Local Full Fibre Network (LFFN) wave one evaluation

Final evaluation

Trans Pennine Initiative

Ipsos

For the avoidance of doubt, the principle purpose of the Local Full Fibre Network (LFFN) wave one projects was not to provide the secondary benefits laid out in this report. For Public Sector Building Upgrades (PSBU)/ Public Sector Anchor Tenancy (PSAT) and Public Sector Asset Reuse (PSAR) projects that purpose is the improvement of public sector connectivity to meet a need, generally demonstrated through a business case, either to reduce the cost of equivalent connections or to provide improved connections which will enable a concomitant improvement in productivity or the provision of public services. PSAR projects followed what is known as the Market Economy Operator Principle (MEOP), which means that they had clear projected commercial outcomes and that these outcomes have been externally validated before the projects began. MEOP is an EU test as to whether a measure is commercial, and thus not State aid, which is a test relevant for those projects commenced prior to the end of the transition period.

The wider benefits which this report describes are secondary to these purposes; however, that does not mean that they are not of legitimate interest to government, local and central, as part of ongoing monitoring of digital connectivity.

To situate this report and the analysis within, note that it was submitted in November 2023.

Contents

1 Introduction

Ipsos UK was commissioned by Building Digital UK (BDUK) in May 2018 to undertake an evaluation of the wave one projects funded through the Local Full Fibre Network (LFFN). This report sets out the final evaluation findings for the Trans Pennine Initiative.

1.1 Description of the programme

BDUK launched the LFFN Programme in 2017 with £200 million funding. The aims of the programme were to accelerate and de-risk the deployment of the next generation of digital infrastructure, create UK digital leadership and drive productivity and growth. The programme provided funding to local councils and other public bodies to achieve these aims. Local councils could choose from three delivery models to apply and deliver locally (in addition to a national voucher scheme which was outside the scope of this evaluation):

- **Public Sector Anchor Tenancy (PSAT):** Bringing together local public sector customers, to create enough broadband demand to reduce the financial risk of building new full-fibre networks;

- **Public Sector Building Upgrades (PSBU):** Directly connecting public sector buildings, such as schools and hospitals, and

- **Public Sector Asset Re-use (PSAR):** Opening up public sector assets, such as existing ducts, to allow fibre to be laid more cheaply.

A Gigabit Broadband Voucher Scheme offering full-fibre broadband connection vouchers for businesses, to increase take-up of services operated in parallel to the three delivery models above. However, the Gigabit Broadband Voucher Scheme is subject to a separate evaluation, and is therefore not covered in this study.

Wave one of the LFFN programme comprised a selection of pilot projects for the wider LFFN programme, which aimed to demonstrate how the interventions can operate and provide learning for the remaining LFFN projects. The Trans Pennine Initiative project was selected as one of these four projects.

1.2 Context

1.2.1 Context at time of LFFN launch

At the time the LFFN programme was designed and launched in 2017, the government had recognised that there was a growing need for ultrafast and gigabit-capable networks in the UK, in order to support businesses and residents. Faster broadband was of growing importance to firms, with greater bandwidth required to take advantage of a range of new digital services and assure reliability and continuity of operations. For residents, ultrafast speeds were needed to support growing demand for data – for example, content-rich websites, streaming services and cloud services. They were also expected to produce significant social benefits by supporting the development of applications enabling remote service delivery such as remote medical diagnostics.

At the end of 2016, the UK lagged behind a range of international comparators in terms of gigabit-capable deployment, with just 2 percent of premises covered by gigabit-capable networks at the end

of 2016 compared with 100 percent in South Korea, 97 percent in Japan, and 86 percent in Portugal.[1] The UK was third from the bottom of 22 European countries for Fibre to the Premises (FTTP) coverage[2]. Traditional copper-based circuits are insufficient to support the high-capacity and highly reliable infrastructure which ultrafast broadband and 5G infrastructure depend upon. 92 percent of homes in the UK were connected through part-fibre, part-copper lines that operate at superfast speeds[3], such as Fibre to the Cabinet (FTTC). The Superfast Broadband Programme has significantly bolstered the coverage of FTTC networks[4]. However, these technologies are insufficient to meet the demands outlined above.

Several factors were thought to have constrained the roll-out of full fibre networks in the UK in 2017. These included:

- Other countries having a greater share of the population dwelling in highly dense buildings of multiple occupation, increasing the commercial viability of the technology.

- Topological issues, with other countries being flatter, making investment less costly.

- Uncertainty around the willingness of consumers to pay for a service which they may not currently need.

- Regulatory barriers such as requirements in relation to wayleaves.

- Market structure issues, with dominant suppliers in the UK utilising technologies which could not, at that time, provide gigabit-capable networks.

- Lack of public investment, with other countries having significant public investment to boost FTTP coverage. For example, in France the state-owned telecoms company rolled out FTTP in response to regulatory pressure, and the French government invested EUR 20 billion in FTTP rollout.

1.2.2 Current context

Since 2017, there have been significant changes to the landscape of the broadband market. There has been a lot of venture capital investment. Investors recognised the position of the UK regarding fibre networks and the need to provide these, which could offer long-term returns on their investment. This meant that some smaller network providers had more resources to expand their fibre networks, and there were many new market entrants who provide gigabit-capable networks. The regulatory position of Ofcom, which encouraged competition in the market, also contributed to this increase in competition in the market. Finally, a period of low interest rates also encouraged network providers to utilise finance to further expand their networks.

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[1] The most recent Ofcom Connected Nations Report (2018) estimated that there were almost 1.8 million homes and businesses (6%) with FTTP connections compared to 840,000 (3%) in 2017. However, the 2% presented in the main text is the most recent estimate available for international comparison.
[2] Ofcom (2017), "International Communications Market Review"
[3] Ofcom (2017), "International Communications Market Review"
[4] Ipsos MORI, Simetrica, Barrett, G. Koutroumpis, P. (2018). Evaluation of the Economic Impact and Public Value of the Superfast Broadband Programme

This increase in market competition has also been characterised by small network providers trying not to overbuild each other's networks, as it would reduce the returns they could generate from their network build.

Further to this, the larger providers of broadband networks, Openreach and Virgin Media, have also increased their investment in fibre networks. In early 2022, it was reported that Virgin Media was seeking to raise hundreds of millions of pounds of investment to support their fibre network rollout.[5] Openreach have also committed to expanding their fibre network, and in 2021 the cost of this additional roll out was estimated to be £15 billion to provide fibre coverage to 80 percent of UK premises.[6]

With an increase in finance and planned commercial roll out, and small competitors trying to avoid each other, the coverage of gigabit-capable networks has grown rapidly over the past six years. This is shown by the latest Ofcom Connected Nations publication (2022), which shows that 70 percent of premises in the UK now have gigabit-capable coverage, compared to two percent in 2016.

Examples of the increase in investment include:

▪ Connectfibre receiving "significant" investment in March 2022;[7]

▪ Lightspeed Broadband receiving a cumulative total of £115 million investment by December 2021;[8]

▪ Truespeed receiving £75 million in January 2022;[9]

▪ Borderlink receiving a cumulative £174.5 million investment by January 2022;[10]

▪ Toob receiving £87.5 million in December 2021;[11]

▪ Zzoomm securing £100 million debt investment in October 2021;[12]

▪ Cityfibre receiving £1.1 billion in finance in September 2021;[13]

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[5] https://www.ispreview.co.uk/index.php/2022/01/virgin-media-o2-uk-reportedly-seeks-funding-for-fttp-rollout.html (Accessed March 2022)

[6] https://www.ispreview.co.uk/index.php/2021/05/bt-raise-fttp-broadband-target-to-25-million-uk-premises.html (Accessed March 2022)

[7] https://www.ispreview.co.uk/index.php/2022/02/connect-fibre-get-funding-for-full fibre-rollout-in-east-of-england.html (Accessed March 2022)

[8] https://www.ispreview.co.uk/index.php/2021/12/lightspeed-broadbands-uk-fttp-rollout-gets-gbp60m-funding-boost.html (Accessed March 2022)

[9] https://www.ispreview.co.uk/index.php/2022/01/truespeed-start-2022-with-gbp100m-boost-for-uk-full fibre-rollout.html (Accessed March 2022)

[10] https://www.ispreview.co.uk/index.php/2022/01/borderlink-get-gbp164m-for-full fibre-rollout-in-north-england-and-scotland.html (Accessed March 2022)

[11] https://www.ispreview.co.uk/index.php/2021/12/toob-gets-gbp87-5m-funding-to-boost-uk-fttp-broadband-rollout.html (Accessed March 2022)

[12] https://www.ispreview.co.uk/index.php/2021/10/zzoomms-uk-gigabit-fibre-rollout-boosted-by-gbp100m-investment.html (Accessed March 2022)

[13] https://www.ispreview.co.uk/index.php/2021/09/cityfibre-secure-gbp1-1bn-to-fuel-uk-fttp-broadband-rollout.html (Accessed March 2022)

- Digital Infrastructure (DI) launching after receiving £100 million investment in 2021;[14]

- Gigaclear securing £525 million in debt funding in 2020;[15] and

- Hyperoptic securing £750 million in two deals in 2018;[16]

This shows that the context for the evaluation is hugely different to the context the UK faced when the LFFN programme was designed and launched.

1.3   Study aims

The key research questions for the evaluation of wave one projects, as defined in the Invitation to Tender, are set out in the table below. These broad questions were further refined as part of an initial planning stage that was completed in May 2019, which involved the agreement of bespoke evaluation questions for each of the projects and evaluation approach. This report builds on a baseline, process and early impacts assessment that was completed in July 2019 and the interim evaluations which took place in 2020-2022.

This evaluation report focuses on both the short-term outcomes around coverage and connectivity, alongside the longer-term outcomes and impacts relating to public sector service provision.

Table 1.1: Key evaluation questions

Question area	Sub-questions
What outcomes can be attributed and were they as intended?	What is the range of local level outcomes from LFFN?
	What local level changes made a difference, were there other explanations?
	What, if any, were the wider benefits of LFFN?
	Were there any unintended outcomes?
How has LFFN achieved these outcomes?	To what extent is this affected by context or circumstance?
	How can LFFN achievements be enhanced?
What can we learn to improve future policy designs and implementation?	LFFN Programme
	Other government broadband infrastructure policy or programmes
	Other government future telecommunications infrastructure policy or programmes (including 5G)
	Demand-led delivery approaches

Source: BDUK Invitation to Tender

1.4   Methodology

The evidence compiled for this report comprised:

- **Review of Management Information and project documentation:** Documentation on the design and the operation of the projects, such as business cases, contractual information provided by BDUK, information about premises passed, meet me points installed, annual project and project close down reports have been reviewed to aid understanding of the projects objectives and progress made.

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[14] https://www.digitalinfra.co.uk/latest-news/new-era-full fibre-network-operator-accesses-ps100m-investment (Accessed March 2022)

[15] https://www.ispreview.co.uk/index.php/2020/04/rural-isp-gigaclear-signs-525m-long-term-funding-strategy.html (Accessed March 2022)

[16] https://www.ispreview.co.uk/index.php/2022/02/hyperoptic-aim-gigabit-broadband-at-2-million-uk-homes-by-2023.html (Accessed March 2022)

▪ **Workshop with key stakeholders:** Prior to final evaluation fieldwork, workshops were held with each wave one project to establish whether alterations were needed in the Theory of Change, which outcomes to focus on and how to evidence wider benefits of projects.

▪ **Analysis of secondary data:** A range of secondary sources were examined to explore changes in the supply and demand for FTTP in areas nearby the assets brought into use for broadband deployment with LFFN funding. This drew primarily on the Connected Nations dataset published by Ofcom which provides postcode level data on superfast and ultrafast availability, FTTP coverage, connections and data usage. Further data was drawn from ThinkBroadband and the published FTTP roll-out plans of Openreach and other telecommunications suppliers to provide local and regional context for the project. Finally, a variety of additional Office for National Statistics data on the evolution of the local economy was drawn on to provide further evidence on local trends on employment growth and unemployment.

▪ **Semi-structured qualitative interviews with project stakeholders:** Consultations with stakeholders in the projects were undertaken in between September 2022 and April 2023 to gather views on how the projects had delivered against their intended objectives, the wider impacts achieved, barriers encountered and lessons learned. Stakeholders consulted included representatives of Network Rail, BDUK project leads, wider Network Rail staff involved with the project and customers of the Trans Pennine Initiative infrastructure. Interviews covered developments in the delivery and management of the project, issues encountered in delivery, emerging demand for fibre services and connections and impacts of the LFFN project on organisations and the local area. The report also builds on previous consultations undertaken for the interim and early impacts research, which included interviews with the same stakeholder groups as above, alongside those involved with the management of the infrastructure build, the Department for Transport and potential customers of the Trans Pennine Initiative network. The findings from the interviews were analysed thematically.

▪ **Econometric analysis:** The most recent longitudinal Connected Nations dataset available at the time of research was for 2022. This data was used to explore the connectivity impacts of the projects to date in terms of FTTP / gigabit-capable coverage, ultrafast, download speeds, number of connections and data usage in the areas surrounding the LFFN build. The research team worked with BDUK to identify a suitable comparator area for the Trans Pennine Initiative project. Several potential areas were selected, areas all of which were areas alongside rail routes, based on an initial assessment of key characteristics. These were discussed with BDUK, to get a better knowledge of commercial roll out plans, government interventions. The comparator areas considered included:

− Reading to Bristol

− Brighton to Southampton

− Milton Keynes to Birmingham

− Leicester to Sheffield

− Durham to Edinburgh

The selected comparator area for the Trans Pennine Initiative project was the rail route between Reading and Bristol. A matching exercise was completed using postcode level data for the areas

surrounding the Trans Pennine Initiative project and the Reading to Bristol rail route. The matching sought to find areas matching in characteristics including the details of the telecommunications infrastructure of the postcodes, including distance from the serving exchange, as well as the availability of ultrafast and gigabit-capable connections in previous years. More details of the selection of the counterfactual areas and the matching approach are provided in the technical annex.

