Queensbury Tunnel

Estimating the economic impact of reopening walking and cycling routes around Queensbury Tunnel



About Sustrans

Sustrans makes smarter travel choices possible, desirable and inevitable. We're a leading UK charity enabling people to travel by foot, bike or public transport for more of the journeys we make every day. We work with families, communities, policy-makers and partner organisations so that people are able to choose healthier, cleaner and cheaper journeys, with better places and spaces to move through and live in.

It's time we all began making smarter travel choices. Make your move and support Sustrans today. www.sustrans.org.uk

Head Office Sustrans 2 Cathedral Square College Green Bristol BS1 5DD

© Sustrans 2017 Registered Charity No. 326550 (England and Wales) SC039263 (Scotland) VAT Registration No. 416740656

Table of contents

1 Executive summary	
2 Introduction	3
Study area	3
Existing evidence and BCRs from comparative case studies	s7
3 Methodology for economic appraisal	g
4 Estimating baseline annual usage	10
Methodology for estimating the baseline annual usage - cor	nmuting10
Methodology for estimating the baseline annual usage - leis	sure 12
Baseline annual usage estimate	14
5 Estimating post intervention annual usage	15
Methodology for estimating post intervention annual usage	- cycling15
Methodology for estimating post intervention annual usage	- walking16
Post intervention annual usage estimate for each route	17
6 Combining multiple routes into scenarios	18
Accounting for double counting – baseline AUEs	18
Accounting for double counting – post intervention AUEs	18
Post intervention annual usage estimate for each scenario.	19
Sensitivity testing	19
7 Costs	21
8 Estimating the economic value of benefits and BCRs of s	even scenarios23
Other inputs used in our economic appraisal	23
Benefit Cost Ratios (BCR)	23
Tourism model	25
Benefit Cost Ratios (BCR) including tourism benefits	
Direct job creation	28
Increased population	
9 Summary	29
10 Appendix	31

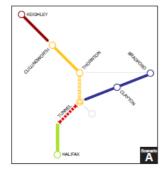
1 Executive summary

Queensbury Tunnel is a 1.4 mile long tunnel beneath the village of Queensbury, between Bradford and Halifax in West Yorkshire. There is local interest in reopening the tunnel as a walking and cycling route. If reopened, the Queensbury Tunnel would be the second longest underground cycle route in Europe. Sustrans' Research and Monitoring Unit (RMU) were commissioned to produce this report to appraise the benefits and value for money of a number of options, and generate benefit to cost ratios (BCRs).

The study area looks at combinations of seven proposed routes around the Queensbury area that could form links between Bradford, Halifax and Keighley (see page 3), including reopening the Queensbury Tunnel itself. The baseline cycling and walking annual usage is estimated for each route, before estimating post intervention usage based on uplift seen in comparable previous Sustrans interventions. Routes are then combined into 11 scenarios (see page 5). This allows for a modular approach to network development and helps appraise relative value for money of different scenarios when using the Sustrans RMU WebTAG Appraisal Tool.

Scenarios are split by inclusion or exclusion of Queensbury Tunnel, and the main findings are:

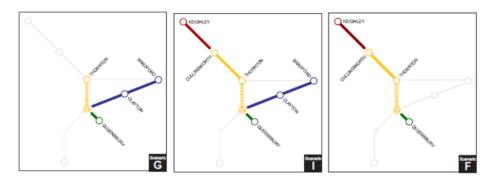
- The scheme type (predominantly on-road or off-road) affects the BCR; scenarios containing the off-road valley floor route 3a between Bradford and Queensbury triangle have consistently higher BCRs than the on-road Thornton Road route 3b
- There is a range of estimated costs for Queensbury Tunnel; from £4.3 million to £35.4 million. This means there is a wide range of BCRs for scenarios containing this route.
 BCRs are dependent on accurate costs, so more accurate BCRs cannot be calculated until more defined costs for reopening Queensbury Tunnel are collected
- This report is a preliminary piece of work and it is intended that the preliminary conclusions
 drawn will need to be revisited once more feasibility work has been undertaken and accurate
 costs have been obtained for Queensbury Tunnel
- As with any economic appraisal there are many assumptions and caveats stated throughout the report
- Estimates of **cycle tourism benefits** are not WebTAG compliant, but for this appraisal have been combined with WebTAG benefits to give a more holistic estimation of the economic impact of scenarios including Queensbury Tunnel (the route is expected to draw in cycle tourists due to its heritage and history)
- When tourism spend is included, the scenarios that return the highest BCR that include the tunnel are scenario A min and scenario D min, both with a BCR of 3.2 to 1, and scenario C min with a BCR of 3.1 to 1. All three 'min' scenarios use the minimum cost option for Queensbury Tunnel:
 - Scenario A min is the most extensive scenario, developing a full network between Halifax, Bradford and Keighley including an off-road valley floor route between Bradford and Queensbury triangle
 - Scenario D min is a network from Halifax to Bradford, including Queensbury Tunnel and an off-road valley floor route between Bradford and Queensbury triangle
 - Scenario C min is a network from Halifax to Keighley, including Queensbury Tunnel







