weight of those within 500m, as they are further away. Those living more than 800m from the origin neighbourhood are excluded.

population of the neighbourhoods within 500m of L11 7AS (the inner concentric circle), and on the other side of this road is 1,807. The total population of the neighbourhoods 500-800m away (the outer concentric circle) and on the other side of the A580 is 807.

A weighted (attractiveness) score for these separated connections combines those potential connections within 500m (1,807) and those within 500-800m (807 halved = 403). This score is 2,210 (1,807 + 403).

The above gives a severance impact on the postcode of:

$$Severance_{L11\ 7AS} = Pop_{L11\ 7AS} \sum_{d \in D} A_d \cdot RSI_d$$

which translates to:

$$Severance_{L11\ 7AS} = 62 \cdot 2,210 \cdot RSI = 137,020 \cdot RSI$$

Were we to follow Ancaes (2013) at this point, we would then need to quantify the road severance index (RSI) of the A580 for this community.¹⁹ With no consensus on what this index should be (nor any straightforward way to interpret it), we opt not to calculate this term and, instead, focus on the number of (weighted) potential connections severed: 2,210.

The value of 2,210 compares to a total weighted value (i.e. the entire population in the vicinity, not just north of the road) of 7,837 such that 28% of the potential connections are separated by the A580. While not necessarily inaccessible, 28% of the connections could only be reached by crossing the road. The deterrent effect, whether physical or psychological, *may* represent potentially weaker social connectedness/capital.

*The approach
only identifies
potential
connections
severed...*

This population-based analysis could be taken to represent the number of (weighted/equivalent) social connections separated by a road. If one were willing to make this assumption, then this represents a proxy for social capital/connectedness which could then be interpreted in the light of the literature as greater risk of physical and mental ill-health. Were there evidence to link to severance, these would be applied at this point e.g. some change in health or some heightened risk of ill-health in response to more severance. As discussed previously, the lack of evidence precludes this final step, even if the analysis above might help in giving some indication of hotspots.

At best, however, the above is only a risk factor: we cannot observe the connections themselves (e.g. whether these people would necessarily have been connected in the absence of a road) nor can we know what the behavioural response might be (e.g. if people are more willing to walk a little further in other directions away from the road to compensate).

The configuration of walking routes may also be relevant. Here, we consider straight-line distance rather than, say, distance by walking paths. How this

¹⁹ The discussion in Ancaes (2013) goes further to consider how different road characteristics might affect severance in terms of road features but also ability to cross and other physical/psychological factors which may have a bearing.

might change the results is, however, beyond the scope of this analysis; as is any consideration of other transport options.

Other aspects of the method that may warrant future investigation include:

- the definition of a neighbourhood (here, taken to be the population living in a given postcode) and, by extension, the boundary around which the 800m radius can be drawn
- what is a reasonable walking distance. We use 0-500m and 500-800m here after Burton & Mitchell (2006) but this may vary over time and by neighbourhood
- whether demographic factors can be incorporated e.g. to consider the likely greater physical and psychological impact on children and the elderly

Extended example: The A1 in Newcastle

*...but may be
useful to
highlight risks of
reduced social
connectedness /
capital*

As an example, this approach could, in principle, thus be applied across an area to understand severance as a function of population density and road configuration. While the analysis still cannot take the step from severance to health, the approach, rooted in population distribution, may help to shed light on potential reductions in connectedness.

Taking the example further, we now apply the approach to a section of the A1 going through west Newcastle. The busy road crosses the edge of the Newcastle metropolitan area, with residential areas on either side. The population of the square area examined is 146,881. Severance, as calculated here, is not affected by any characteristics of the road, such as speed limit or number of lanes, since the methodology used does not have the means to account for these. It is therefore a function only of the sizes of the populations separated by the road. Also, we will only consider connections within 500 metres for (computational) simplicity, although different definitions of an area could be applied.

Figure 5.25 below shows a section of the A1 crossing a densely populated area in Newcastle.

Figure 5.25: Severance imposed by the A1 in Newcastle

Note(s): Connection severed defined as the percentage of total connections within 500 metres of a postcode interrupted by a major road.

For clarity, only postcodes with at least some (potential) severance are shown.

Source(s): Ordnance Survey 'OpenMap Local', UK Data Service 'UK 2011 census Postcode Headcounts'; Cambridge Econometrics analysis.

In total, 524,660 potential connections within 500 metres are on the other side of a major road in the area examined. These are concentrated in areas where both sides of the road are densely populated. Because the map only shows postcodes with at least some (i.e. non-zero) severance, while there is a populated area near the A1 in the south-east part of the map, there is no estimated severance risk here, because the population is entirely located to the south with no-one living north of the road. Some postcodes are more affected, with a higher proportion of their connections severed (up to a maximum of 83%). Higher proportions are observed in postcodes with major roads on multiple sides (see both roundabouts) and bends in the road.

The total number of connections severed should be interpreted with caution, because of significant double counting. A single postcode might lose connection to multiple (n) other postcodes within 500 metres. In that case, its population will be counted as 'severed' n times. For reference, the area examined has a total population of 146,881 people.

An adaptation of this approach could be used to compare the severance value of various road configurations in the same area.

6 Conclusion

This report considers the impacts of transport on health and wellbeing in the North of England

6.1 Summary

This project considered the impacts of transport on health and wellbeing in the North of England, with the aim of improving how such effects might be quantified to inform: the further development of TfN's Strategic Transport Plan (STP), TfN's Decarbonisation Strategy, and TfN's capacity to analyse the impacts of transport in the North.

We divided the work into:

- 1 an evidence review (a review of reviews) to see how strongly identified various the links for ten impacts were, and to assess their amenability for subsequent modelling
 - expert interviews helped with this process, to augment both the causal representation (the system map, as in Appendix A) and the body of evidence reviewed
- 2 the development of an impact framework to operationalise the evidence (where such evidence were suitably robust) in a way that could then be applied to questions of transport, health and wellbeing
 - a spreadsheet accompanies this report, setting out the various evidence, links and data requirements (and availability)
 - our analysis (in Chapter 5) shows how to apply the analysis and datasets we have developed as part of this work

6.2 Impact framework

Through the evidence review we identified three tiers of evidence

Through the evidence review, we identified three tiers of evidence according to the robustness of the quantitative findings and their amenability for further analysis. By this system, we categorised the ten types of impact as follows:

- Tier 1: Evidence from the literature and expert interviews supported by sufficient quantitative data and robust analysis for it to be possible to characterise the identified relations with high levels of confidence.
 - Physical inactivity
 - Incidents and safety
 - Air pollution
 - Limited access to green space, recreation and leisure
- Tier 2: Evidence from the literature and expert interviews is supported by sufficient quantitative data to estimate the strength of the relationship. However, either the data were insufficiently comprehensive, or econometric results were not strong enough, for this to be characterised as a robust result.
 - Noise pollution
 - Severance
 - User experience
- Tier 3: Evidence from the literature review and expert interviews provides insight as to the direction, approximate scale, and nature of the relationship between two or more variables; however no attempt to quantify this has yet been made.

- Limited access to healthcare facilities
- Limited access to high-quality employment
- Environment quality

Some impacts are amenable to analysis...

By this categorisation, Tier 1 impacts are in principle amenable to quantitative analysis of transport. This is reflected in the impact framework and, moreover, these are also aspects in which there tend to be good data on the necessary parts of the causal chain to carry out analysis.

but others face various analytical challenges

Tier 2 impacts present more of a challenge for quantitative analysis because of some (related) combination of:

- weaker or less conclusive quantitative evidence
- more complex chains of causation, possibly with evidence gaps (or unobservables) that make it difficult to operationalise the framework
- limited data availability to combine with the above

While this does not necessarily preclude quantitative analysis, depending on the impact, the degree of feasibility varies from broadly assessable (as in noise pollution) to tentatively, with caveats (as in our test case of severance) to not modellable (user experience).