1.5   Limitations

There are several limitations to the methodological approach described above. These are:

- **Connected Nations discontinuity:** The results make extensive use of the Ofcom Connected Nations datasets. The Connected Nations dataset is the most comprehensive dataset which provides data on broadband coverage and usage. Therefore, it has been used extensively in this research. However, there are some challenges when utilising the dataset to undertake longitudinal analysis. The network providers which provide information to inform the dataset are not consistent over time. Additionally, the methodology used to compile this data has evolved and there are inconsistencies between years. For the years 2018 and 2019, there are notable decreases in some postcodes in terms of broadband coverage. This was due to a change in the methodology used by Ofcom. This change related to the method used to identify premises, with the addition of more premises in areas diluting coverage in some places. This means that we are unable to clearly separate the impact of changes in the data to those impacts on coverage driven by LFFN. Ipsos initially conducted analysis on LFFN areas, which includes approximately 10,000 postcodes, which was then extended to all postcodes in the 2018 and 2019 cross sections. A fuller breakdown of the analysis conducted is available in the technical annex for the wave one reports. These challenges should be considered when interpreting the results presented.

- **Challenges with qualitative research:** There have been challenges with undertaking the planned qualitative research for this evaluation. The main challenge has been in arranging interviews with stakeholders with a knowledge of the programme and how the projects have supported their organisation. The key challenges for the Trans Pennine Initiative project have been:

  - **Lack of contact details for indirect beneficiaries:** The initial evaluation plan aimed to explore the impact of the projects on businesses which had subsequently obtained gigabit-capable connections to explore how the connection had affected their business, and organisations that have utilised the network. The delivery of this project was delayed, as shown below, which means that take up of gigabit connections in project areas is still low. As a result, there are limited businesses that have upgraded at this stage. Further, some of the internet service providers providing services through the network are using the Trans Pennine Initiative to provide additional resilience rather than completely new connectivity, therefore businesses would not necessarily notice any change. Finally, for businesses that utilise services from the Trans Pennine Initiative project, Network Rail do not hold any details of businesses as these would be held by the internet service providers, creating an additional challenge for the researchers. The route to obtaining business contact details would have been through their internet service provider, which was not possible.

- **Limitations of Management Information:** LFFN wave one projects faced some challenges in collecting useful Management Information. This was partially the result of the projects being

set up as pilots with the aim of generating learning. The projects were set up at an early stage and did not receive instructions on the type of data that should be collected in order to monitor the project and assess its outcomes. The main issue for the Trans Pennine Initiative project was the timeliness and completeness / accuracy of Management Information. There were some issues with delays in BDUK receiving Management Information. These issues have been addressed by BDUK for subsequent phases of the LFFN programme delivery, but they did present challenges for the Wave one evaluation.

▪ **Challenges with approach to measure impact:** The approach to measure the impact of the four projects, has some limitations. The first of these is that the geographic boundary to measure the impact of the project has been selected at 1km away from the network build. However, some of the projects aimed to provide greater gigabit connectivity a wider region. The geographic area was selected as the areas closer to the network build were anticipated to be the most likely to benefit from the project, and measuring the impact at a wider geographic area would be difficult (at a larger geographic level the impact would need to be much larger to be detectable in the analytical framework). Therefore, the analysis focuses on a smaller geographic area for practical reasons, while it should be acknowledged that some impacts of the project may be overlooked. A second limitation is the selection of a comparator area, which has been selected to closely match the characteristics of the project area. However, it was not possible to know at the point of selection what network provider commercial roll out plans were, which could mean that there were unobservable differences between the project and comparator areas.

▪ **Limitations given progress of projects:** The completion of the Trans Pennine Initiative project was slightly slower than anticipated. There were a variety of reasons for the slow progress which are discussed in this report. A further challenge for the Trans Pennine Initiative project was attempting to launch a new telecommunications product as Covid-19 restrictions were introduced, which slowed the progress of the project. A challenge for the evaluation of the Trans Pennine Initiative project is that, because of these delays, there are fewer years between the project completion and the final evaluation research than expected, meaning outcomes have had less time to materialise. Therefore, it is still possible that some of the longer-term outcomes and impacts for the projects could be realised in the future and it is still early to form conclusions about the wider impact of some projects. For example, take-up and economic impacts could be expected to be achieved four to five years post completion, meaning these would not have been fully achieved or be observable in the data at this stage.

Table 1.2: Progress of projects

Project	Baseline (prior to build activity)	Project completed	Interim evaluation research	Years post network build / connections completion for final evaluation fieldwork
Trans Pennine Initiative	2017	2019	Late 2020	3

▪ **Limitations of matching approach:** Undertaking a PSM to improve the comparability of the treatment and comparator areas has some limitations. These are that the approach is data intensive, it discards observations in both the treatment and comparator areas that are not matched. A reduction in the number of observations reduces the statistical power of the regression models, despite increasing the comparability of the two areas. Therefore, large samples are needed, and the LFFN projects were delivered in relatively small local areas, meaning that the statistical power of the models is low. Secondly, the matching between

treatment and comparator areas can only use variables where data exists, but there are factors which could influence broadband rollout and economic performance where data does not exist (such as broadband rollout plans). Therefore, the matching can only be as good as data availability.

▪ **Openreach Fibre First:** Openreach rolled out the Fibre First programme in many of the areas the LFFN programme has operated in and also in comparator areas. This presents a challenge for the analysis. The impact the LFFN programme had on Fibre First roll out is unclear. For example, would Openreach have brought forward FTTP deployments at this speed without the leadership displayed by BDUK in the LFFN programme? Therefore, for the econometric analysis, areas where the Fibre First Programme has been rolled out have been excluded from the analysis.

In addition to these wave one portfolio level limitations, there were also some project specific limitations. This was:

▪ **Tameside 'thin layer model' and Trans Pennine Initiative operating in the same area:** There is a potential attribution challenge in some areas as the LFFN wave one Trans Pennine Initiative project and Tameside project operate in the same area. There could also be further complications with the Greater Manchester LFFN projects in wave two of the LFFN programme. As these projects are contributing towards similar outcomes and impacts, it may be difficult to disentangle the effects of the projects within the Tameside area.

These limitations relate to different strands of the research. However, by combining the findings from across the different research strands, the evaluation provides robust conclusions about the likely outcomes and impacts the Trans Pennine Initiative project has contributed towards as of 2022.

1.6 Structure of the report

The remainder of this report is set out as follows:

▪ Section 2 provides the intervention logic for the project;

▪ Section 3 provides details of how the Trans Pennine Initiative project has been delivered;

▪ Section 4 provides the broadband outcomes for the Trans Pennine Initiative project;

▪ Section 5 presents the wider outcomes and impacts of the Trans Pennine Initiative project; and

▪ Section 6 presents the conclusions from the evaluation of the Trans Pennine Initiative project.

2 Intervention logic

This section presents an overview of the project, the rationale for investment, what the physical build work aimed to achieve, before discussing the expected longer-term outcomes and impacts of the Trans Pennine Initiative project.

2.1 Rationale for intervention

The government was committed to improving fibre network access and mobile coverage for the consumers through the LFFN programme. Trackside infrastructure was identified as an effective approach to deliver future proofed, high-quality connectivity along rail routes.

The railways provide links between populated areas of the UK. However, these have not previously been exploited to connect pockets of internet connectivity and to provide links to digital exchanges. DCMS and Network Rail were interested in exploring whether the railways could be used for internet connectivity to achieve the aims of both organisations. For Network Rail a fibre network could improve the connectivity for signalling on the line and improve the speed and reliability of connections at stations, which would support provision of up-to-date passenger information and of services for station staff. For BDUK, the network could be exploited to provide gigabit connectivity to the surrounding area. An initial meeting between the two organisations took place in 2017 to explore this possibility.

Network Rail were not able to finance any building work for the fibre network. The finances of the organisation are strictly governed by the Office of Rail and Road, and all expenditure must be used for the delivery of rail transport. Therefore, without any funding from other government departments, or private investment, there would be no opportunity to explore using the railways for fibre networks.

The commercial case for Network Rail investing in trackside infrastructure was that the project would be, at minimum, cost neutral for them. Any costs required to build and maintain the telecommunications network are fully offset by the income it will receive from selling access to the infrastructure. By planning to lay fibre at the same time as other rail network upgrades, build costs could also be further reduced. This is because most of the build costs would be spent in digging and laying or repairing ducting, therefore if this takes place at the same time as other network upgrades this digging and repairing cost is only incurred once.

It was assumed that the passenger demand for 5G and the ability of the rail network to connect and expand existing pockets of fibre network would justify the required investment. To verify that these assumptions were correct, the Trans Pennine Initiative project was developed to analyse the delivery approach for track side infrastructure and to explore the future commercial case for investment.

The Trans Pennine route was selected for several reasons, including:

- The Trans Pennine route goes through a mix of cities, suburbs and rural villages offering connectivity to a variety of communities and enables the testing of market reaction to use the new digital infrastructure to serve these different types of communities;

- The Trans Pennine route is one of the last routes to receive upgrades to connectivity through franchise agreements, with upgrades not due to take place until 2024;

- The route has a mix of passengers, from commuters, day trippers, long distance travellers and short distance travellers.

▪ There are other railway upgrades scheduled to take place on this route which could benefit from the infrastructure deployed through the Trans Pennine Initiative;

▪ The location of the Trans Pennine route lends itself to contribute to the objectives of the Northern Powerhouse, a key priority for government.

2.2   Description of the intervention

The Trans Pennine Initiative laid a dark fibre[17] network along 117km of the Trans Pennine railway route between York and Manchester, connecting to Digital Exchanges in Leeds and Manchester. The network was laid in existing trackside troughing, an existing public asset (see Figure 2.1). Jointly with the Tameside PSAR project, the Trans Pennine Initiative was the first of several PSAR projects delivered through the Local Full Fibre Network (LFFN) programme.

Initially, the Trans Pennine Initiative project was planned to be delivered alongside a 5G testbed project. The 5G project would have involved building masts along the route to provide enhanced 5G coverage to rail passengers. The masts would have been connected to the fibre network being laid for the Trans Pennine Initiative project. However, after a study of the feasibility of the 5G element of the project, it was decided that the 5G project should not be initiated. This was due to uncertainty about the number and size of masts required, and that the route of the Trans Pennine line would be altered in the coming years, meaning the masts would no longer be close to the line and providing coverage to the rail passengers. This was not an issue for the fibre network as it can be moved with the rail route at no additional cost.

The original aim of the project was to develop a commercial business model to sell access to the fibre network laid along the route to provide a wholesale network to Internet Service Providers and other customers alongside backhaul to the Internet Exchanges. Suppliers would be able to use the Trans Pennine Initiative network to connect existing or newly built fibre networks to the Digital Exchanges in Leeds and Manchester, providing greater speeds and resilience for their fibre networks. It was expected that this would generate spillover build in the local areas in proximity to the Trans Pennine Initiative route. Subsequently, this would increase the number of network providers offering services along the route, increase take-up of fibre services and provide income to Network Rail as the owner of the fibre network. A further objective was to provide enhanced connectivity for passengers using the Trans Pennine rail route, both onboard trains and at stations. There was also an objective to utilise the project to generate learning for Network Rail and BDUK about delivering dark fibre services along the railways and the commercial use of fibre on the railways.

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[17] Dark Fibre is an unused fibre optic cables with no service or traffic running on it.

Figure 2.1: Trans Pennine Initiative network build
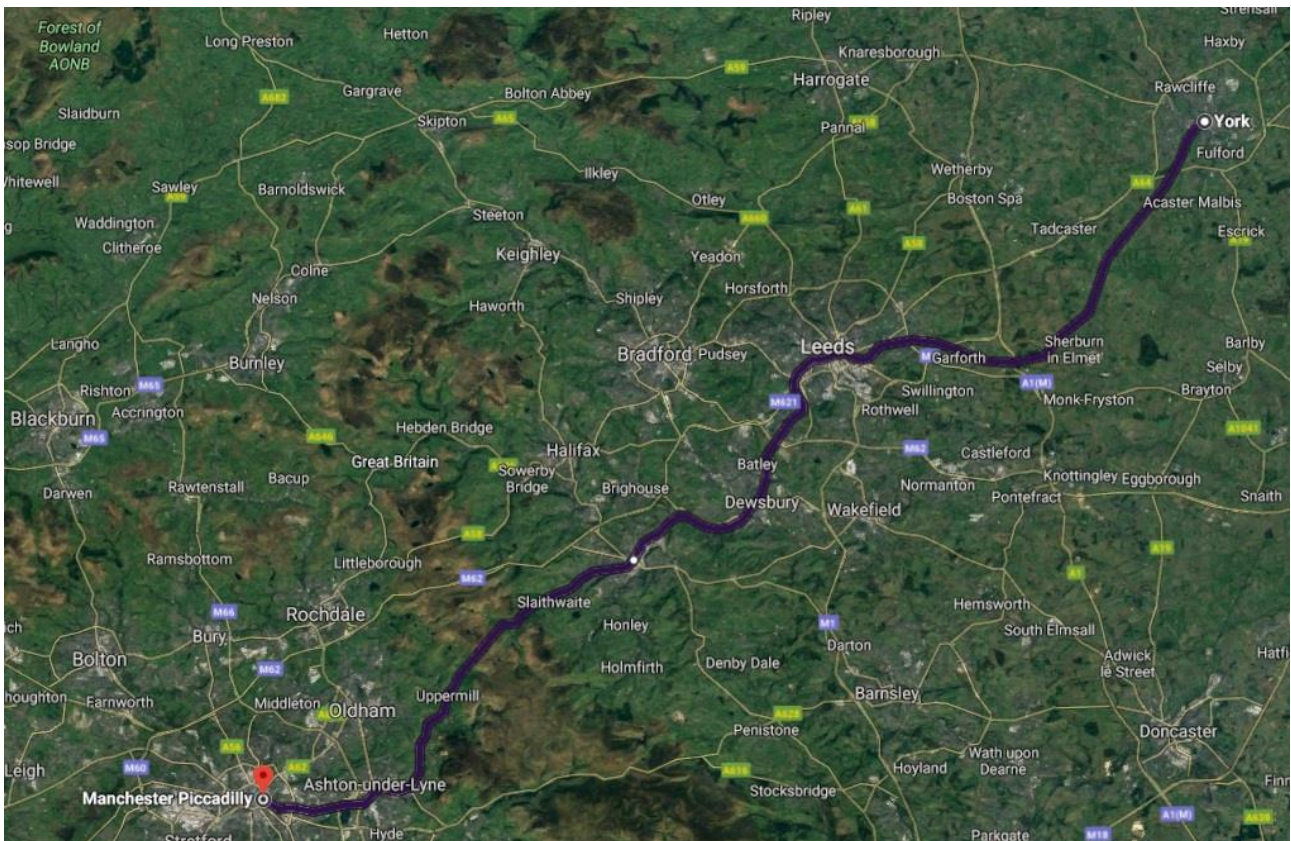
2.3   Theory of change

This section outlines the Trans Pennine Initiative and the anticipated process by which it was expected to deliver its anticipated impacts. Ipsos UK developed this framework in 2019 during the planning phase of the evaluation, and BDUK agreed the evaluation framework. This was done following reviews of project documentation, relevant literature, and secondary data, as well as a series of consultations with BDUK, Network Rail and other key stakeholders.