- The scenarios that return the **highest BCR that exclude the tunnel** are scenario G and scenario I, both with a **BCR of 3.8 to 1**, and scenario F with a **BCR of 3.7 to 1**:
 - Scenario G is a route from Bradford to Queensbury along an off-road valley floor route between Bradford and Queensbury triangle
 - Scenario I is a route from Bradford to Keighley via Queensbury, along an off-road valley floor route between Bradford and Queensbury triangle
 - Scenario F is a route from Keighley to Queensbury village



• It's necessary to consider all **impacts presented here as conservative**. This is the standard approach to minimise the impact of optimism bias, as some high performance schemes could distort expectations. Estimations however do point towards a positive impact for a number of scenarios listed above.

2 Introduction

Queensbury Tunnel is a 1.4 mile long tunnel beneath the village of Queensbury, between Bradford and Halifax in West Yorkshire. Queensbury Tunnel is currently the responsibility of Highways England, who plan to spend around £3 million¹ to close and make safe the tunnel. There is local interest in reopening the tunnel as a walking and cycling route. If reopened, the Queensbury Tunnel would be the second longest underground cycle route in Europe.

In 2015 Jacobs (commissioned by Highways England) estimated a cost of £35.4 million² to restore the tunnel and shafts. In 2016 the Queensbury Tunnel Society commissioned an independent assessment of the tunnel and estimated a much lower cost of £4.3 million³ to repair the tunnel to make it safe (including creation of a cycle path and lighting).

Sustrans' Research and Monitoring Unit (RMU) were commissioned to produce this report by Bradford Metropolitan District Council on behalf of Calderdale Council, Highways England and local group Queensbury Tunnel Society (QTS), to appraise the benefits and value for money of a number of options, and generate benefit to cost ratios (BCRs).

The report will begin by defining the study area and identify comparative studies to demonstrate the economic benefits evidenced from past interventions. We will then look at how we have modelled demand on the proposed routes and how we have valued the benefits. The report concludes with a summary and discussion of BCRs for each route for each scenario.

This analysis will inform a business case on why reopening Queensbury Tunnel as part of a network of routes is good for the local economy, including overcoming barriers and linking communities, creating jobs and boosting tourism. By looking at the economic and social impacts of similar infrastructure projects (notably Bath Two Tunnels), the possible economic impact of reopening Queensbury Tunnel can be estimated.

Study area

Queensbury Tunnel runs from north-east to south-west beneath the village of Queensbury, between Bradford and Halifax. Reopening of the tunnel is considered alongside further development of existing cycle routes in the surrounding area. The seven routes that are considered in this report are listed in Table 1 and mapped in Figure 1 below.

Table 1 – Potential cycling and walking routes around Queensbury

Route name & number		Details	
Great Northern Railway Trail		Proposed completion of the Great Northern Railway Trail (GNRT) between the north end of Queensbury Tunnel and Cullingworth, mostly off-road along a dismantled railway, including refurbishment of a 605m tunnel. Please note that part of the GNRT also considers linking Bradford and Keighley, but for the purposes of this report the stretch between Queensbury Tunnel and Cullingworth is referred to as the GNRT	
Cullingworth to Keighley Valley floor 3a		Proposed route between Cullingworth and Keighley, mostly off-road	
		These are two options for routes between Bradford and Queensbury	