The remaining impacts (Tier 3) tend to represent more in the way of hypothesised pathways that link transport to specific health outcomes, with little or no supporting quantitative evidence.

The impact framework thus identifies:

- five impacts for which there are sufficient evidence and appropriate geospatial datasets some form of analysis of health impacts (as presented in Chapter 5)
- one impact, severance, for which we carried out some test analysis of how a measure based on population density/proximity might help signal risks of social disconnectedness
- four impacts for which quantitative analysis is not currently possible, with some discussion of the gaps and how they might be filled

6.3 Analysis

Our summary findings from the analysis (in Chapter 5) are as follows.

Four of the six impacts analysed in this report considered the whole of the North of England. The two remaining impacts (physical inactivity and severance) were evaluated at smaller scales due to the complexity of the analysis and/or the availability of data. Where possible, we analysed not only the spatial distribution of health risks but also how these risks are distributed among the population of the North. Table 6.1 summarises the estimated number of people at risk from the health impacts analysed in Chapter 5.

The data (shapefiles) that informed this analysis accompany this report, both as analyses in their own right but also as examples of how such analysis could be carried out in the future.

Table 6.1: Summary of the estimated number of people at risk, by transport-related health impact and geography

Impact category	Impact	Geography analysed	Estimated number of people at risk in geography ('000s)
Physical inactivity	Lower walking and cycling activity	Greater Manchester	163
Incidents and safety	Number of traffic casualties		33*
Air pollution	Higher risk of mortality from nitrogen dioxide	The North	5,880
	Higher risk of mortality from PM ₁₀		5,850
	Higher risk of mortality from PM _{2.5}		5,640
Limited access to green space, recreation and leisure	Higher risk of type 2 diabetes		9,720
	Higher risk of psychosocial distress		200
	Lower self-rated general health		5,750
Noise pollution	Higher risk of hypertension		2,500
	Higher risk of coronary heart disease		2,500
	Higher risk of depression		2,500

Note(s): * This number does not represent those at risk of traffic incidents but the number of traffic casualties in the North for 2019.
 We did not calculate the number of people at risk for physical activity and subjective wellbeing from proximity to parks and severance.
 For air pollution, only the three most harmful pollutants were considered.

Source(s): Cambridge Econometrics analysis.

Physical inactivity

The analysis of physical inactivity suggests that:

- in Greater Manchester, more than 2.6m people have access to a cycle path within 1 km of their home, translating to 61.2 additional minutes of physical activity per week relative to those who live more than 4 km from a cycle path
- parks in urban areas within 0.5 km of one's place of residence are associated with a 1.86% increase in a measure of physical activity per park in range, which we demonstrated as suggesting benefits to residents of Sheffield and Greater Manchester

The evidence points to the value of built environment interventions such as cycle routes and urban parks as ways to stimulate physical activity for those nearby. Insofar as built environment interventions increase access and use of features that promote physical activity within a community, healthier populations should result. However, we note that some of these effects may be quite small in scale, possibly limiting the degree of health improvement.

The principal limitations of the analysis concern the needs to:

- consider the quality of the infrastructure and whether/how it drives physical activity, especially given the finding that, in principle, much of the population of Greater Manchester is in reasonable proximity to a route
- consider access in a more nuanced way beyond straight-line distance i.e. to capture features of the environment and what it really means for travel routes and times/distances

Incidents and safety

Various features of roads and vehicle traffic patterns are associated with the number and severity of vehicle collisions and casualties. For example, average speed, traffic volume, speed variation, and speed difference are all factors shown to affect the occurrence of traffic incidents. Our analysis considered the rate of traffic incidents by local authority and daily traffic volume of major roads in metropolitan districts.

Our deeper analysis of Greater Manchester showed that, while traffic volume was high on major motorways, such as the M60, the bulk of incidents were concentrated on A roads, especially near the urban core of the area. Further, the casualty rate per distanced travelled is ten times lower for motorways when compared to A roads.

The risk of a road traffic incident is highly context-specific, meaning it can be hard to model the risk without a detailed representation of local factors. Further data with a measure of traffic density might be helpful in modelling the risk of traffic incidents. Additional data that identify incidents by point on the map may also be helpful in broadening the analysis.

Air pollution

Air pollutants, some of which are directly attributable to transport, are related to many negative health outcomes that can result in hospitalisation and/or mortality. We analysed six pollutants in the Northern regions to estimate the expected increase in risk of hospital admissions and mortality:

- most of the increased risk of hospitalisation and mortality comes from NO₂, PM_{2.5}, and PM₁₀ emissions. Of these, NO₂ and PM_{2.5} are highly localised,

with maximum effects near the kerb, with implications for road design and pedestrian crossings

- NO₂ concentrations are much higher during the morning and evening rush hours: higher uptake of public transport commuting may thus added health benefits through cleaner air

Increased use of public transportation, especially low-emissions forms of public transportation, could be a means of alleviating the burden of transport-related air pollution.

As well as encouraging modal shift, policies that reduce pollution from motor vehicles or that encourage uptake of vehicles that pollute less (e.g. electric vehicles) could thus benefit human health by reducing emissions. However, pollutants such as PM₁₀ can result from tire and brake wear, which would likely persist if such vehicle use were to continue.

Limited access to green space, recreation and leisure

Proximity to green space and proportion of green space nearby were analysed relative to subjectively and objectively measured health outcomes:

- the amount of green space within 300 metres of one's place of residence has a relationship with improved subjective wellbeing measures
 - focusing on the Manchester area, the urban core of the city has relatively lower access to public green space
 - the population of this core tends to be younger, suggesting that they are benefitting less from enhanced wellbeing
 - However, the analysis of Newcastle showed a very different story, with over two-thirds of the population estimated to live within 300m of greenspace.
- the proportion of green space near to one's place of residence is also associated with improved health outcomes, including lower risks of type 2 diabetes, psychosocial distress, and self-rated general health. When looking at the North:
 - the benefits of decreased risk of diabetes from green space were spread across the region, concentrated in more rural areas and lowest in the southeast corner of the region
 - the benefits of reduced risk of psychosocial distress from green space were wide-ranging through the region, including in urban areas
 - the benefits of reduced risk of self-rated fair or poor general health were most diffuse, concentrated in pockets of forested areas in the northern half of the region

The health benefits of proximity to green space in the North are unevenly distributed. Areas with lowest risks of negative health outcomes are less likely to have populations in the lowest IMD decile.

The North of England is fortunate to have an abundance of green space within its borders, including both urban parks and more rural areas of open or forested green space. Urban areas tend to be at higher risk of having more limited access to green space, so transportation options to increase access would be expected to improve health.

Further analysis on access to mountainous or coastal areas (not defined as green space in this analysis) could be useful, as these natural features most

likely also provide access to recreation and leisure that could accrue health benefits to the population of the North.

Noise pollution

Noise resulting from transport traffic from roads and railways is related to several physical and mental health outcomes, including coronary heart disease, hypertension, and depression. With data on the extent of road and rail traffic noise in the North, the resulting health impacts were modelled for the whole region. We conservatively estimate that over 2.5m people in the North are affected to some degree by road traffic noise, concentrated in the more urbanised southern half of the region and along the major motorway routes. These populations face higher risks of hypertension, coronary heart disease, and depression, relative to areas with low levels of traffic noise.