2.3.1 Inputs

For the Trans Pennine Initiative project, the most significant expected input was capital investment, in the form of funding provided to Network Rail to construct the dark fibre network and Fibre Interface Points. In addition to the capital funding, resources from within BDUK and Network Rail would be required to deliver the project. These were administrative costs – staff time and expertise required to deliver the project.

There was a small amount of expenditure that would be provided by the Northern Powerhouse Investment Fund. This funding would be used in the early stages of the project to scope the feasibility of the 5G component of the project.

There was no private sector investment specified in the Trans Pennine Initiative business case. The Trans Pennine Initiative was expected to lead to private investment in the form spill-over build from the funded fibre network, and staff time and maintenance costs for the installed fibre network.

2.3.2 Activities

The key activities outlined for the delivery of the Trans Pennine Initiative project were:

- Feasibility study for rail fibre cable: The first activity undertaken would be a feasibility study, to explore the need for fibre networks alongside the railway, the cost of the project and how these could be installed and utilised on the railway network.

- Pre-project 5G Survey research: A separate strand of activity was to undertake a survey and research for the 5G component of the project. This examined the line of sight, spread of connectivity and costs associated with the 5G masts included as part of the Trans Pennine Initiative project.

- Survey of the route - condition of the ducts, identify access points: The Trans Pennine route would be surveyed by Network Rail, to identify the ducting which would be suitable for fibre cable, where access points would need to be installed and the condition of the ducting.

- Repair substandard ducts: Following the survey, any ducts that have been identified for use that are not in a condition to be used would be repaired.

- Lay cable: The fibre cable would be laid alongside the Trans-Pennine route, between York and Manchester. Network Rail were responsible for laying the infrastructure.

- Establish Fibre Interface Points on the route: Fibre Interface Points are locations where telecommunications companies, or any other company requiring fibre access can physically connect to the Trans Pennine network, supporting spill over build. These points would be built into the Trans Pennine network.

- Build 5G masts: 5G masts would be built in line with the recommendations of the scoping exercise and the pre-project 5G Survey. However, these were cancelled by ministerial decision in January 2019 as a result of forecast high costs and prolonged timescales that would require the closure of track lines.

- Market engagement exercise: Network Rail would carry out a market engagement exercise. This would collect information on the number of suppliers/operators that had a presence in the area served by Trans Pennine Initiative, and the numbers of suppliers that were interested in using their fibre network and the types of products they offered.

2.3.3 Outputs

The key intended outputs of the Trans Pennine Initiative were:

- Produce a feasibility report for the Trans Pennine Initiative fibre network, a pre-project survey for the 5G component, and a market engagement report: These documents were intended to examine whether the initial assumptions for the cost and timelines of the project were accurate. The market engagement report would detail suppliers operating in the area and the types of products that suppliers intend to offer.

- Lay 117km of fibre cable alongside rail track between York and Manchester: The rail track is owned and maintained by Network Rail. The fibre would be owned by Network Rail.

- Repair existing ducting: Some of the ducting between York and Manchester would require work to ensure the ducting was in a suitable state for fibre cable. This ducting was repaired as part of the project.

- Feed into Manchester and Leeds Digital Exchanges: the planned network would feed into the Digital Exchanges in Leeds and Manchester, to improve the capacity, and resilience of the underlying digital infrastructure in the area.

- Installed Fibre Interface Points: These Fibre Interface Points would allow telecommunication firms, and other firms which need to access fibre networks, to connect to the Trans Pennine network which would support spill-over build at points along the route.

2.3.4 Outcomes and impacts

The activities and outputs were expected to lead to several medium and longer-term outcomes and impacts that can be summarised into the following categories:

- **Connectivity outcomes:** The full fibre network between York and Manchester was expected to reduce the marginal cost of further fibre investment, meaning new areas will likely become commercially viable for suppliers. These additional investments were expected to encourage other suppliers to make additional investments in fibre connectivity, increasing the size of the network in the medium and long-term. The Trans Pennine Initiative network was also expected to reduce the marginal cost of extending the network to serve households and businesses in the local areas in close proximity to the line.

  − Linked to the above, end users would be expected to experience **improved speed and reliability** in their connectivity service. More extensive FTTP deployments can be expected to produce a range of network benefits in terms of increased speeds, latency, and resilience. FTTP also has potential to reduce maintenance costs.

- **Commercial outcomes:** It was expected that the Trans Pennine Initiative would enable Network Rail to develop a commercially sustainable business model through ownership of the network. It would be able to sell access to the network to suppliers, covering the capital expenditure of the build and maintenance costs. The Trans Pennine Initiative project was expected to generate increased commercial awareness if the commercial model works of the possible rates of return for fibre network investment and demonstrate the commercial viability of fibre investment in existing railway infrastructure. This could reduce investor uncertainty and stimulate further investment on the railway network in other areas.

- **Public sector learning:** A key outcome for the project was to learn lessons from the delivery of the Trans Pennine Initiative project. Network Rail were considering similar approaches for other parts of the rail network; therefore, it was crucial that key lessons were learned from this pilot about the suitability of the approach. Specific lessons included the additional cost of laying fibre above the cost of the planned rail upgrade barriers to delivery, and opportunities for suppliers. The cancellation of the 5G component of the project provided one such lesson in that it appears to be least disruptive to include such upgrades as part of other upgrade work.

- **Business use and economy:** As businesses take up new fibre connections along the network it was anticipated that firms may relocate to be closer to the Trans Pennine Initiative route. This includes towns and cities along the route, but also in more rural areas where connectivity could be greatly improved by the project. This may enable clustering of businesses in areas which has potential for further job creation. It could also change the profile or sector of businesses operating in these areas.

- **Transportation effects:** The Trans Pennine Initiative project also aimed to contribute to improvements in the transport service delivered along the Trans Pennine Initiative route. These

impacts would be improved connectivity at stations along the route, allowing passengers to have better access to the internet at these points, and also provide more accurate and timely updates on the rail services to the stations. Additionally, the fibre technology could also be used to enhance the safety of rail travel along the route.

- **Social and environmental**: Specific social and environmental effects were not expected to be achieved within the evaluation period, and have not been included in the Theory of Change. However, as the project had the potential to lead to spillover FTTP build, general social and environmental impacts could potentially be anticipated. These could include reduced commuting enabled by remote working, increases in leisure time or reducing the digital divide in the community through initiatives like digital education programmes.

A summary of the initiative's pathways to impact, outlining how the inputs and activities are expected to translate into immediate outputs, short and medium-term outcomes and longer-term impacts, is set out in the figure 2.2.

Figure 2.2: Logic model for the Trans Pennine Initiative project
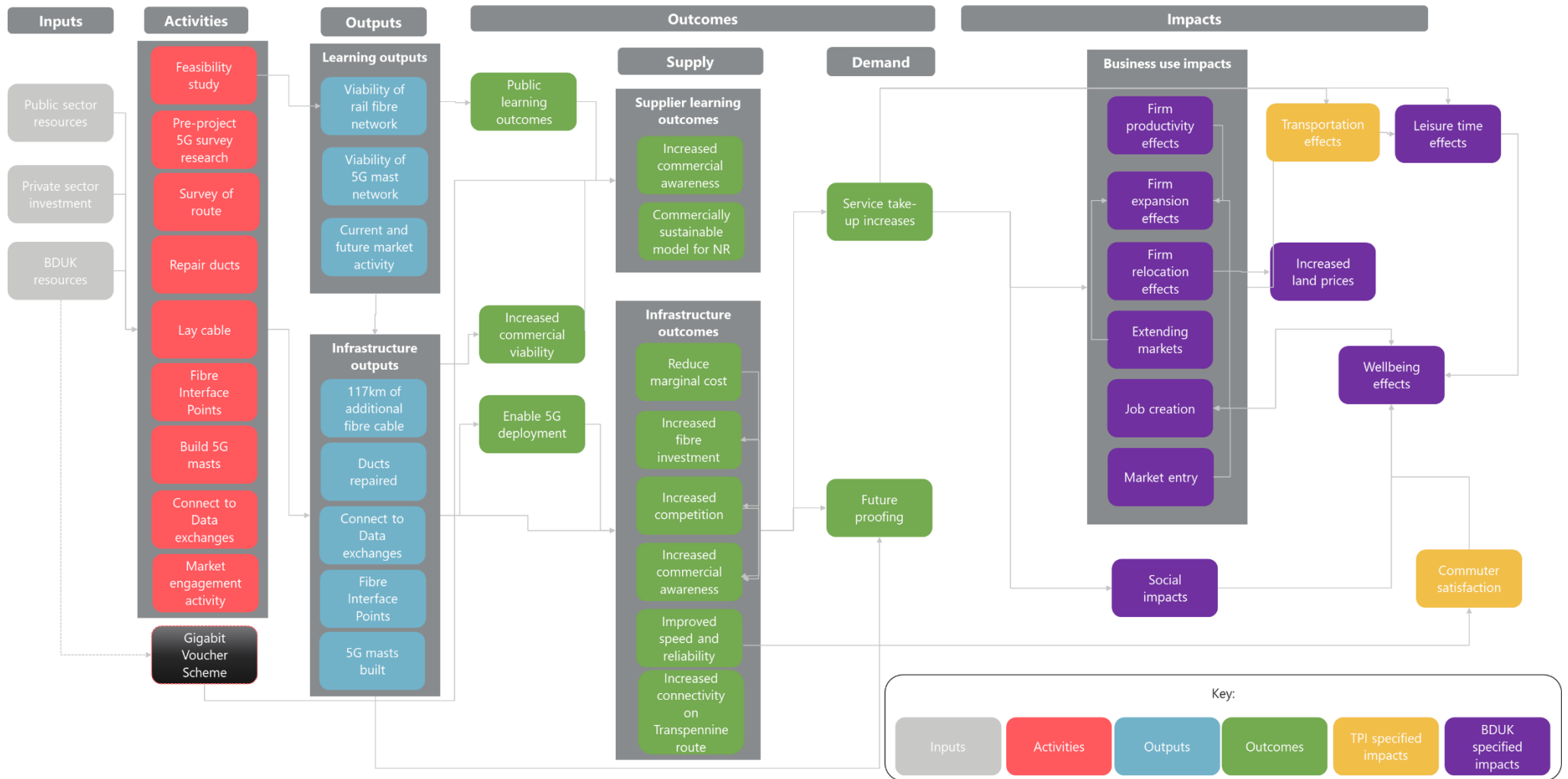
3 Project Delivery

This section discusses the physical works and subsequent activity which was required to deliver the Trans Pennine Initiative project. It presents the expenditure, an assessment of the physical works, the work to develop a pricing strategy, the installation of Fibre Interchange Points and marketing activity.

3.1 Expenditure and management

By January 2023, £11.3 million had been spent on the Trans Pennine Initiative project, with the vast majority of costs relating to payments to contractors to purchase materials and construct the network and Fibre Interface Points.

In August 2020, oversight of the Trans Pennine Initiative was handed over from BDUK project delivery to Network Rail Operations for business as usual delivery. At this point the vast majority of physical infrastructure work relating to the network had been completed.

3.2 Construction of the network

Prior to the LFFN build activity, several activities were undertaken to provide further evidence for how the build would be carried out. The most important of these activities was a survey of the route. For this, Network Rail staff walked the entire route of the Trans Pennine Initiative, examining the troughing alongside the rail route that the proposed Trans Pennine Initiative project would use. This included identifying troughing that needed repairing or replacing. For example, the troughing could have slipped from its initial position and no longer be in a useful location and therefore need repairing. Additionally, in areas where the theft of rail cables had been an issue, some of the troughing had been glued shut to prevent theft. This troughing would need replacing for the project. The examination of the route was useful in that it identified areas where the build activity may take longer than anticipated, and where the cost could increase. This helped to provide a more accurate project plan and timeline.

Following the planning stage, construction was undertaken. The Trans Pennine Initiative route had been selected for the project because other engineering work was being carried out on the line. To reduce the cost and disruption on the line, the Trans Pennine Initiative project "piggybacked" their construction work on the back of other engineering work taking place on the line. This meant that the Trans Pennine Initiative team at Network Rail identified when other construction work was taking place on the Trans Pennine line, and accessed the section of line adjacent to the existing engineering work.