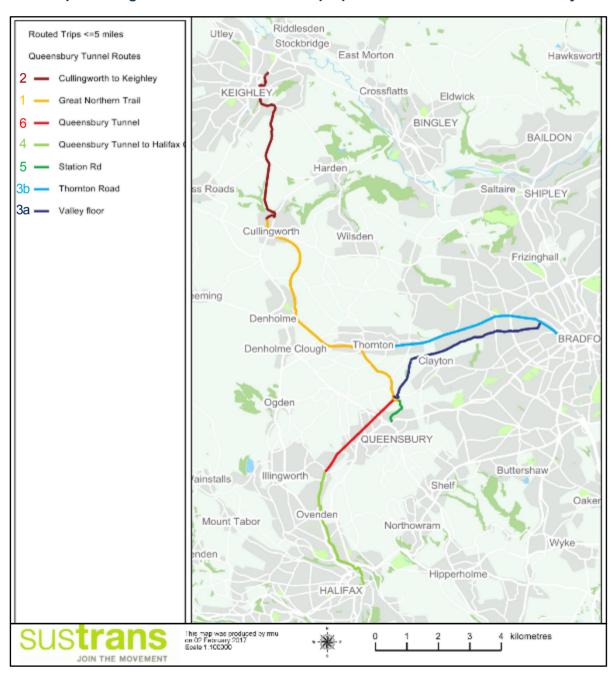
¹ Queensbury Tunnel – Proposal for economic appraisal, Sustrans, May 2016

² HQU 3D Queensbury Tunnel, Queensbury Tunnel Options report, Jacobs, February 2016

³ http://www.queensburytunnel.org.uk/reports/QueensburyTunnelReport(October2016).pdf

Thornton Road	3b	triangle. The mostly off-road route follows the valley floor and the other is on-road alongside the existing Thornton Road.
Queensbury Tunnel to Halifax	4	Mostly on-road route between the south end of Queensbury Tunnel and Halifax centre
Station Road	5	Existing steep on-road route connecting Queensbury triangle to Queensbury village, currently in poor condition
Queensbury Tunnel	6	Refurbishment and reopening of an existing railway tunnel beneath Queensbury village

Figure 1 - Map showing the location of the seven proposed routes around Queensbury

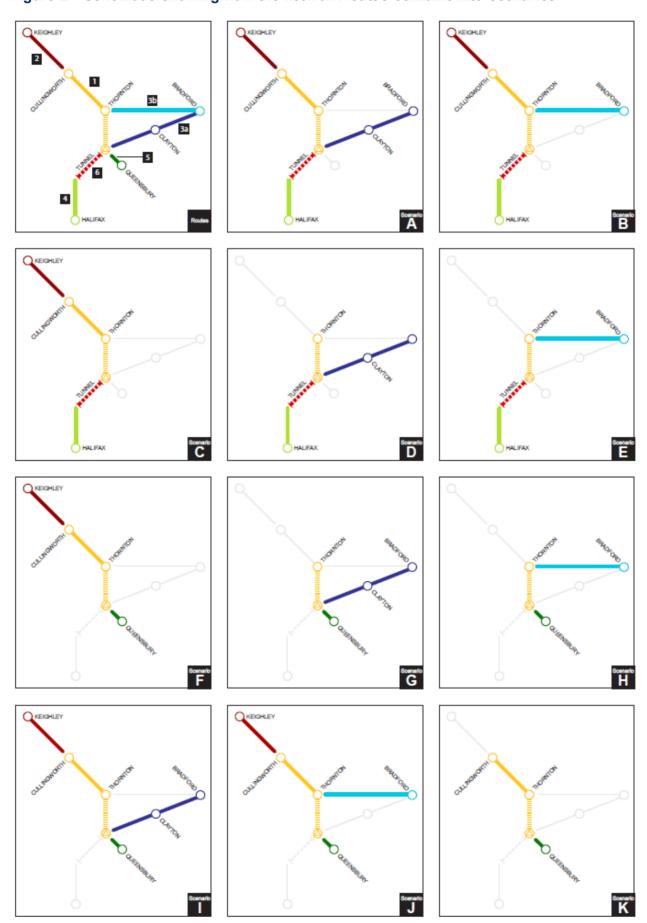


These routes are combined into 11 different scenarios to be appraised, listed in Table 2 and visualised in the schematic in Figure 2 below. Appraising each of these 11 scenarios allows for a modular approach to network development, and helps appraise relative value for money of different scenarios. Scenarios are defined by inclusion or exclusion of Queensbury Tunnel, and by which of the two Bradford routes is included (valley floor or Thornton Road).