While road traffic noise pollution does not penetrate into areas very far from major roads, this does affect large segments of the population, as residences and populated areas tend to be found near major roads. Interventions to help reduce noise pollution in residential areas, especially those near major motorways, would be expected to improve health outcomes. The risks due to railway traffic noise are much less widespread.

Further analysis could also look at air traffic noise pollution and consider the interaction of the noise pollution from the three sources, which may point to areas at particular risk.

Severance

TfN was also keen to consider if there might be some way to advance some understanding of the health impacts of severance. Here, the causal evidence chain is broken in the sense that there is some understanding that road traffic can lead to severance and that a lack of connectedness can be detrimental to health; however, the evidence on specifically severance-related health impacts is limited.

In this report, we have carried out small pieces of example analyses that look at how roads might limit how one neighbourhood can reach the people in another within a defined radius (of walkable distance) for both Liverpool and Newcastle. The total population within this radius represents one measure of *potential* social connections and, taking this as one possible proxy for social connectedness/capital, the extent to which the accessible population might be at risk of negative health impacts as a consequence.

Given the limited evidence in the literature, such analysis should be taken as indicative of the health impacts only, but it may be a promising route to better understand the spatial distribution of risk.

6.4 Directions for future work

There are various directions to expand the currently feasible analysis

In terms of how this work might be extended in the future, we identify three main themes:

- 1 the challenges of identifying access and usage, rather than just proximity (which is only a surrogate for access/usage): this concerns in particular physical inactivity and green space
- 2 context-specificity as a challenge to identifying appropriate upstream effects, which is most pertinent to incidents and safety

- 3 identified gaps in the evidence for impacts (in Tiers 2 and 3) thought to be of importance in understanding the role of transport in health and wellbeing

Indicators of, or insight into, usage would be valuable

As stated in this report, there is a lack of data on usage of infrastructure and green space and, in turn, the determinants of that usage. This is a challenge because, as the cycling routes analysis shows, in principle, large proportions of urban populations are reasonably close to these paths and understanding who makes use of them (and why) and not (and why not) is vital to understanding both the performance of the intervention itself, but also the health outcomes.

In the analysis (and, indeed, in the evidence), proximity is taken as a surrogate indicator of use/access such that being located closer to such infrastructure is associated with improved health, acknowledging that this effect must be mediated by usage.

As such, a fruitful area of further research would be to understand, perhaps in a consumer choice manner, what affects usage of routes and space, to gain a more nuanced understanding of whether and how an intervention might be effective.

Context-specific phenomena likely require expanded models upstream of the health analysis

In the case of road traffic incidents, we also noted the context-specific nature of certain effects. While there may be ways to crudely estimate the upstream causes (in this case, the likelihood of incidents, of varying severity), the challenges of prediction in order to then calculate the consequences has precluded more detailed analysis. Given the complexities, it may be that more sophisticated transport analysis is required before feeding into the health outcomes work.

Gaps in the impact framework may concern impacts of high importance

Finally, the clearest gaps in the impact framework concern those impacts for which both evidence and data are too limited. The following are perhaps most pertinent given the intuition / *a priori* expectation that they are material/important:

- severance, which is an issue of much concern and, as our example analysis suggests, it may be possible to begin advancing work on the social connectedness of populations (albeit under various caveats and assumptions)
- from a wellbeing perspective, user experience (which the evidence shows differs greatly by mode of transport) seems ripe for deeper exploration, not least from a behavioural perspective and in the context of efforts to encourage modal shift – understanding, for example, what is preventing people from switching to lower-stress transport options
- the benefits of access to healthcare tend to be taken as given in the literature, with the presumption that closer is better – while a reasonable assumption, from a strategic transport perspective, understanding the patterns of impact in quantitative manner, rather than simply the (likely) direction of impact, would be useful to prioritise investments
- access to employment, which is increasingly recognised as an important social determinant of health, would also be critical to understand in concert with other economic analyses for the North (not least given the devolution agenda and recent interest in levelling up). Here, there are challenges to

do with identifying data on access and travel (the routing) but also in appreciating the spatial variation in labour supply and demand (e.g. skills/occupational mismatch)

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Appendices

Appendix A System maps

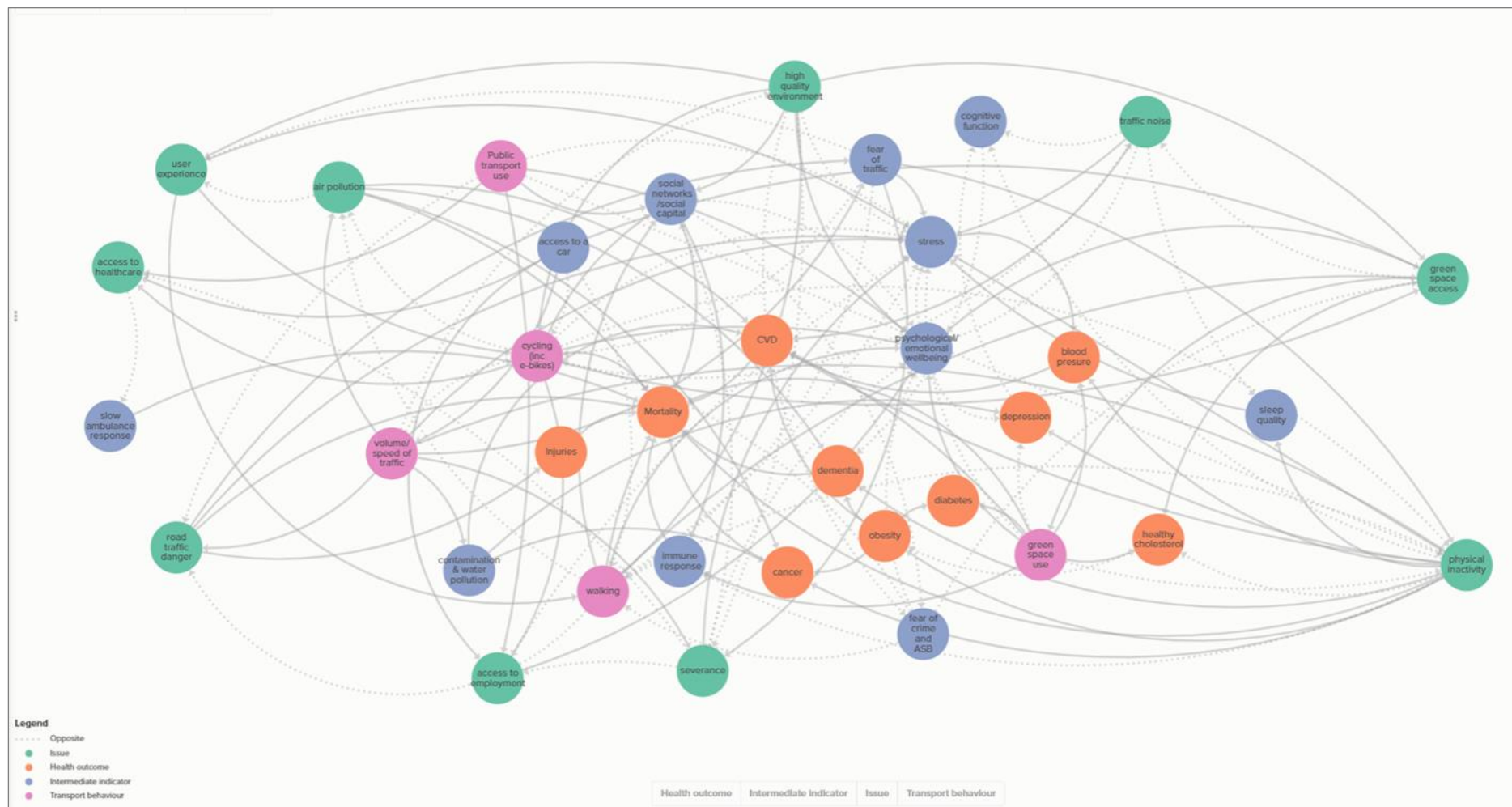
The following pages present the full system map before showing, in sequence:

- links from Tier 1 evidence
- links from Tier 1 and 2 evidence
- links from Tier 1, 2 and 3 evidence

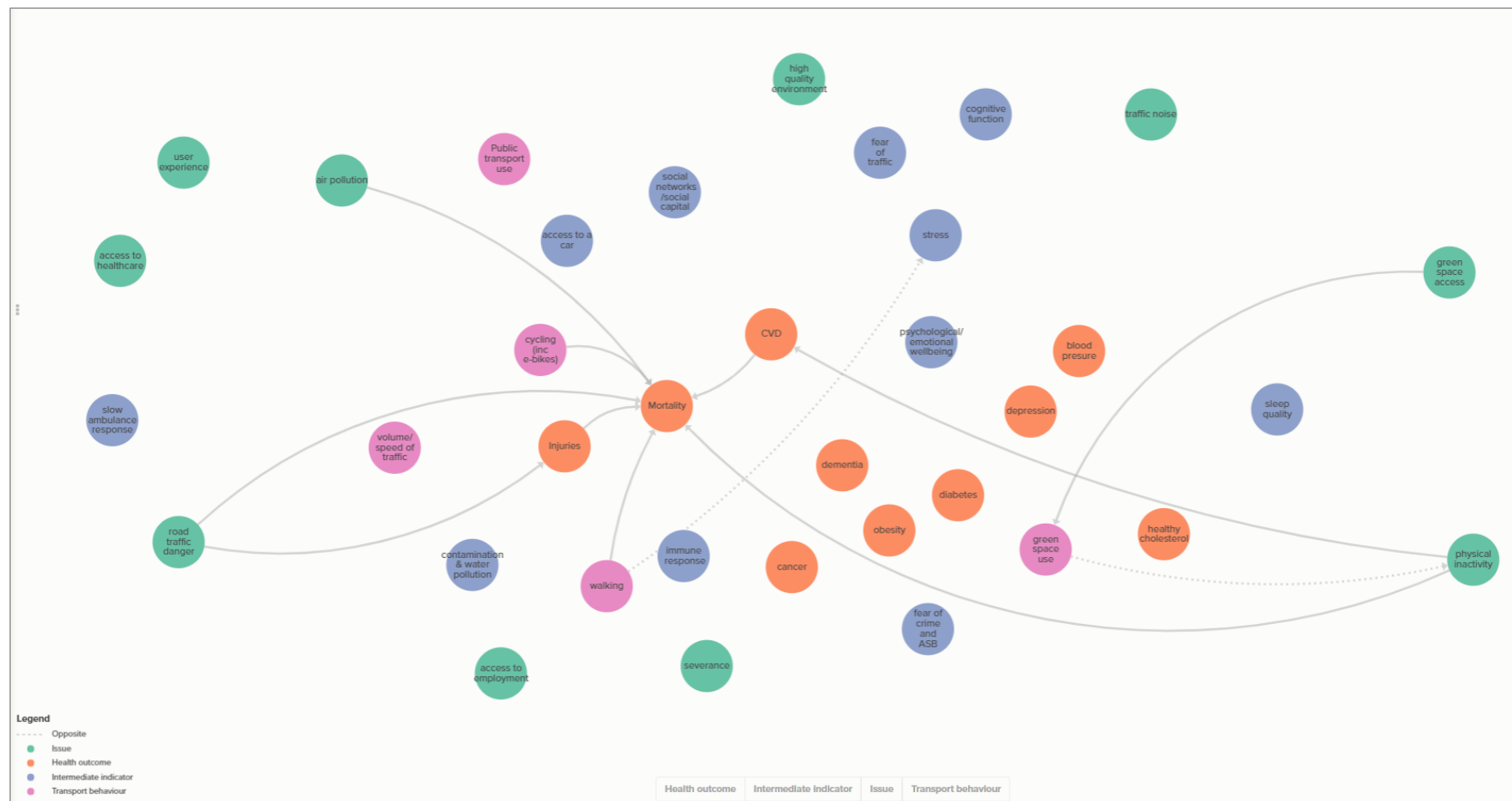
Interactive versions of the system maps are available from:

<https://nickcavill.kumu.io/transport-for-the-north-transport-and-health>

Appendix Figure A.1: Complete system map



Appendix Figure A.2: System map for Tier 1 evidence



Legend

- Opposite
- Issue
- Health outcome
- Intermediate indicator
- Transport behaviour

Health outcome Intermediate Indicator Issue Transport behaviour

Legend

- Opposite
- Issue
- Health outcome
- Intermediate indicator
- Transport behaviour

Health outcome | **Intermediate indicator** | **Issue** | **Transport behaviour**

Appendix B Expert consultations

Appendix Table B.1 below summarises the key discussion points from each expert interview, including (in the two rightmost columns) how the exchange informed an augmented evidence base and system map.

Appendix Table B.1: Transport and health expert consultations

Name	Organisation	Primary expertise	Topics discussed	Additional evidence cited	Amendments to system map
Dr Andy Cope	Sustrans Research and Monitoring Unit	<ul style="list-style-type: none"> • Active travel • Local monitoring and data collection 	<ul style="list-style-type: none"> • Land use planning, as a significant determinant of transport patterns • 20-minute neighbourhoods • Inequalities • Use of green space • Physical activity • Importance of WHO HEAT tool • Growing importance of e-bikes • Mental health and the needs of different transport users • Loneliness and isolation • Potential for local data collection 	-	<ul style="list-style-type: none"> • Link environment to public transport • Added micro-mobility e.g. scooters • Link walking and cycling to social networks

Name	Organisation	Primary expertise	Topics discussed	Additional evidence cited	Amendments to system map
Dr Christian Brand	Transport Studies Unit, University of Oxford	<ul style="list-style-type: none"> • CO₂ • Air quality • Active travel 	<ul style="list-style-type: none"> • Public transport • Air pollution • Differences in wellbeing during an episode (i.e. journey) and how this varies by mode • Argued for the inclusion of carbon emissions in the model • Social capital • Access to healthcare • Fuel/transport poverty (as a cause of stress and ill-health) 	PASTA (Physical activity through sustainable transport approaches) project	<ul style="list-style-type: none"> • Added public transport • Added multiple links especially to wellbeing • Link cardiovascular fitness to cardiovascular disease
Prof Adrian Davis	Transport Research Institute, Edinburgh Napier University	<ul style="list-style-type: none"> • All 	<ul style="list-style-type: none"> • Spatial mismatch: people living away from destinations they need • Environmental quality: lack of evidence on this issue • Electric vehicles • Physical activity and immune response (highlighted by the Covid pandemic) 	-	<ul style="list-style-type: none"> • Added numerous links • Added immune response and links to physical activity and social networks/capital • Links to obesity (cancer etc.) • Link car use to fear of traffic
Prof Jenny Mindell	Department of Epidemiology & Public Health, UCL	<ul style="list-style-type: none"> • Severance 	<ul style="list-style-type: none"> • Quantifying severance • Use of community severance indices • Community severance costing tool • Health impact assessment • Physical activity 	UCL Street Mobility Project Toolkit (see Appendix Section C.5)	<ul style="list-style-type: none"> • Additional links from severance