Building simultaneously to other engineering work reduced administration and cost of construction. Construction sites and equipment stores were already in place, which reduces cost, and no additional applications were needed to access the line, reducing administration. Accessing the track for the LFFN build would have been lower priority than engineering work, as running the rail network takes priority over other activities for Network Rail. Therefore, if the project had not used the piggybacking approach then it is more likely that their access to the line would have taken longer to get. This would have postponed build work and delayed final delivery of the project. The physical works associated with the Trans Pennine Initiative fibre network were completed in December 2019, a few months behind the original timeline. 432 core fibre optical cable was installed and connected

between Manchester and York, connecting to two internet exchanges on route: AQL Leeds Data Centre and Equinix Manchester Data Centre.[18]

Without LFFN funding, it is unlikely that this would have been brought forward in the timescales it has been delivered in. Network Rail has previously leased access to their infrastructure for private companies to install fibre networks on an ad hoc basis. Large scale access to the Network Rail infrastructure was previously considered, but no mutually agreeable solution could be found between Network Rail and suppliers. At the time of the design of the Trans Pennine Initiative project, Network Rail did not have any plans to construct fibre networks and allow wholesale access on any rail route.

3.3 Funding / pricing mechanism

While the build was taking place, Network Rail, the Department for Transport and DCMS were working together to develop a model for selling access to a dark fibre product. This process took longer than anticipated, and various options were considered. The main considerations for developing the model to sell the fibre were State Aid considerations. The delivery model needed to be State Aid compliant, but also financially sustainable for Network Rail as they have no means to increase spending for the network.

The funding arrangement for the Trans Pennine Initiative project and the pricing strategy that Network Rail can use to sell their product are dictated by State Aid requirements. These requirements can be summarised in the following way:

- Network Rail maintains ownership of the fibre network and receives fees from suppliers using the network. Network Rail is responsible for the maintenance of the Trans Pennine Initiative network.

- The funding from BDUK has been treated as a sales contingent loan for the Trans Pennine Initiative project. Therefore, Network Rail will pay back the investment to BDUK. This will be paid back using a percentage of the revenue generated from the Trans Pennine Initiative network. This arrangement was put in place to ensure the project was State Aid compliant.

- Network Rail sells access to the Trans Pennine Initiative network to network providers / customers. This has to be sold at commercial rates, meaning prices must be in line with the rest of the market to maintain State Aid compliance;

In this way, Network Rail maintains control of the Trans Pennine Initiative network and can generate funds to maintain the network, but is operating in a commercial manner and is State Aid compliant.

3.4 Fibre Interface Points

As part of the Trans Pennine Initiative project, BDUK and Network Rail sought to establish a series of Fibre Interface Points along the route for customers to access FTTP connectivity. The overall aim is to install eight Fibre Interface Points along the route. By 2023, nine had been connected and were in service, with a further three in development. Some of the Fibre Interface Points have been funded by Network Rail, outside the funding agreement with BDUK. These Fibre Interface Points are installed alongside the rail track to ensure that staff from telecommunications companies can obtain access independently. If the Fibre Interface Points had been installed trackside, Network Rail

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[18] TPI Operational Report 1 January-March 2020 – Category 4 supporting documentation.

permission and staff would be required for a telecommunications company to access the Fibre Interface Point, as it would require accessing the active railway.

The Fibre Interface Points work package was slightly delayed for three reasons:

- **The original Fibre Interface Points delivery plan needed to be updated:** The delays with the Trans Pennine Initiative network physical works meant that the original Fibre Interface Points delivery plan to deploy the Fibre Interface Points was outdated when Network Rail engaged with the market. This meant that the Fibre Interface Point construction had to be replanned, and was not prioritised by Network Rail in terms of booking in physical work. This was because it was not directly related to the provision of rail services.

- **The Market Economy Operator Principle[19] for Fibre Interface Points found that the original approach was not State Aid compliant**. In the original plan, BDUK, DfT and Network Rail would identify Fibre Interface Points locations based on their internal assessments looking at criteria like locations with suitable surrounding communities and backhaul. This approach would potentially distort the market for FTTP. Consequently, the project delivery team adopted a demand-led approach, informed by an updated market assessment that established clear customer requirements.

- **The agreed funding mechanism**, whereby Network Rail recover profit from the network to pay back BDUK and DfT for the work in order to remain state aid compliant, **encouraged Network Rail to spend more time ensuring it chose the optimal Fibre Interface Points locations**.

Network Rail adopted an iterative approach to selecting the location of the Fibre Interface Points. Firstly, Network Rail completed an appraisal of potential Fibre Interface Points. These were located on the boundary of the network, at the edge of the railway line, to minimise complications or delays in accessing the Fibre Interface Points.[20] The locations considered by Network Rail are outlined in the map presented in Figure 3.1. The first three Fibre Interface Points were placed at train stations in York, Dewsbury and Huddersfield. This decision was based on a desk based commercial assessment to find the areas with the likely highest demand for FTTP connectivity. This assessment looked at an array of factors, including whether the local authority had explicit connectivity ambitions, the local population and socioeconomic factors. Consultees reported that the selection process for Fibre Interface Points location became more sophisticated as Network Rail and BDUK better understood the delivery process and deepened their understanding of the market.

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[19]The Market Economy Operator Principle are used to determine whether a transaction entered into by a public body is market distorting.

[20] Only Network Rail staff are permitted to undertake physical work on the railway line, and additional permission is needed to access areas on the railway that may disrupt rail services (e.g. cables / meet me points too close to the railway line). By placing the meet me points at the boundary of the railway, this reduces the risk that engineers would not be able to access the meet me point, and allows engineers from other network providers (customer organisations) to access the meet me point.

Figure 3.1: Potential Fibre Interface Points location
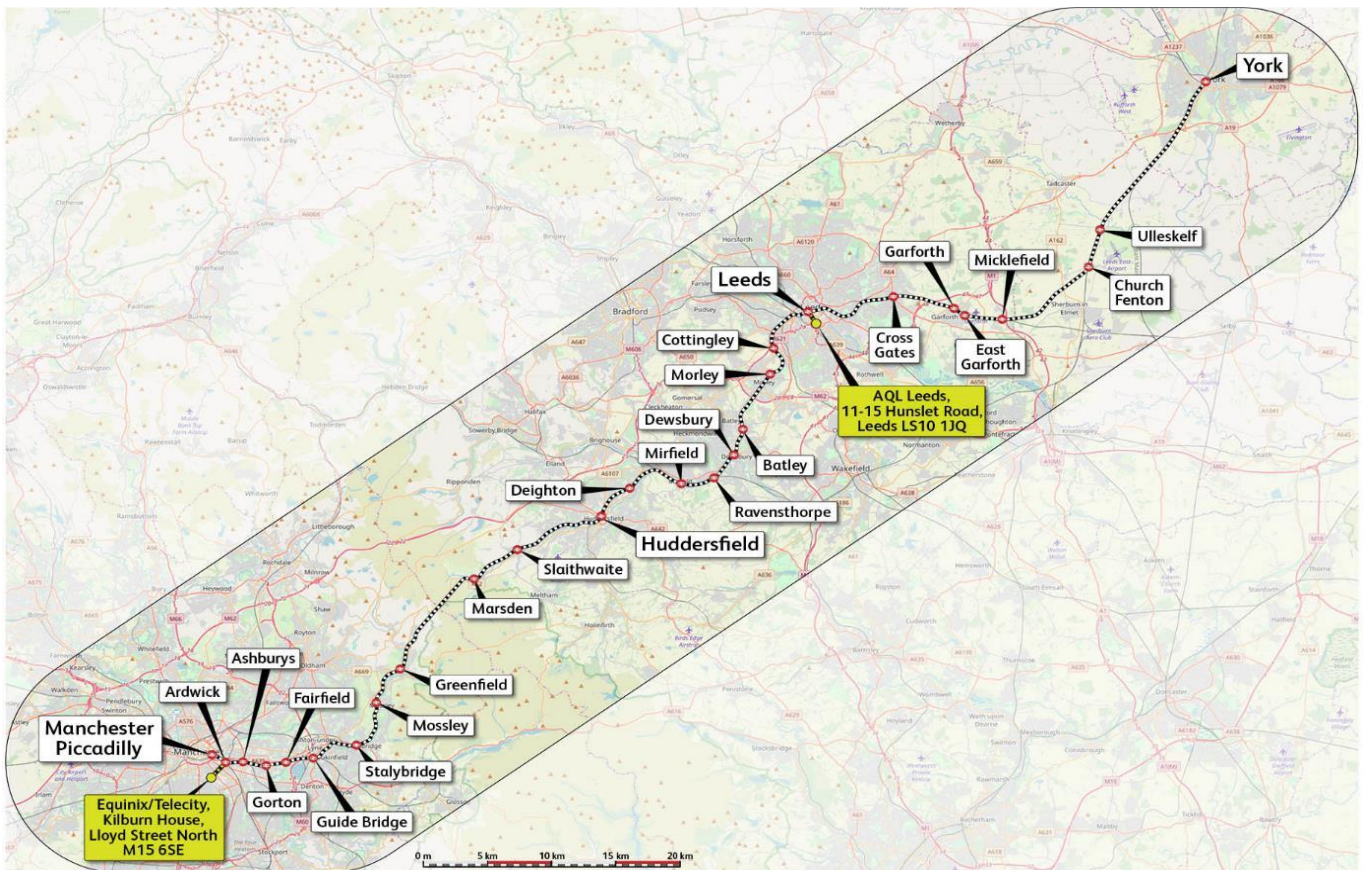
Source: Network Rail Fibre Interface Point Location Tool version 8

Construction and testing of York, Dewsbury and Huddersfield Fibre Interface Points was completed in March 2020. Two additional locations in Stalybridge and Marsden, using the first Trans Pennine Initiative fibre path, connecting Marsden to AQL-Leeds. Further Fibre Interface Points have been connected at the data centres in Leeds and Manchester, and two non-commercial connections for railway use have been put in service in Manchester and York. Three additional locations were in progress and were initially expected to be completed by the end of 2020, but are yet to be put in service. The location and station of the Fibre Interface Points are detailed in the table 3.1.

Table 3.1: Location of Fibre Interface Points

Location	Status	In commercial use
Dewsbury	In-service	Yes
Huddersfield station	In-service	Yes
Leeds data centre	In-service	Yes
Marsden station[21]	In-service	Yes
Manchester ROC	In-service	No
Manchester data centre	In-service	Yes
Stalybridge Station	In-service	Yes
York	In-service	Yes
York ROC	In-service	No
Guide Bridge	In-build	
Mossley Station	In-build	
White Rose Shopping Centre, Leeds	In-build	

Source: Network Rail MI, BDUK MI, January 2023

Network Rail are still exploring the possibility of constructing further Fibre Interface Points in the future. The siting of future Fibre Interface Points will be driven by the needs of Project Reach concessionaire, who will take responsibility for running all future fibre networks alongside the railway, including the Trans Pennine Initiative (for more information about Project Reach and the concessionaire, please see Section 5). These Fibre Interface Points would not be funded by the LFFN.

3.5   Marketing and promotion

A campaign to raise awareness and stimulate interest in the Trans Pennine fibre was launched in 2019. This was informed by a high-level communications plan that was developed by Network Rail and BDUK, and coordinating with the Trans Pennine Route Upgrade team to ensure it aligned with and contributed to their existing communications. The marketing activities were targeted at regional Internet Service Providers, including integrated service providers[22] and Local Authorities along the route, with a particular focus on those with connectivity ambitions on their development strategies.

Despite these challenges, the Network Rail Development Lead did make efforts to market the Trans Pennine Initiative network to telecommunications providers and public service providers. They made contact with hundreds of organisations to provide information about the network and the Trans Pennine Initiative offer. This led to:

- A total of 74 opportunities to be further explored, these opportunities represented interest from a potential customer. Of the 74 opportunities: Five completed orders, meaning sales were made; and

- 69 closed opportunities with no sales.

The sales that have been made are to both public sector organisations and telecommunications companies. The customers have utilised the Fibre Interface Points in eight locations.

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[21] Marsden Fibre Interface Point is not TPI funded.

[22] These are Internet Service Providers which offer services directly to customers, but also own and utilise their own networks (rather than using wholesale products to offer services to customers), e.g. Virgin Media.

However, due to the challenges faced in marketing the product, Network Rail changed their approach to marketing the Trans Pennine Initiative product. It became clear to Network Rail that a third party partner that specialises in commercialisation of fibre networks would be better placed to market access to the Trans Pennine Initiative fibre and to fibre more widely across the rail network. As a result of the learning from the Trans Pennine Initiative, Network Rail decided to launch Project Reach to secure private sector investment in high-capacity fibre along the rail network in return for granting rights to commercialise a portion of capacity in the fibre network. Network Rail will retain ownership of new high-capacity fibre deployment. Network Rail announced in 2023 that it had entered exclusive discussions with a private sector consortium. Network Rail expects that the concession agreement will grant rights to commercialise the Trans Pennine Initiative fibre product.

4 Broadband coverage in the local area

4.1 Number of network providers

The Connected Nations dataset does not break down coverage by supplier, making it difficult to establish how far any changes in coverage can be linked to the scheme. Data from ThinkBroadband provides a breakdown by supplier and is more up to date than Connected Nations. ThinkBroadband data was used to gain insight into whether any observable increase in gigabit coverage along the Trans Pennine Initiative route occurred. Data could then be used to explore whether suppliers were utilising the Trans Pennine Initiative network build.

At the time of the baseline research (2019), the area was extensively served by numerous network providers including:

- Virgin Media providing coverage across most of the populated areas along the Trans Pennine Initiative route;

- Openreach providing pockets of gigabit-capable coverage in York, Leeds and Manchester;

- CityFibre offered gigabit-capable within York; Hyperoptic with pockets of gigabit-capable coverage in Leeds and Manchester; and

- Vodafone offering gigabit-capable within Leeds and Huddersfield.

There was little coverage in many of the less populated areas of the route and a limited amount of competition in many places, with some areas only having one provider present.

The figures below show the level of gigabit-capable coverage in the area surrounding the Trans Pennine Initiative project in January 2023 from the network providers which offer the most coverage. These show that there has been an increase in gigabit-capable coverage along the Trans Pennine Initiative route, both in terms of coverage among the network providers present in 2019, and new network providers offering coverage in the area. ThinkBroadband shows that there are at least ten network providers now offering gigabit-capable services along the Trans Pennine Initiative route.

Of those that had a presence on the route in 2019, Openreach FTTP is now more widely available. There has also been a slight increase in the coverage of Hyperoptic, and CityFibre have increased their presence to include Leeds and Huddersfield. Virgin Media have continued to provide coverage to a large number of areas along the route.

There has also been an increase in the number of network providers offering services. There has been a large increase in provision from ITS in and around Tameside, and there is provision in a small number of postcodes from OFNL and Fibrenest Persimmon. Internetty now has a small amount of coverage within Manchester and Swish and Zzoomm offer services close to the Trans Pennine Initiative route in Sherburn in Elmet in North Yorkshire.

Additionally, the Trans Pennine Initiative project has supported **[redacted]** to roll out broadband coverage in an area on the Trans Pennine Initiative route. **[Redacted]** is connected to a Fibre Interface Point and is a customer of the Trans Pennine Initiative. **[Redacted]** did not have a presence

in this area prior to the Trans Pennine Initiative. This is a promising sign of potential future build using the infrastructure built in this project.

Figure 4.1: Cityfibre coverage along the Trans Pennine Initiative route, January 2023
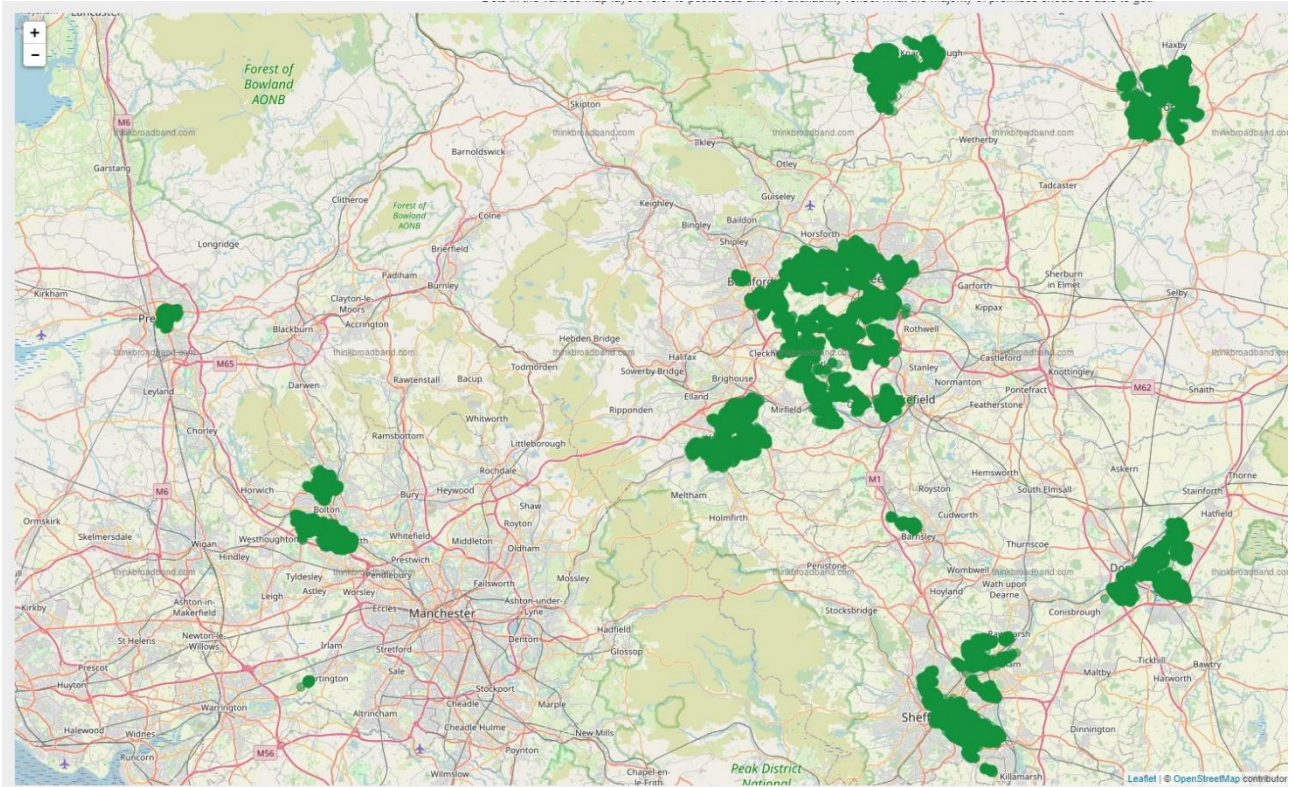
Source: ThinkBroadband

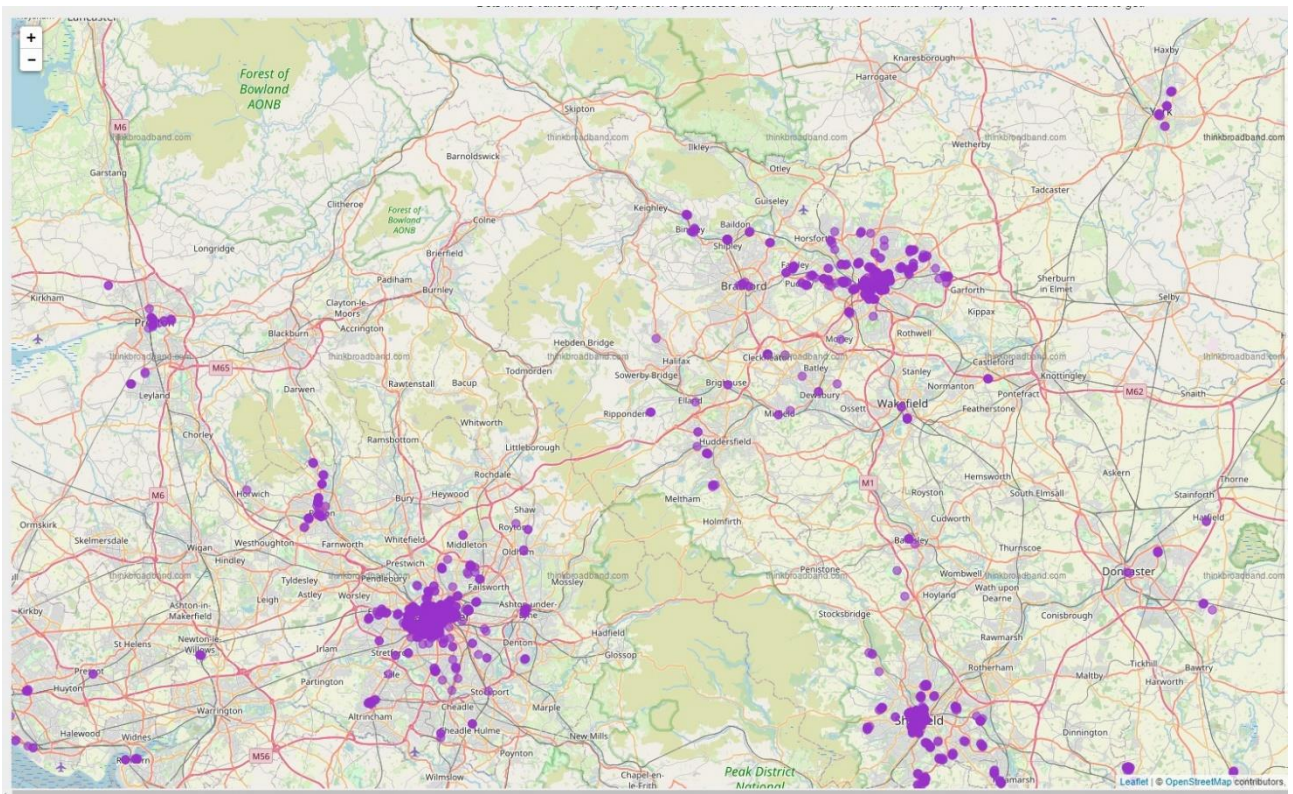**Figure 4.2: Hyperoptic coverage along the Trans Pennine Initiative route, January 2023**
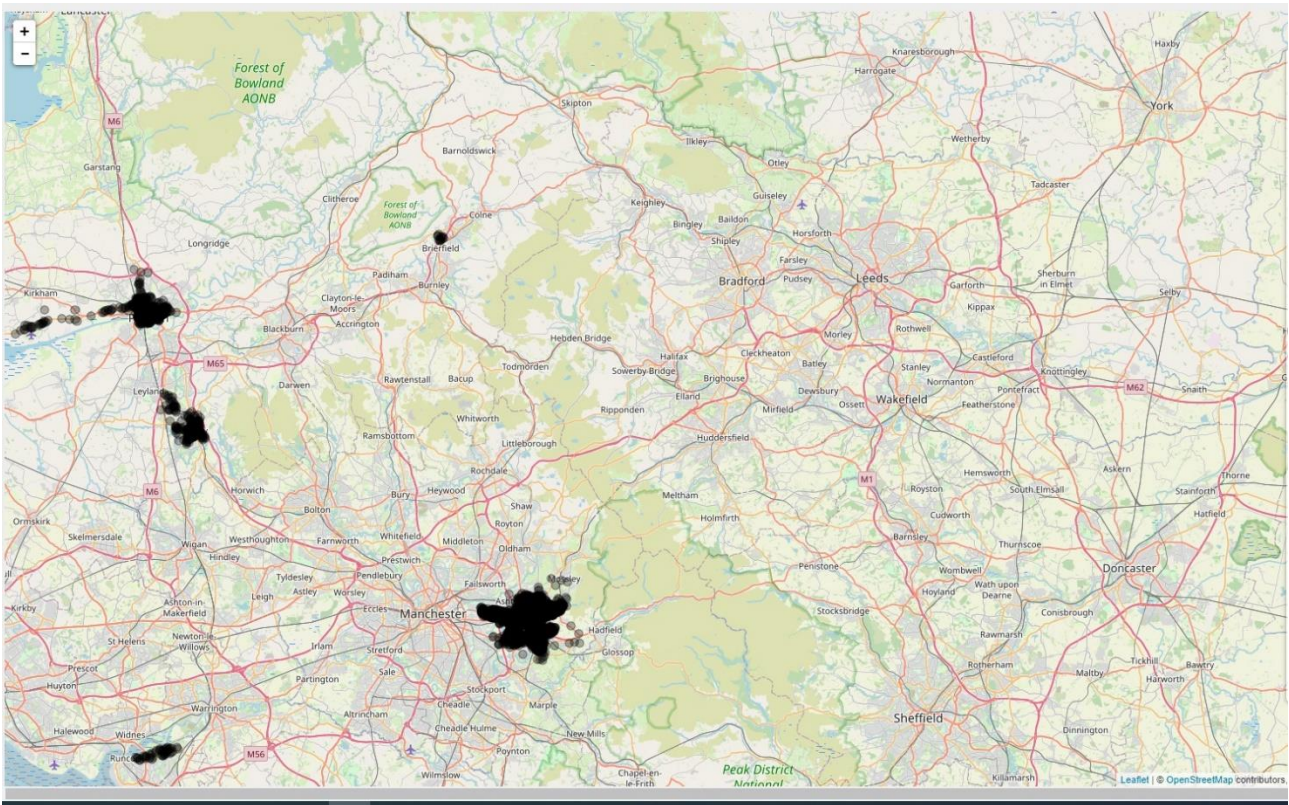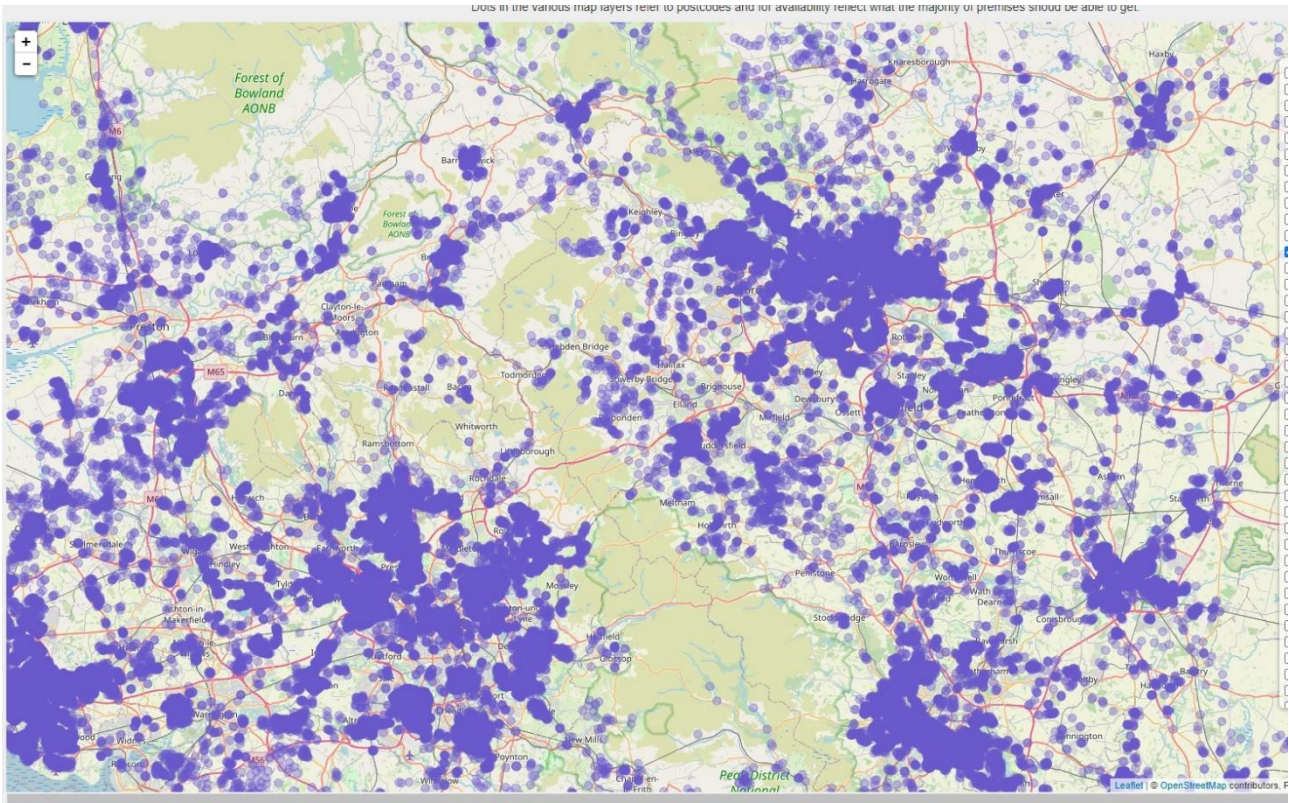
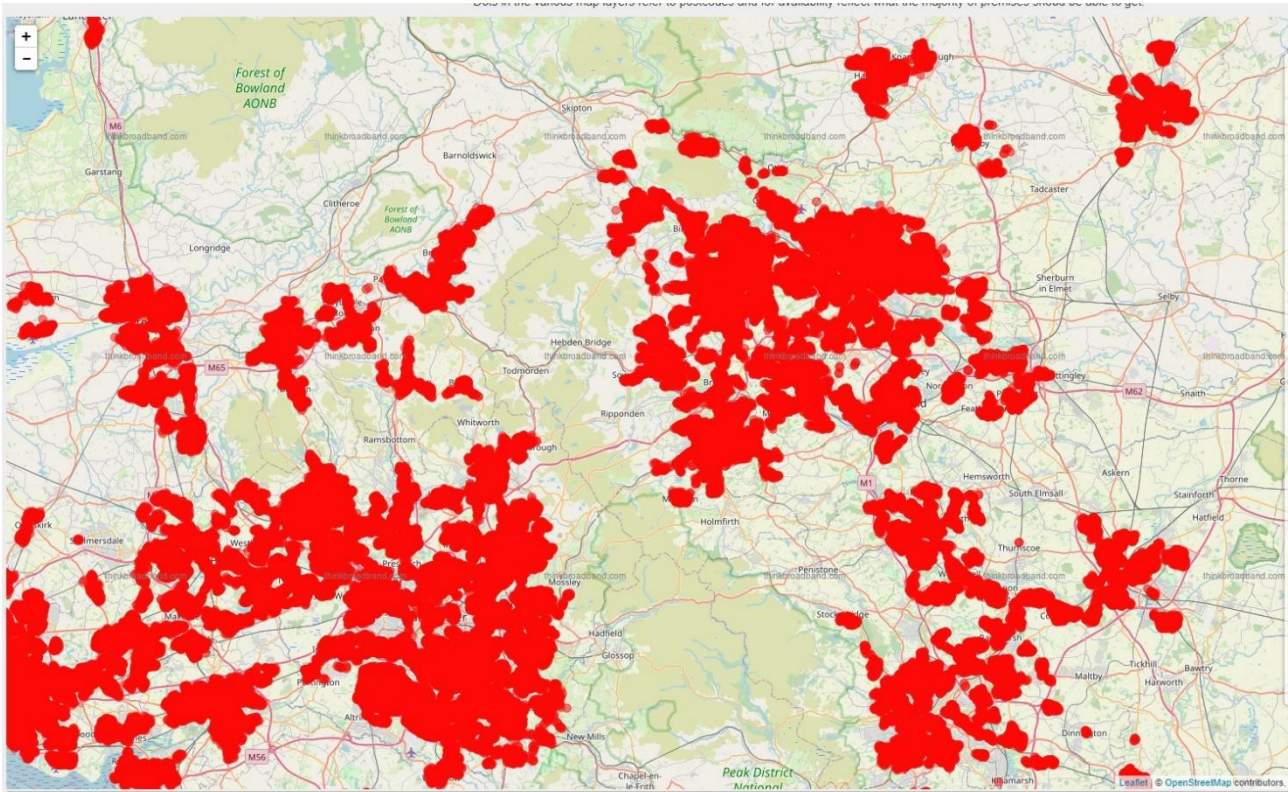**Figure 4.3: ITS coverage along the Trans Pennine Initiative route, January 2023**