Name	Organisation	Primary expertise	Topics discussed	Additional evidence cited	Amendments to system map
Dr Francesca Racioppi	Head of the WHO European Centre for Environment and Health	<ul style="list-style-type: none"> All 	<ul style="list-style-type: none"> Walking Cycling Economic assessment Access to education Cognitive function 	Various WHO and other modelling tools (see Appendix C)	<ul style="list-style-type: none"> Added numerous links, notably to walking and cycling Made the case for 'access to education' as a separate issue Added carbon emissions Suggested specific outcome of 'cognitive function'
Prof Karen Lucas	School of Environment, Education and Development, University of Manchester	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Access to health services Journey quality Severance 	-	<ul style="list-style-type: none"> Some additional links from severance
Prof Charlie Foster	School for Policy Studies, University of Bristol	<ul style="list-style-type: none"> Physical activity 	<ul style="list-style-type: none"> Physical activity and links to disease outcomes Green space (both access and use) 	-	<ul style="list-style-type: none"> Added more links to physical activity, notably direct link from walking and cycling to mortality
Prof Nicola Christie	Faculty of Engineering Science, UCL	<ul style="list-style-type: none"> Safety 	<ul style="list-style-type: none"> Inequalities in road traffic casualties Proposed that deprivation should be included on the map Psychological wellbeing (and links to deprivation) Links between cars and crime 	-	<ul style="list-style-type: none"> Added fear of crime Added links to social inclusion Added links public transport and casualties
Dr Kiron Chatterjee	University of the West of England	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Commuting and wellbeing Stress during travel 	Transport reviews: commuting and wellbeing	<ul style="list-style-type: none"> Added links to employment

Name	Organisation	Primary expertise	Topics discussed	Additional evidence cited	Amendments to system map
Prof Mark J Nieuwenhuijsen	Barcelona Institute for Global Health	<ul style="list-style-type: none"> Health impact assessment Air quality 	<ul style="list-style-type: none"> Pathways to health impacts, as in Glazener <i>et al.</i> (2021) Importance of socioeconomic status for health Accessibility Green space The importance of physical activity in most health impact assessments Noise (and the challenges of quantifying) Urban heat islands Use of urban land for transportation 	Glazener <i>et al.</i> (2021)	<ul style="list-style-type: none"> Additional links especially to noise Potentially additional topics, as per Glazener <i>et al.</i> (2021)
Prof Catherine Ward-Thompson	University of Edinburgh	<ul style="list-style-type: none"> Environment 	<ul style="list-style-type: none"> Links between environment and walking and cycling Green space and health Engagement with nature Safety and walking/cycling 	-	<ul style="list-style-type: none"> Amended to 'high quality environment' Added links to walking and cycling Links to emotional wellbeing
Prof Andy Jones	University of East Anglia	<ul style="list-style-type: none"> Walking Green space 	<ul style="list-style-type: none"> Green space access Evidence for links to health outcomes (from his meta-analysis) Physical activity as the main pathway for health benefits (i.e., being active in green spaces), and also factors such as microbiome 	-	<ul style="list-style-type: none"> Added green space use (in addition to access)
Dr Sally Cairns	Institute for Transport Studies, University of Leeds	<ul style="list-style-type: none"> Access 	<ul style="list-style-type: none"> Health benefits of employment Absenteeism Evidence on access to employment 	-	<ul style="list-style-type: none"> Added links to employment Suggested absenteeism as pathway

Appendix C Other tools for economic assessment

C.1 WHO Health Economic Assessment Tool (HEAT) for walking and cycling

WHO Health Economic Assessment Tool (HEAT) is designed to enable users without expertise in impact assessment to conduct economic assessments of the health impacts of walking or cycling. HEAT estimates the value of reduced mortality that results from specified amounts of walking or cycling, answering the following question:

If x people regularly walk or cycle an amount y, what are the health impacts on premature mortality and their economic value?

As well as the health benefits from physical activity, HEAT can also take into account the mortality effects of exposure to air pollution and traffic crashes while walking or cycling. HEAT can further assess the effects on carbon emissions from shifting travel by motorised modes to walking or cycling.

URL: <https://www.heatwalkingcycling.org>

C.2 GreenUr: The Green Urban spaces and health tool

GreenUr is a plug-in for QGIS, a free and open-source desktop geographic information system (GIS). GreenUr offers the possibility to measure availability and accessibility of green space in cities. It accommodates algorithms to calculate potential direct health effects of green space, for example, on mental health, and indirect impacts, for example, through ecosystem services.

URL: <https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/activities/greenur-the-green-urban-spaces-and-health-tool>

C.3 AirQ+: software tool for health risk assessment of air pollution

AirQ+ estimates:

- the effects of short-term changes in air pollution (based on risk estimates from time-series studies)
- the effects of long-term exposures (using life-tables approach and based on risk estimates from cohort studies).

URL: <https://www.euro.who.int/en/health-topics/environment-and-health/air-quality/activities/airq-software-tool-for-health-risk-assessment-of-air-pollution>

C.4 Carbon Reduction Benefits on Health (CaRBonH)

The Carbon Reduction Benefits on Health (CaRBonH) calculation tool allows quantification of the physical and economic consequences for human health achieved through improvements in country-level air quality from domestic carbon reductions, specifically policy mitigation actions and measures as

reported in the NDCs submitted by the Conference of the Parties to the UNFCCC in support of the objectives as set out in Article 2 of the Convention.

URL: <https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/2018/achieving-health-benefits-from-carbon-reductions-manual-for-carbonh-calculation-tool-2018>

C.5 UCL Street Mobility Project Toolkit

The UCL Street Mobility Project Toolkit contains various tools developed by the UCL Street Mobility & Network Accessibility project team to support assessments of community severance in local areas.

URL: <https://www.ucl.ac.uk/epidemiology-health-care/research/epidemiology-and-public-health/research/health-and-social-surveys-research-group/toolkit>



Transport & health policy position

3rd draft – November 2022



Development phases & governance

Stages	Due date	Status
1 st draft	28 th September 2022	Complete
TfN internal comments	5 th October 2022	Complete
Strategic Oversight Group	13 th October 2022	Complete
SOG comments deadline	27 th October 2022	Complete
Exec Board	17 th November 2022	Underway
Scrutiny Committee	23 rd November 2022	
TfN Board	14 th December 2022	

Context

Among the many legacies of the COVID-19 pandemic has been an unprecedented level of political, media, and public attention to health and wellbeing. For many, conversations about healthcare, the spread of illness, mental health, and wellbeing became part of daily life in a way that they would not have been beforehand. As legal public health restrictions linked to COVID-19 eased, this attention has increasingly turned to access to healthcare, and the impacts of the challenges facing the NHS. These features of public, media, and political attention have added to long-running attention to the extent of health inequalities across the UK, including how issues such as air and noise pollution, physical inactivity, and road traffic incidents disproportionately impact deprived areas and communities.

In 2022/23, Transport for the North (TfN) undertook research with Cambridge Econometrics and Cavill Associates on the impacts of the transport system on health and wellbeing. This research brought together evidence on the range of impacts of the transport system on health and wellbeing, quantified the scale of these impacts, and facilitated analysis of variations in these impacts across the diverse place and population contexts of the North. This research built on the commitment in TfN's 2019 Strategic Transport Plan (STP) to improving *"inclusion, health, and access to opportunities for all"*. Drawing on this research and STP commitment, this policy position sets out the health challenge that exists around the transport system in the North, the links between this challenge and other key policy areas, and defines TfN's role in addressing these issues.