Source: ThinkBroadband

Figure 4.4: Openreach coverage along the Trans Pennine Initiative route, January 2023

Source: ThinkBroadband

Figure 4.5: Virgin Media coverage along the Trans Pennine Initiative route, January 2023

Source: ThinkBroadband

4.2 Broadband coverage

The Connected Nations dataset provides data on broadband coverage at the postcode level. This allows a detailed analysis of how broadband coverage in areas close to the LFFN build has altered over time. However, there have been some changes to the Connected Nations dataset which impacts upon this analysis. In 2020, Connected Nations introduced gigabit-capable coverage as a new variable, whilst removing the FTTP variable from their publicly available data. FTTP and gigabit-capable are similar, in that all FTTP coverage is gigabit-capable, however the gigabit-capable variable also includes other technologies that deliver gigabit-capable speeds but are not FTTP, such as cable. The analysis below presents the FTTP and gigabit capable variables together as a single time series, but the change in definition explains the large increase in 2020.

The figures below present the evolution of superfast, ultrafast and FTTP / gigabit coverage in the areas within 1km of the Trans Pennine Initiative route. This shows that prior to the LFFN funding, superfast coverage along the route was slightly above the national average, and has tracked along the national average since.

Ultrafast coverage along the route was broadly in line with the national average up to 2017, but this then increased at a faster rate to 57 percent in 2018, compared to 46 percent nationally. Since 2018, the increases in ultrafast coverage along the Trans Pennine Initiative route have been slightly smaller than the national average, and in 2022 ultrafast coverage was 68 percent along the Trans Pennine Initiative route, six percentage points higher than the national average.

The trend in gigabit-capable coverage along the Trans Pennine Initiative route shows a rapid increase in coverage since 2019, reaching 65 percent in 2022. Gigabit-capable coverage has grown along the Trans Pennine Initiative route at a faster rate than nationally between 2019 and 2021, and remains five percentage points higher than the national average, at 65 percent in 2022.

A comparator area for the Trans Pennine Initiative LFFN project has been formed using postcodes along the rail route between Reading and Bristol (for more details see the technical annex). The evolution of superfast, ultrafast and gigabit-capable networks in the comparator area is also presented in the figures below. This shows that in the comparator group the trend in superfast, ultrafast and gigabit-capable networks matches that of the Trans Pennine Initiative route quite closely. Ultrafast and gigabit-capable coverage along the Reading to Bristol route was at the same level as along the Trans Pennine Initiative route in 2022, with both above the national average.

Figure 4.6: Superfast broadband coverage within 1km of the TPI route, nationally and along Reading to Bristol comparator area, 2015-2022
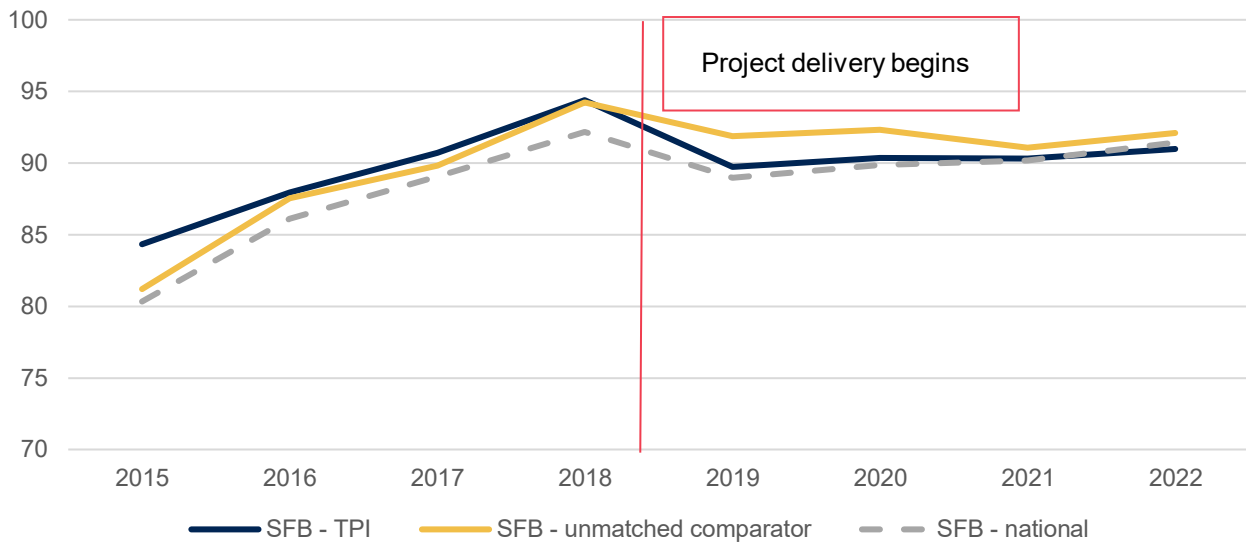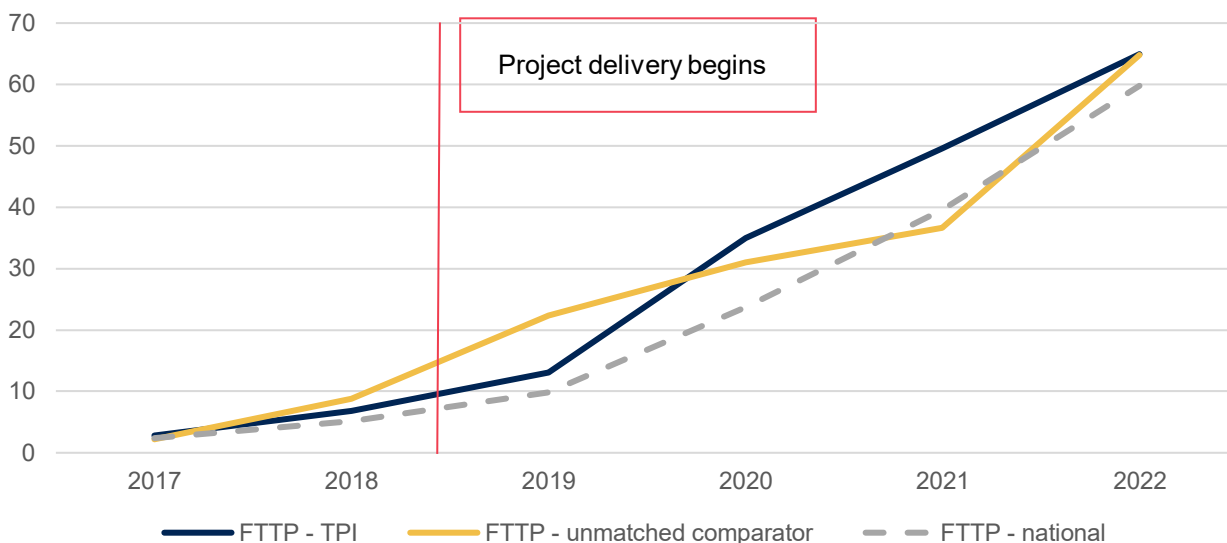

Source: Connected Nations, Ofcom

Figure 4.7: Ultrafast broadband coverage within 1km of the TPI route, nationally and along Reading to Bristol comparator area, 2015-2022
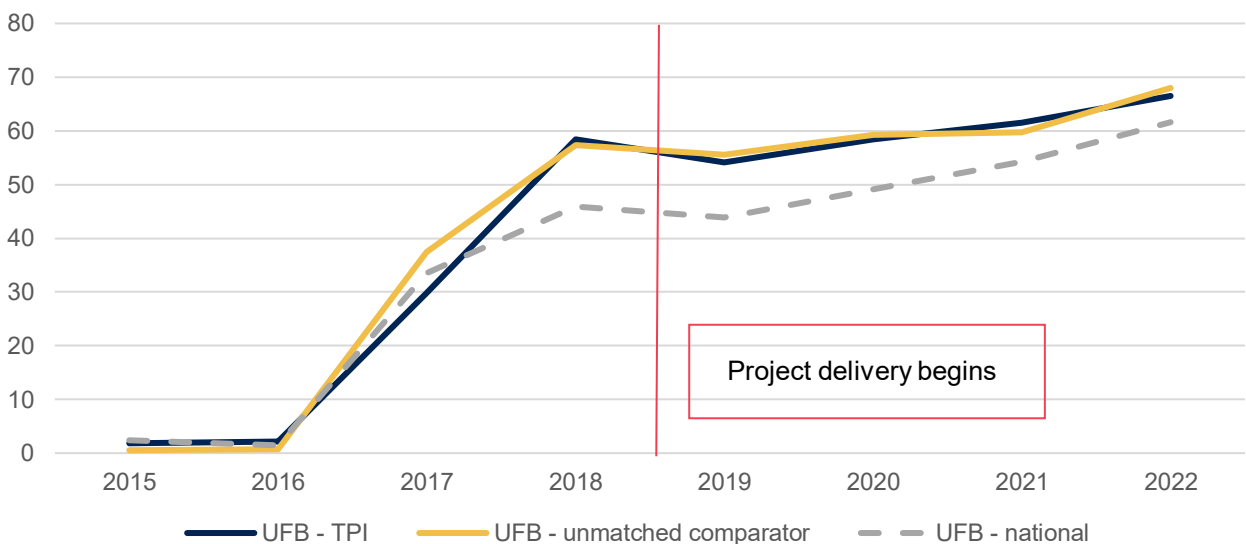
Source: Connected Nations, Ofcom

Figure 4.8: FTTP / Gigabit-capable broadband coverage within 1km of the TPI route, nationally and along Reading to Bristol comparator area, 2015-2022

Source: Connected Nations, Ofcom

The change in ultrafast and gigabit-capable networks has also been analysed at different distances from the funded build. The table below presents the findings from this analysis, which shows that the biggest changes in coverage are seen further away from the LFFN funded network build, particularly for gigabit-capable networks.

Table 4.1: Percentage point change in ultrafast and gigabit-capable / FTTP coverage in Tameside areas between 2018 and 2022 by distance from the Trans Pennine Initiative route

Distance from Trans Pennine Initiative route	Change in Ultrafast availability	Change in Gigabit-capable availability
Within 50m	14.7	50.47
50m to 100m	17.83	58.81
100m to 150m	12.59	59.58
150m to 200m	13.56	63.11
200m to 500m	13.13	64.03
500m to 1000m	18.6	71.01

Source: Connected Nations, Ofcom

4.2.1 Impact of the LFFN programme

To provide a clearer view of the impact of the LFFN Wave one project along the Trans Pennine Initiative route on gigabit-capable coverage, postcodes within 1km of the route were compared to similar postcodes sharing similar characteristics along the Reading to Bristol rail route. These areas were selected as they are along a rail route and share similar levels of rural and urban features. Additionally, there was no known other BDUK funded intervention in the area. See the technical annex for more details.

An econometric analysis was undertaken using a fixed effects analytical framework. For more details of the analytical approach please see the technical annex. The analysis comparing gigabit-capable

and ultrafast availability in areas along the Trans Pennine Initiative route to matched areas along the Reading to Bristol route found that the LFFN programme had a significant positive impact on gigabit-capable coverage of 7.2 percentage points. However, the modelling also indicated that the LFFN project had a significant negative effect of four percentage points on ultrafast coverage.

One explanation for these results is that the increase in gigabit-capable networks has discouraged investment in networks which offer ultrafast, but not gigabit-capable networks. This could be satellite or wireless solutions in more rural areas of the route. Conversely, these same ultrafast technologies may have been planned or implemented in the comparator area, and thus discouraged investment in gigabit-capable networks in the comparator area.

This estimated increase in gigabit-capable coverage around the Trans Pennine Initiative route differs from the findings from the other LFFN wave one projects. The estimations for the other projects showed either no significant impact or a negative effect on gigabit-capable coverage. This could be due to some of the areas the Trans Pennine Initiative route runs through (larger cities) where roll out of gigabit-capable coverage is more commercially viable for network providers, whereas the other projects operate in more rural / urban fringe geographies.

4.3 Take-up

The Connected Nations dataset provides data on the number of connections taken up at a postcode level. This allows a detailed analysis of how broadband coverage in areas close to the LFFN build has altered over time. The Connected Nations data does not suggest widespread take-up of FTTP or ultrafast in the areas surrounding the Trans Pennine Initiative route as of 2022 with the average number of connections per postcode approaching two in 2022. However, the take-up has shown a rapid increase since 2019, where connections per postcode were still hovering around zero. The increase in take-up of ultrafast connections along the Trans Pennine Initiative route has been mirrored by the increase along the Reading to Bristol rail route, with the exact pattern observed in both areas. This is illustrated in the figure below.

Figure 4.9: Ultrafast broadband connections, 2015-2022
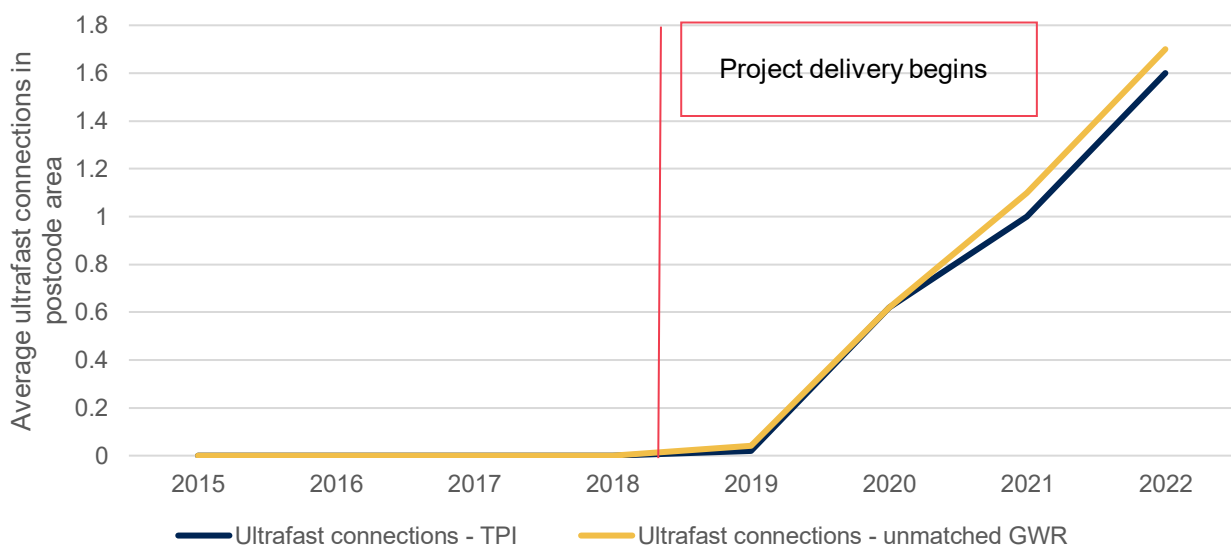
Source: Connected Nations, Ofcom

4.3.1 Impact of the LFFN programme

To provide a clearer view of the impact of the Trans Pennine Initiative on take-up of faster broadband connections, postcodes within 1km of the Trans Pennine Initiative route were compared to similar

postcodes sharing similar characteristics which are within 1km of Reading to Bristol rail route. An econometric analysis was undertaken using the same fixed effects analytical framework as described above. The analysis found that the Trans Pennine Initiative had a statistically significant positive impact on take-up of ultrafast connections, with an increase of 0.5 percentage points of the average number of connections per postcode. This increase in take up would be explained by the increase in coverage described in Section 4.5.

This estimated increase in ultrafast take-up around the Trans Pennine Initiative route differs from the findings from the other LFFN wave one projects. The estimations for the other projects showed either no significant impact or a negative effect on take-up, which again is in line with the estimated changes in gigabit-capable coverage in the other project areas.

5 Knowledge and spillover benefits

This section provides an overview of the evidence obtained of the wider outcomes and impacts generated by the Trans Pennine Initiative project. These include knowledge outcomes, outcomes for the railways and wider social and economic outcomes.

5.1 Knowledge for delivery of infrastructure on the railways

There were some key lessons learned from this project, which were useful in subsequent LFFN projects, and will be useful in future digital infrastructure projects. These are:

- **Survey of the line:** This was highlighted as a key driver of the success of the build. The survey of the line allowed Network Rail to identify particular areas where the building work may be more difficult and resource intensive and where troughing needed to be replaced. This meant that the materials and equipment required to replace or repair troughing was in place when the building work was undertaken, reducing delays. Network Rail were also able to more accurately plan the timelines and resources required for the project following the survey of the line.

- **Piggybacking build to other engineering works:** The project decided to build in a non-linear manner, laying cable at different areas along the line to coordinate with other engineering works taking place on the route. This provided the benefits described in the section above. The stakeholders interviewed suggested that this was a success in ensuring that the project was delivered in a timely and cost-effective manner.

5.2 Technical knowledge

There was also key technical learning for Network Rail. The technical learning included realising the benefit of using 432 core fibre optical cable for all fibre upgrade work on the railway. While this is slightly more expensive than the standard fibre used for rail services, it provides the opportunity to use the fibre for other commercial means in addition to providing fibre capacity to meet increasing future rail demand as Network Rail embraces more digital technology. There is no added complication of laying the fibre, it is just ensuring that the correct fibre is purchased.

There was further technical learning about the positioning of the Fibre Interface Points, to ensure that they are in commercially viable areas (see Section 3). Fibre Interface Points were also positioned alongside the track where access is not restricted, and not trackside, to ensure telecommunications companies can access the Fibre Interface Points. These factors make the network more commercially appealing.

5.3 Commercial knowledge

There have been significant commercial learnings for Network Rail from the Trans Pennine Initiative project. The initial plan of Network Rail becoming a commercial provider of fibre networks has faced significant challenges. Network Rail were unable to offer services at a lower rate than established market providers. As new entrants to the market, they also lacked a track record in terms of quality of service and ability to meet Service Level Agreements. These factors in conjunction with the launch of the Openreach Fibre First product meant that it would be challenging for Network Rail to launch as a new provider into the market. This is underlined by the relatively small number of sales that have been made through the Trans Pennine Initiative.

Therefore, a different approach to selling access to trackside fibre has been developed, which has utilised the key learnings from the Trans Pennine Initiative project. In 2021 Network Rail announced the launch of Project Reach. This project is seeking private sector investment in Network Rail's trackside fibre cable network and to enable performance, safety and connectivity benefits for passengers. Project Reach also aims to deliver wider benefits for passengers and society more broadly. Project Reach will offer a private sector concessionaire the opportunity, using its own capital, to deploy fibre along the totality of the rail network, up to around 16,000km. Once constructed the concessionaire can use a portion of the fibre capacity for their own purposes. The fibre will be owned by Network Rail and utilised for the running of the rail network alongside the private partner using the fibre for their commercial interests. A certain amount of capacity will be reserved for the rail network, to ensure that rail services can be delivered. This is a new commercial model for Network Rail, and has attracted significant interest from the telecommunications market. In February 2023, Network Rail announced its preferred partner for the Project Reach concession.

This arrangement also helps to bring forward investment and reduce the cost to the tax payer of rolling out trackside fibre. By attracting funding from the private sector this investment can be made, which can also help to provide some of the wider benefits described below. The fibre network built as part of the Trans Pennine Initiative project has been included in Project Reach. Network Rail expects the concessionaire, once appointed, to be being able to utilise the fibre along the route in the future.

5.4   Service provision benefits

The network that has been provided through the Trans Pennine Initiative project has led to service provision benefits to Network Rail and to customers of the Trans Pennine Initiative. Some of these benefits are yet to be fully realised due to a lack of take-up of the fibre connections offered through the Trans Pennine Initiative network. These include:

- **Cost savings from reducing the number of broadband connections required:** Train stations often require multiple broadband connections to ensure that the station has the required speed and reliability to provide services. This can lead to a station having a separate connection for ticketing services, CCTV and retail. For stations connected to the Trans Pennine Initiative network, they only require a single connection, which has reduced costs to the station. These savings can be rolled out to stations across the route in the future, providing savings to more stations.

- **Benefits to passengers:** Stations that have connected to the Trans Pennine Initiative network provide added benefits to passengers as well. This is mainly due to improved reliability of service provision, like better ticketing, and better platform and departure information being provided to passengers. Passengers at connected stations also have access to improved wifi availability, which improves the quality of their journey.

- **Improved resilience:** The telecommunications companies that have utilised services through the Trans Pennine Initiative stated that the main benefit to their organisation was an increase in resilience and reliability the network offered. By using the Trans Pennine Initiative route, they were able to offer their customers more reassurance that they would be able to access the speeds they required and minimise the risk of broadband dropouts. This is because the telecommunications companies utilise multiple networks to connect between their customers and data centres. Using the Trans Pennine Initiative as well as other routes therefore reduces risks associated with the routes being overloaded or out of commission, so if one route is not working the other route will remain operational. In general, the telecommunications providers

did not feel that they were now offering their customers a step change in the quality of the connection, just improved guarantees on the quality of service.

- ▪ **Potential future benefits:** There are also potential future benefits from the fibre network which have not been utilised yet or could not be assessed as part of the evaluation due to fieldwork challenges. Retailers based in stations along the route could experience cost savings and improved service efficiency due to having faster and more reliable broadband. Passengers on trains could benefit from extended ranges of wifi availability as trains arrive and leave stations. This would require some further infrastructure investment which has not yet taken place.

5.5   Economic and social impacts

It should be noted that the qualitative research suggested that the economic impacts of the project may be limited at this stage. This is because there was limited evidence that network providers were using the Trans Pennine Initiative project to provide additional services in the area, although the econometric modelling indicates there has been an impact.

5.5.1 Labour supply

Tables 5.1 and 5.2 highlight the labour supply across the districts the Trans Pennine Initiative route runs through, alongside the national average. This shows that four of the seven areas now have economic activity rates which exceed the national average, whereas in 2017 only Selby and Leeds exceeded the national average, and all are above 70 percent. However, this is variable over time, with the data for 2021 showing only York was above the national average. Unemployment across the seven areas varies with areas such as York and Leeds both below three percent, with Oldham also below the national average of 3.6 percent. This contrasts with Manchester which has an unemployment rate of six percent, yet this may be explained by Manchester's relatively high percentage of the population within the working age (16 to 64) at 89.9 percent, compared to the national average of 77.1 percent.

City districts have a higher proportion of their populations with degree level education. The districts of Leeds, Manchester and York all compare favourably with the 41.3 percent national average of the UK population. However, there has been a large increase in the proportion of the population educated to degree level in Selby, which is now slightly above the national average. The non-city districts are considerably below the national average, with 22 percent of residents of Tameside being educated to degree level. In general, there has been an increase in the proportion of the population educated to degree level in districts along the Trans Pennine Initiative route, particularly in Leeds and Selby.