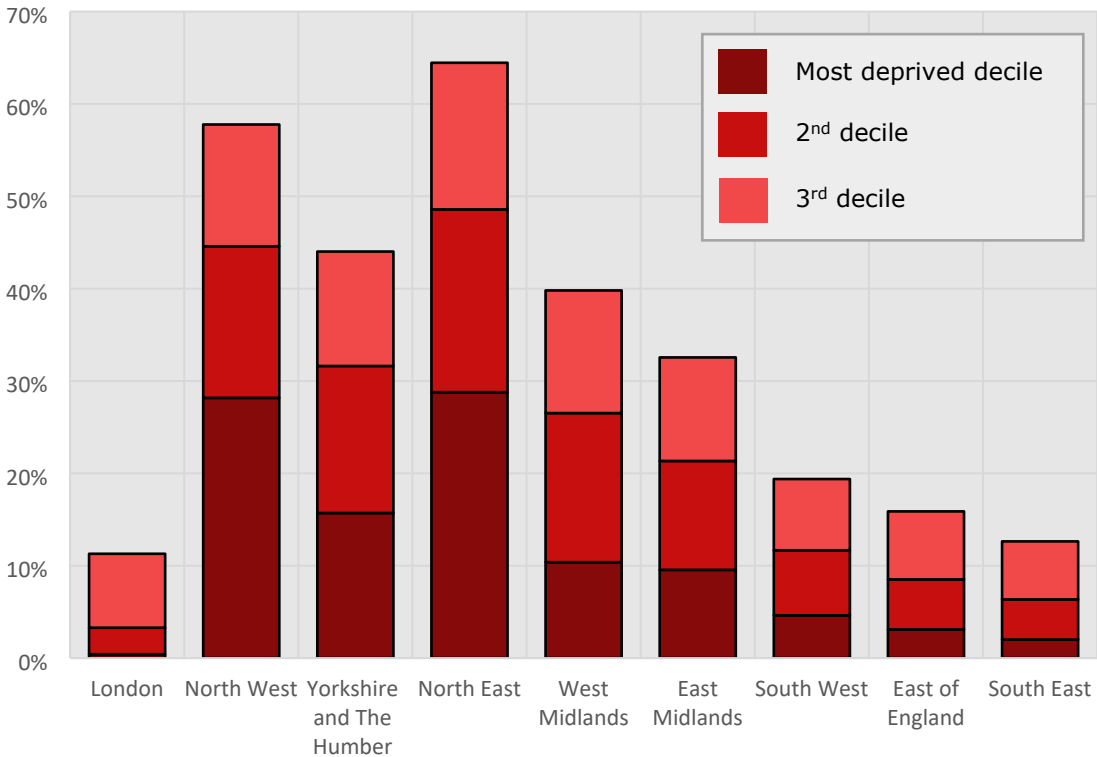
Consistent with wider patterns of regional inequality in England, the three regions of the North face a relatively greater health deprivation. The 2019 English Indices of Deprivation found that 23.9% of areas in the North fall in the most deprived decile for health, and 54.1% in the most deprived three deciles. This compares with 4.4% and 20.2% of the rest of England.¹ Contributing to this, life expectancy at birth and healthy life expectancy at birth is lower in the North than the averages for England as a whole, and the prevalence of obesity among children, levels of smoking among adults, and levels of hospital admissions related to alcohol are all higher in the three regions of the North than the average for England as a whole. Linked to and feeding into these health inequalities, levels of poor self-reported wellbeing in the North are marginally higher than the average for England as a whole, and levels of death due to suicide are also proportionally higher.²

The causes of health and wellbeing inequalities in England are multiple and complex, and both contribute to and are driven by wider patterns of regional socioeconomic inequality. However, both TfN's research and the wider body evidence on the determinants of health and wellbeing in England demonstrate that the transport system has a significant role. Broadly, this role reflects: (1) The capacity of the transport system to provide access to healthcare, opportunities, key services, and community life, and through this its role as a determinant of poverty, social connectedness, and access to resources supportive of health, and (2) The wider impacts associated with transport systems, including through pollution, physical activity, and quality of place. These impacts often occur as the negative externalities of transport use by others, rather than being linked to personal use.

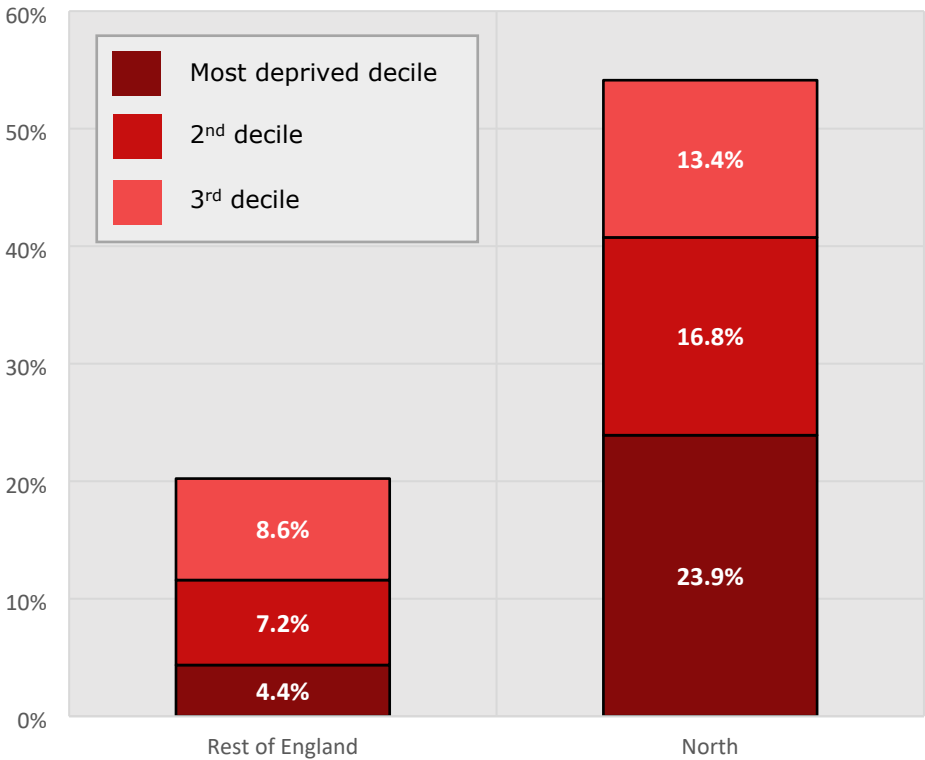
¹ DLHC, 2019, [Available here](#)

² OHID, 2022, [Available here](#)

Population by health deprivation decile by region of England³



Population by health deprivation decile by area of England⁴



³ DLHC, 2019, [Available here](#)
⁴ DLHC, 2019, [Available here](#)

The key impacts of transport on health in the North

There are a large number of ways in which the transport system impacts the health and wellbeing of people in the North. However, not all of these impacts are rigorously quantifiable across this broad geography. Through research with Cambridge Econometrics and Cavill Associates, and recognising TfN's role as a sub-national transport body, this policy focuses on the following links between transport and health and wellbeing:

Incidents and safety: Between 2016 and 2020, the last five years for which data are available, 30,367 people were killed or seriously injured in road traffic incidents in the North of England. Of these, 37.6% were drivers or passengers in cars, 24.3% were pedestrians, and 19.2% motorcycle riders or passengers. Over this same period, 143,451 slight injuries were recorded. Together, this represents a significant burden of mortality and morbidity, and is among the key causes of trauma-related hospital admissions.⁵

Access to healthcare: Statistics published by the Department for Transport (DfT) indicate that approximately 390,000 people in the North cannot access a GP surgery within 30 minutes by public transport, and approximately 510,000 cannot access a hospital within an hour by public transport.⁶ This has the potential to place significant barriers to accessing healthcare among those solely or primarily dependent on public transport, both in the absolute sense and through the knock-on time and cost impacts of these journeys. Owing to wider inequalities in the transport system, this is particularly likely to impact those on lower incomes, those with disabilities, and those living outside of major cities.