Table 5.1: Labour supply characteristics in Trans Pennine Initiative areas (2022)

Area	Economic activity rate (% aged 16-64)	Unemployment rate (% aged 16-64)	NVQ4+ (% aged 16-64)[23]	Population aged 16-64 (%)	Population aged 65+ (%)
York	86.5	1.2	54.2	78.5	21.5
Selby	80.9	-	41.8	72.7	27.3
Leeds	79.3	2.5	46.4	81.3	18.7
Kirklees	73.3	4.1	32.3	77.8	22.2
Oldham	76.0	3.1	28.5	76.3	23.7
Tameside	78.4	3.7	22.0	78.2	21.8
Manchester	72.1	6.0	43.2	89.9	10.1
UK	78.3	3.6	41.3	77.1	22.9

Source: ONS Annual Population Survey (APS)

Table 5.2: Change in labour supply characteristics, 2017 to 2022

Area	Economic activity rate (% aged 16-64)	Unemployment rate (% aged 16-64)	NVQ4+ (% aged 16-64)[24]	Population aged 16-64 (%)	Population aged 65+ (%)
York	9.4p.p	-1.6p.p	5.5p.p	1.4p.p	-1.4p.p
Selby	-2.7p.p	-	12.6p.p	-0.5p.p	0.5p.p
Leeds	-0.9p.p	-1.9p.p	11.3p.p	-2.1p.p	2.1p.p
Kirklees	-0.4p.p	0.1p.p	2.4p.p	0.2p.p	-0.2p.p
Oldham	4.4p.p	-2.9p.p	2.7p.p	-3.4p.p	3.4p.p
Tameside	2.2p.p	-1.4p.p	-0.9p.p	-0.2p.p	0.2p.p
Manchester	0.1p.p	-0.3p.p	2.9p.p	2.3p.p	-2.3p.p
UK	0.1p.p	-0.9p.p	4.9p.p	-0.9p.p	0.9p.p

Source: ONS Annual Population Survey (APS)

5.5.2 Impact on unemployment

The Department for Work and Pensions provide data on unemployment claimant counts at a Lower Super Output Area (LSOA) level on a monthly basis. To provide a clearer view of the impact of the Trans Pennine Initiative project on unemployment, LSOAs which contained a postcode within 1km of the Trans Pennine Initiative route were compared to similar LSOAs sharing similar characteristics which are within 1km of Reading to Bristol rail route. An econometric analysis was undertaken using the fixed effects analytical framework as described in Section 4. The analysis found that the Trans Pennine Initiative project had no significant impact on unemployment.

5.5.3 Earnings

The figure below highlights pay in the areas around the Trans Pennine Initiative, looking specifically at how much employers pay, labelled workplace, and how much residents earn, labelled resident. We see that employers in Manchester pay slightly above the national average earnings, with employers in the remaining areas paying below average earnings. Resident data is different however, as this shows that people living in Leeds and Selby are the only areas to earn more than the average.

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[23] Most recent data available for 2021
[24] Most recent data available for 2021

Figure 5.1: Median hourly pay in LFFN areas in 2019
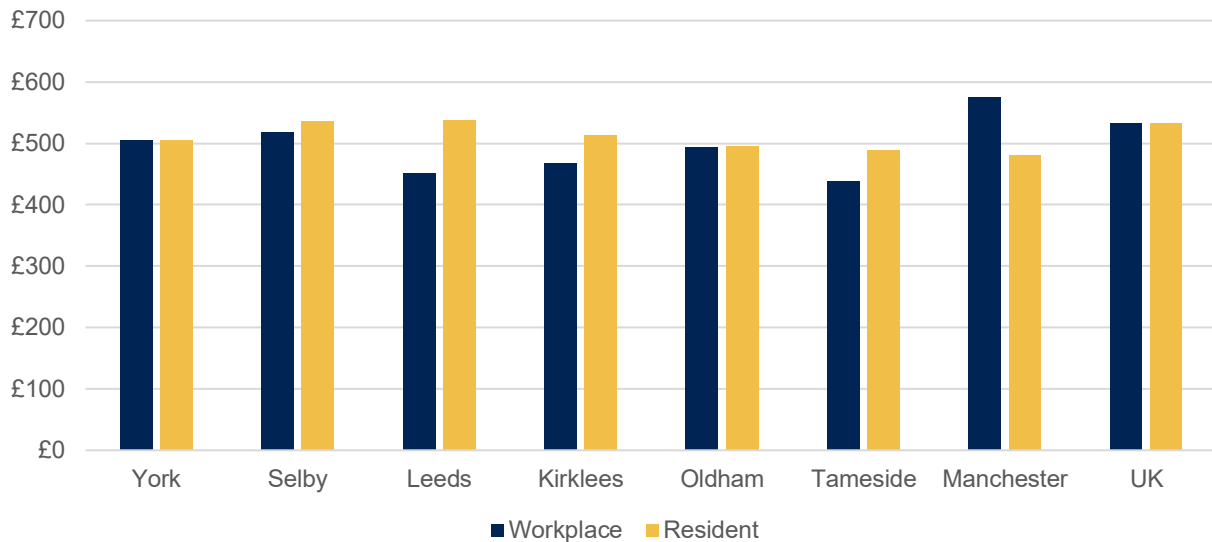
Source: ONS Annual Survey of Hours and Earnings (ASHE) 2022. Workplace earnings refers to employees working in each area; Resident earnings refers to workers that live in each area.

Changes in earnings can be viewed as a proxy measure for changes in productivity, as employers are more likely to pay productive staff higher wages. Median wage growth varied between areas along the Trans Pennine Initiative route. There is less variation in the residents growth in earnings, with all areas experiencing a larger than national average growth in earnings between 2017 and 2022. By comparison, there is more variety in workplace based pay. Earnings for workplaces in Leeds declined between 2017 and 2022, where areas like Kirklees and Oldham both experienced growth at a much higher rate than average, above 30 percent.

Table 5.3: Change in earnings, 2017 to 2022

Area	Percentage growth in earnings (%) - workplace	Percentage growth in earnings (%) - resident
York	19.3%	19.6%
Selby	20.8%	18.8%
Leeds	-1.7%	20.0%
Kirklees	30.1%	25.1%
Oldham	38.7%	22.7%
Tameside	11.7%	22.0%
Manchester	15.4%	19.5%
UK	18.7%	18.7%

Source: ONS Annual Survey of Hours and Earnings (ASHE) 2022. Workplace earnings refers to employees working in each area; Resident earnings refers to workers that live in each area.

5.5.4 Impact on earnings

The Office for National Statistics Secure Research Service allows access to more granular data on earnings. To provide a clearer view of the impact of the Trans Pennine Initiative project on earnings, the research team undertook econometric modelling, using a similar framework to that described in Section 4.2.1. The econometric modelling explored wages paid by employers within 1km of the Trans Pennine Initiative route and employers based within 1km of Reading to Bristol rail route. The analysis found that there was no statistically significant impact on earnings. More details on the modelling
approach are presented in the Technical Annex.

5.5.5 Impact on businesses

The Office for National Statistics Secure Research Service allows access to granular data on business performance through the Business Structure Database. This data was also examined using a similar framework to that described in Section 4.2.2, and explored the impact of the Trans Pennine Initiative on the number of jobs, turnover and productivity (turnover per worker) on businesses located within 1km of the project. The analysis found that there was no statistically significant impact on the number of jobs, turnover or productivity.

5.5.6 House prices

Data from the Land Registry provides information about the prices paid for premises at a postcode level. Using this data, the research team have been able to explore the evolution of house prices within 1km of the Trans Pennine Initiative route. The figure below presents the evolution of house prices within 1km of the Trans Pennine Initiative route from 2013 to 2022. This shows that there has been a general positive trend in house prices.

Figure 5.2: Evolution of house prices within 1km of the Trans Pennine Initiative route, by type of premises (2013 to 2022)
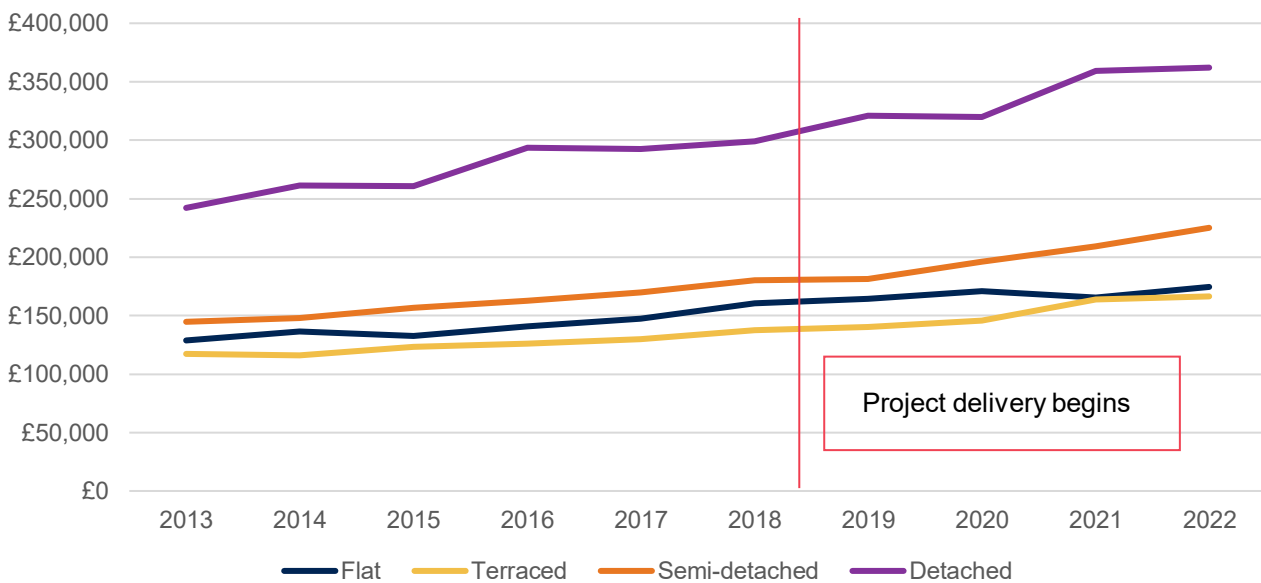
Source: Land Registry, 2013 to 2022.

Exploring the change in prices in more detail, house prices have increased most markedly for semi-detached and terraced properties, with increases of 33 and 28 percent respectively between 2017 and 2022 (2017 being the year prior to work starting on the Trans Pennine Initiative). These changes were compared to the changes in house prices for properties within 1km of the Reading to Bristol rail route. It should be noted that the base house prices were between 50 and 120 percent higher along the Reading to Bristol route in 2017. However, the growth in prices along the Trans Pennine Initiative route has been far higher than along the Reading to Bristol route, for all property types with the exception of detached houses.

The analysis here presents an overview of house prices in two areas, but does not attempt to draw inferences of the impact the Trans Pennine Initiative project has had on house prices. This is because the qualitative findings did not suggest that there has been widespread use of the networks to provide additional gigabit-capable coverage to areas along the route – therefore there is limited evidence that any changes in house prices would be driven by the Trans Pennine Initiative project itself.

Table 5.4: Change in house prices, 2017 to 2022

Area	Trans Pennine Initiative route		Reading to Bristol route	
	Average price 2017 (£)	Increase in price 2017-2022 (%)	Average price 2017 (£)	Increase in price 2017-2022 (%)
Flat	£147,600	18.3%	£231,900	-0.2%
Terraced	£130,000	28.0%	£288,200	18.6%
Semi-detached	£169,600	32.7%	£328,000	16.0%
Detached	£292,500	23.8%	£500,500	27.5%

Source: Land Registry data (2017-2022).

6 Conclusions

The key findings from the Trans Pennine Initiative evaluation are:

- The physical works were completed in December 2019, with a core fibre optical cable installed and operational between Manchester and York, and connected to two internet exchanges. Nine Fibre Interface Points have been installed along the route, with a further three in development. Network Rail or a third party partner have the opportunity to install further Fibre Interface Points along the route if there is a commercially viable reason for doing so.

- Marketing and promotion of the Trans Pennine Initiative product proved challenging for Network Rail, due to the price constraints and the launch of a new Openreach dark fibre product around the same time as their marketing activity. The project was able to generate 74 potential customers, but of these only five were converted into sales. This shows that there are significant challenges to marketing the trackside fibre in this way.

- As a result of the lessons learned from the Trans Pennine Initiative project, Network Rail have altered their commercial approach to trackside fibre. The lessons learned were around the need to have telecommunications specialists involved to sell access to dark fibre products, as the Trans Pennine Initiative struggled to gain traction in this area. In 2021, they launched Project Reach, which offers a commercial provider access to trackside fibre, in exchange for the capital investment to construct the trackside fibre network.

- Deployment of gigabit-capable networks within 1km of the Trans Pennine Initiative route has increased between 2017 and 2022. The econometric analysis undertaken, comparing connectivity outcomes along the Trans Pennine Initiative route and the Reading to Bristol rail route indicates that the project has had a positive impact on gigabit-capable coverage and take-up of ultrafast broadband connections. This is despite there being a limited number of network providers actually using the Trans Pennine Initiative network to provide broadband services.

The table below summarises the Trans Pennine Initiative projects achievements against its original stated objectives and those included in the Theory of Change:

Table 6.1: Summary of Trans Pennine Initiative project achievements – green highlights strong evidence of achievement, orange indicates limited evidence of progress towards objective

Objective	Achieved
Generate learning	Learning generated for Network Rail in terms of delivery and commercial environment.
Public sector cost savings	Evidence some stations have experienced cost savings, and the potential for further savings along the route.
Enhanced (public sector) service provision	Evidence that services at some stations have improved, and the potential for further improvements along the route.
Improve resilience	Evidence that broadband providers have utilised the network to improve resilience for customers.
Future proofing	Evidence that Network Rail and stations can further exploit the fibre network in the future.
New broadband providers	Limited evidence that new broadband providers are offering services along the route.
Broaden connectivity	Evidence of enhanced connectivity along the route, in spite of limited use of the network by broadband providers.
Introduce new commercial models	Evidence of demand for a commercial model to provide access to rail fibre Limited evidence that Network Rail can and should enter the market as a new broadband provider to offer commercial access.
Enhanced connectivity for passenger	Limited evidence that the project has led to enhanced connectivity for rail passengers
Economic and social outcomes	Limited evidence that the project has led to economic and social benefits.

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