Air pollution: Transport – particularly road transport – is a significant contributor to air pollution, particularly nitrogen dioxide and fine particulate matter (PM10 and PM2.5). These pollutants are significant contributors to asthma, diabetes, lung cancer, and dementia, with nitrogen dioxide and PM2.5 pollution estimated to cause 1.14 million and 1.33 million additional cases of disease across England between 2017 and 2035.⁷ Modelling undertaken for TfN indicates that, within the North, approximately 5.88 million people live in areas where nitrogen dioxide pollution poses an increased risk of early death.⁸ Reflecting this, the vast majority of Air Quality Management Areas in the North (135 out of a total of 139) are in place because of nitrogen dioxide emissions from road transport.⁹

Noise pollution: Noise pollution has a range of physiological and psychological impacts, and chronic exposure to noise pollution increases the risk of heart disease, high blood pressure, and depression. These effects occur at a relatively low level of noise, with chronic exposure to traffic noise of only 55 decibels robustly linked with increased levels of coronary heart disease and hypertension. Modelling undertaken for TfN indicates that approximately 2.5 million people in the North are impacted by harmful levels of road traffic noise, the vast majority of whom are in large urban centres. Noise associated with rail is also likely to contribute to poor health, however the impacts are significantly smaller in scale and more diffuse across the North.¹⁰

⁵ DfT, 2022, [Available here](#)

⁶ DfT, 2022, [Available here](#)

⁷ PHE, 2018, [Available here](#)

⁸ Transport for the North, 2022

⁹ DEFRA, 2022, [Available here](#)

¹⁰ Transport for the North, 2022

Physical inactivity: Physical inactivity is a major public health challenge, contributing to heart disease, diabetes, and cancer. The combination of poor-quality active travel infrastructure, car-focused urban design, and high levels of car dependency is a significant limiting factor in levels of physical inactivity. Evidence from the Active Lives Survey indicates that the majority of adults in the North do not undertake more than one significant active travel trip per month, and that a significant minority had not undertaken a significant active travel trip in the last year.¹¹ Incorporating physical activity into everyday life – particularly through walking, cycling, and wheeling for transport – is an effective and well-evidenced public health intervention.

Alongside these five key effects, TfN's research and the wider literature also identifies a number of other impact pathways.¹² This includes:

- The quality of the environment; particularly the impacts of road infrastructure on urban environments.
- The level of access to green space, recreation, and leisure; particularly the impacts of this on levels of physical inactivity, and levels of wellbeing associated with exposure to nature, recreation, and leisure.
- The level of access high-quality employment; particularly the link between transport accessibility and the level of secure and well-paying work among the population.
- The experience of users in the transport system; particularly the level of stress associated with using public and private transport, and the positive wellbeing impacts that can be associated with active travel.
- Community severance; particularly the impacts of road infrastructure and levels of road traffic on social interaction and connections.

In general, these impacts either have a high degree of evidence at the local level, but are not possible to aggregate to the pan-northern geography (as in the case of community severance and the quality of the environment), or have a high degree of evidence for one part of the relationship, but not the relationship as a whole (as in the case of access to high quality employment). Consequently, it is not possible for TfN to monitor changes in these factors over time.

¹¹ Sport England, 2022, [Available here](#)

¹² Transport for the North, 2022

Challenges

TfN's policy position on transport and health reflects the following challenges:

A complex and multi-dimensional relationship: The previous section describes the complex and multi-dimensional relationship between transport and health. Of the elements of this relationship, five are measurable at the pan-northern geography, and a further five cannot be reliably measured at this scale with the evidence currently available. Further, even where the extent of the health impact can be quantified across the North, this is typically in isolation rather than combination. For example, while it is possible to estimate the scale of impacts from air pollution and noise pollution in isolation, there is less certainty on the combined effects of these forms of pollution.

Impacts on users and non-users: The level of individual exposure to negative health impacts from the transport system has an indirect relationship with the level of use. For example, harmful levels of noise pollution can impact communities living close to major road infrastructure, regardless of their level of use of that infrastructure. Added to this, impacts often occur across modes; for example, the impact of road traffic incidents on people walking and travelling by bike, and the impacts of severance effects from road traffic levels on physical activity. These 'negative externalities' are not reflected in the costs of transport use and, owing to inequalities in levels of transport use based on gender, age, ethnicity disability, and income, contribute to wider patterns of social inequality.

Links to multiple policy areas and stakeholders: The impacts of transport on health and wellbeing crosses multiple policy areas and stakeholders. This creates complexities in a context in which budgets and policy are fragmented. Most significantly, measures to address negative health externalities from transport do not necessarily deliver the most rapid or largest improvements in traditional transport indicators. For example, the set of transport policies that deliver the largest reductions in journey times for car users would likely result in a significant worsening of negative health externalities. Further complexity is evident in attributing changes in health to changes in transport policy, and through this assessing the value obtained. For example, attributing changes in levels of physical inactivity as a result of transport policy changes, given the large number of other determinants of physical inactivity that fall outside of transport policy.

A complex relationship with transport decarbonisation: Decarbonisation is increasingly becoming the defining issue in transport policy at all levels. The failure to deliver on net zero in the transport sector and elsewhere will have significant negative impacts on health through the impacts of extreme weather, damage to the supply of key resources, and natural disasters. However, different approaches to decarbonisation are also likely to have vastly different impacts on health. In general, an approach to transport decarbonisation that prioritises the rapid uptake of electric vehicles is likely to lead to increased levels of physical inactivity and severance, and remain a significant source of air pollution, noise pollution, and traffic incidents. By contrast, a model of decarbonisation that prioritises modal shift to active travel and public transport is likely to deliver benefits through increased physical activity, relatively lower air and noise pollution, and lower levels of road traffic incidents.

The particular link with car use: The high levels of car use and car-dominated urban environments widely evident in the North are a key factor in road traffic incidents, air and noise pollution, and physical inactivity, and contributes to severance, poor user experience, and poor-quality environments. Making significant progress in reducing the negative impacts of the transport system on health requires policy to enable significant modal shift away from private car use, towards public transport and active travel. This is relevant to all area types, but is particularly significant in larger towns and cities, where there are relatively high population densities in close proximity to road infrastructure. While opinion surveys indicate majority public support for reducing car dominance and car dependency, this has the potential to be politically contentious.

The role of TfN

As a sub-national transport body, TfN's role is to set a vision for the transport system, and to provide statutory advice on planning and priorities for large scale transport investment. Recognising the scale and significance of the transport system for the health and wellbeing of people in the North, TfN's 2019 Strategic Transport Plan committed to "improving inclusivity, health, and access to opportunities for all", and to "further explore how investment can have a positive impact on people's health". It also called on TfN's partners to "work together to deliver a transport system that promotes social inclusion and improves the health outcomes and quality of life for communities across the North". The STP links this specifically to reducing levels of air pollution, enabling modal shift towards public transport and active travel, and improving access to natural environments.

The STP states that "Air pollution is the UK's largest environmental risk to health, with 5% of deaths in England being attributable to exposure to air pollution. Road transport is a significant cause of air pollution through carcinogenic emissions, high levels of nitrogen dioxide (NO₂) and particulate matter (PM). Children and older people are more susceptible to the effects of air pollution and both long and short-term exposure to air pollution is known to adversely affect health. It is estimated that if no action is taken, the effects of air pollution could cost the NHS and social care system up to £18.6 billion by 2035"

On physical activity, the STP sets out that "The National Institute for Health and Care Excellence (NICE) recommends that active travel and use of public transport should be encouraged. They recommend doing this by making sure there are high quality walking and cycling routes that are convenient, safe, appealing and well maintained." This includes addressing the severance impacts and barriers to active travel posed by other forms of transport infrastructure – particularly road infrastructure.

Population health and health inequalities have intrinsic importance, but alongside this the STP details the role of health in the significant disparity in productivity between the North and London and the South East. The STP set out that "Ill health can reduce productivity through increased absence from work or education, while affecting the ability to perform tasks efficiently and effectively whilst unwell (presenteeism). Around 131 million working days are lost due to sickness absence every year and employers spend £9 billion each year on sick pay and associated costs. Improving health and wellbeing can improve employment rates, raise educational attainment, and increase productivity. Conversely, unemployment is associated with poor mental and physical health."

Links to other TfN workstreams

Decarbonisation Strategy: TfN's Decarbonisation Strategy sets out a trajectory to achieve close to zero carbon emissions from surface transport in the North by 2045, and the policy agenda required to achieve this. Significant and rapid modal shift away from private car use towards public transport and active travel has a key role in this transition. Given the impacts of air and noise pollution, traffic incidents, and severance associated with high levels of car use, this element of the transition is likely to significantly reduce the negative impacts of the transport system on health. Linked to this, TfN's Clean Mobility Visions project is developing a set of evidence-based policies for Local Authorities to reduce carbon emissions by reducing levels of private car use.

EV charging framework: Petrol and diesel vehicles are a major source of air pollution, and the transition to electric vehicles is a key component of reducing these impacts. TfN's Electric Vehicle Charging Infrastructure Framework provides robust evidence on charging demand, and a comprehensive and consistent regional route map towards an effective network. Through this, the EVCI framework reduces investment uncertainty in EV infrastructure, enabling a more rapid and equitable transition to electric vehicles than would otherwise be the case. This, along with modal shift towards public transport and active travel, will deliver a significant portion of the North's carbon reduction trajectory and the required reductions in air pollution - particularly nitrogen dioxide.

Socially Inclusive Transport Strategy: TfN's draft Socially Inclusive Transport Strategy sets out how TfN, Local Authorities, central government, and other stakeholders can act to reduce transport-related social exclusion (TRSE). This includes TRSE linked to health, in which poor access to healthcare services reinforces poor health outcomes, poverty and deprivation. TfN's report on TRSE sets out that 3.05 million people in the North live in areas where there is both high levels of health deprivation and poor access to healthcare services with the transport options available. It also demonstrates that there is a significant gap between the North and the rest of England, with 19.7% of the population at high risk of TRSE specific to health, compared with 16.4% of the rest of England.

Active travel policy position: Walking, cycling, and wheeling for everyday journeys provides significant health benefits. For the user, these benefits principally occur through the physical activity entailed in active travel, but also through the wellbeing impacts of travelling actively – particularly in natural environments. More broadly, increases in active travel lead to reduced levels of air and pollution compared with other modes, and lower levels of severance compared with other modes. TfN's Active Travel Policy Position defines these and other benefits associated with active travel, sets out TfN's ambition to "make cycling and walking a natural choice for shorter journeys", and defines TfN's role in achieving this ambition – alongside Local Authorities, DfT, and Active Travel England.

Spatial planning: The manner in which spaces are designed – particularly the extent to which spaces enable active travel and access to public transport or prioritise car access – shares a number of links to health. TfN's framework outlining the role of Spatial Planning sets out actions for TfN to support those involved in the planning process in rebalancing away from car-dominated environments to promote healthier and more liveable places for all. This complements and builds on the set of actions in TfN's Decarbonisation Strategy and Active Travel Policy Position.

Future travel scenarios: TfN has adopted a scenario planning approach to help futureproof decision-making and establish a detailed and holistic representation of TfN's vision. TfN's Future Travel Scenarios represent strategic factors that are external to TfN's direct control and are used as 'reference case' scenarios to test different TfN strategies and policies in terms of their performance against objectives. Attitudes to health are included as one of the drivers of change in these scenarios, and are linked directly to the level of uptake of active travel, and the nature of the wider public health policy agenda.

Major roads report: TfN's Major Roads Report sets out TfN's vision for the major roads network as part of a multi-modal transport system. This includes first considering alternatives to road expansion to address the challenges faced in different local contexts, actions to identify and reduce the negative externalities associated with road transport, and a focus on integration with local transport networks. As well as reducing negative externalities through air pollution, severance, and noise, TfN's strategy for the major roads network seeks to maximise economic opportunities and access to key services – both of which share direct links to population health.

TfN's role in transport and health

Vision zero for the major and strategic roads network: TfN will adopt a vision for zero deaths and serious injuries on the major and strategic roads network, and will consider this vision in developing future policy related to this network. This reflects the significant burden of mortality, morbidity, and trauma associated with road traffic incidents, and the extent to which these incidents exacerbate health inequalities linked to age, ethnicity, and income. Linked to this, TfN will work with National Highways and Local Transport Authorities to identify and address common incident sites on the Major Roads Network, including through the support TfN delivers to business case development.

Enhance links with OHID and local Directors of Public Health: TfN will enhance its links with the Office for Health Improvement and Disparities (OHID) and with local Directors of Public Health in the North. This will develop new arrangements for evidence sharing on the impacts of transport on health, and identify evidence gaps of mutual interest. OHID officials contributed extensively to the development of TfN's research on transport, health, and wellbeing, and TfN will build on this.

Enhance evidence on access to healthcare and links to health inequality: TfN's research on transport, health and wellbeing and transport-related social exclusion demonstrate significant inequalities in the level of access to health services across the diverse place and population contexts of the North. However, owing to limitations in the evidence available, it is not currently possible to quantify the link between changes in access and changes in health outcomes. Subject to available resources, TfN will undertake research to address this significant evidence gap.

Develop a severance tool: TfN's research on transport, health and wellbeing developed a methodology to estimate severance effects caused by major road and rail infrastructure. This facilitated estimates of severance effects in two local area examples. However, the level of data required, and the methodological complexity of this approach, means that it is not easily transferable to other contexts. Subject to available resources, TfN will work

to overcome these methodological challenges, and provide a transferable tool for Local Authorities to estimate the severance impacts of road and rail infrastructure.

Develop a broader impacts costing tool and estimate for the North: The negative health externalities and wider impacts of transport choices are particularly challenging to address because they fall outside of the costs faced by users. Reflecting this, TfN will collate existing evidence and, if required, conduct additional research, to establish the whole systems impacts of different transport modes in the North and carry out a comparative analysis against existing pricing models. This is with the intention of supporting policy-makers in decisions on road user charging, parking policy, public transport fares, and investment in active travel.

Support partners in identifying areas with poor access to health services: TfN's TRSE data tool allows Local Authorities and other transport stakeholders to access LSOA-level data on access to jobs, education, and key services – including healthcare. TfN will promote this tool and provide support to partners in using it to identify areas in where there is both poor access to healthcare and high levels of need, as part of wider efforts to reduce transport-related social exclusion and improve the transport network.

Measure progress towards health outcomes: TfN's Monitoring and Evaluation Framework includes several health-related metrics and provides a transparent means of monitoring progress towards the ambitions set out in Strategic Transport Plan. This includes areas such as active travel, road traffic incidents, and air and noise pollution. Consideration of these metrics will be included in an annual Action Plan to review progress towards STP objectives. The focus within this framework is on those metrics that can be reliably measured at a pan-northern level. TfN will publish updates on these indicators and, where required, develop further policy actions to address any emerging gaps.

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