Table 2 – Potential cycling and walking scenarios around Queensbury

Scenario			Details		
Including tunnel	A	Most extensive scenario developing a full network	Great Northern Railway Trail + Cullingworth to Keighley + Bradford valley floor + Queensbury Tunnel to Halifax + Queensbury Tunnel		
	В	between Halifax, Bradford and Keighley	Great Northern Railway Trail + Cullingworth to Keighley + Bradford Thornton Road + Queensbury Tunnel to Halifax + Queensbury Tunnel		
	С	Developing a network from Halifax to Keighley	Great Northern Railway Trail + Cullingworth to Keighley + Queensbury Tunnel to Halifax + Queensbury Tunnel		
D		Developing a network from Halifax to Bradford	Bradford valley floor + Queensbury Tunnel to Halifax + Queensbury Tunnel		
	E		Bradford Thornton Road + Queensbury Tunnel to Halifax + Queensbury Tunnel		
Excludin g tunnel	F	Developing a network from Queen sbury to Keighley	Great Northern Railway Trail + Cullingworth to Keighley + Station Road		
	G	Developing a route from Bradford to	Bradford valley floor + Station Road		
	Н	Queen sbury	Bradford Thornton Road + Station Road		
	I	Developing a network from	Great Northern Railway Trail + Cullingworth to Keighley + Bradford valley floor + Station Road		
	J	Bradford to Keighley, via Queensbury	Great Northern Railway Trail + Cullingworth to Keighley + Bradford Thornton Road + Station Road		
	K	Developing a route from Cullingworth to Queen sbury	Great Northern Railway Trail + Station Road		

Figure 2 – Schematic showing how the network routes combine into scenarios



Existing evidence and BCRs from comparative case studies

Physical barriers, whether natural or man-made, can strongly influence the extent to which people are willing and able to travel by bike. Local travel can be transformed by overcoming these barriers to enable cycling to become part of everyday life for more people. Reopening tunnels in the UK is relatively rare so there are few examples to draw on, so examples of new bridge schemes of similar costs that connect communities are also used. The benefit cost ratios (BCRs) associated with four of these type of schemes delivered by Sustrans are listed below, alongside two combined BCRs for successful applications to Department for Transport walking and cycling funding streams.

A 2013/14 Highways Agency technical note⁴ provides guidance on the value for money categories of BCRs for schemes:

- BCR of less than 1 = poor value for money
- BCR between 1 and 1.5 = low value for money
- BCR between 1.5 and 2 = medium value for money
- BCR between 2 and 4 = high value for money
- BCR above 4 = very high value for money

BCRs for Queensbury Tunnel scenarios are referenced throughout this report, and can be compared to these guidelines and other similar projects as outlined below, to understand the relative benefit of each scenario.

Bath Two Tunnels (Connect2)

No adequate cycling and walking link existed between rural North East Somerset and the centre of Bath. A four-mile stretch of the former Somerset and Dorset railway line was transformed, including renovation of two tunnels (one the longest cycling tunnel in Britain) and a viaduct.

The Two Tunnels Greenway has become a well-used route for local people and also a tourist attraction in its own right. As the second longest walking and cycling tunnel in Europe, the Queensbury Tunnel opening could be expected to have considerable impact as a tourist attraction. The Bath Two Tunnels project has realised the following benefits:

- Scheme cost: £5,158,000
- 131% increase in total route usage after the opening of the route 366% increase in cycling, and 50% increase in walking
- Estimated BCR over 30 years 3.4 to 1

Shoreham harbour bridge (Connect2)

For many years, the aging and narrow drawbridge that crossed the River Adur and linked Shoreham town centre to the nearby beach had been difficult to cross, especially for cyclists and people on foot. Sustrans worked with partners to build a new walking and cycling bridge, including a dramatic transformation of East Street in the town centre into a pedestrian area. Conditions for cyclists and walkers on roads in the area have been further improved by installing new safer crossings. The project has realised the following benefits:

Scheme cost: £11,126,835

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361412/PS_2013-15_ _4.19_The_Percentage_of_Major_Project_Spend_which_is_Assessed_as_Good_or_Very_Good.pdf

- 16% increase in total route usage after the opening of the route 65% increase in cycling, and 10% increase in walking
- Estimated BCR over 30 years 3.6 to 1

Pont y Werin bridge, Cardiff (Connect2)

This bridge (translated as the People's Bridge) was constructed to provide a pedestrian and cycle link across the River Ely between Cardiff and Penarth. The bridge enabled the creation of a 10.5km circular trail around Cardiff Bay, which is accessible for both walkers and cyclists. The circular loop links all the key attractions of Cardiff Bay, including the International Sports Village, Cardiff Bay Barrage and the Norwegian Church. The project has realised the following benefits:

- Scheme cost: £4,893,237
- 86% increase in total route usage after the opening of the route 115% increase in cycling, and 78% increase in walking
- Estimated BCR over 30 years 3.0 to 1

Bretons Bridge, Havering (Connect2)

This bridge is the centrepiece of a walking and cycling route that links Dagenham in east London to green spaces such as Ingrebourne Valley. The bridge connects to new and existing paths on either side of the river. The project has realised the following benefits:

- Scheme cost: £4,481,932
- 20% increase in total route usage after the opening of the route 10% increase in cycling, and 21% increase in walking
- Estimated BCR over 30 years 3.3 to 1

Cycle City Ambition schemes (DfT)5

The Cycle City Ambition (CCA) Grant was created to support the Government's commitment to promote cycling and walking. Funding was awarded to eight successful cities in 2013. Bids were judged on five criteria, one of which is the economic case. The combined BCR across all eight successful cities as estimated in their bids is outlined below:

- Total DfT funding for the eight schemes: £77 million
- Estimated combined BCR across all eight schemes 5.1 to 1

Cycling in National Parks schemes (DfT)⁵

The Cycling in National Parks Grant was created to support cycling and walking in rural areas. Funding was awarded to four of the nine National Parks in England. Bids were judged in the same way as CCA schemes, and the combined BCR across all four successful National Parks as <u>estimated in their bids</u> is outlined below:

- Total DfT funding for the four schemes: £17 million
- Estimated combined BCR across all four schemes 7.4 to 1

8 June 2017

_

⁵ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348943/vfm-assessment-of-cycling-grants.pdf

3 Methodology for economic appraisal

The following section outlines the application of a model to examine the likely impacts of the reopening the Queensbury Tunnel alongside a network of routes.

In order to estimate the possible impact of developing a network of routes around Queensbury, the Department for Transport's WebTAG methodology can be used. Sustrans' RMU have used guidance set out in WebTAG to build a tool which can be used in the appraisal of sustainable transport initiatives. This tool will model the expected monetized benefits from different scenarios of increase in the annual usage estimate (AUE) of pedestrians and cyclists on the proposed routes around Queensbury.

The WebTAG framework permits the inclusion of the economic value of health benefits associated with increased walking and cycling using the Heath Economic Assessment Tool (HEAT). HEAT has been developed by the World Health Organisation (WHO) and is accessed at the following link: http://www.heatwalking.cycling.org/

The following steps have been taken as part of the economic appraisal process:

- Estimating baseline annual usage (number of users and journey purpose) for each route
- Estimating post intervention annual usage for each route, from past evidence on the impact of interventions on usage of similar routes
- Combine routes into the 11 scenarios listed in Table 2 above, accounting for double counting when estimating baseline and post intervention annual usage for each scenario
- Determining costs
- Estimating the economic value of benefits and BCRs of the 11 scenarios, split by inclusion
 or exclusion of the tunnel

4 Estimating baseline annual usage

In order to use the Sustrans RMU WebTAG Appraisal Tool, a baseline annual usage estimate (AUE) for each of the routes being examined is required. This section outlines the AUE methodology; we estimate annual usage for commuting journeys and leisure journeys (for cyclists and pedestrians) before combining them to obtain a baseline annual usage estimate for each route.

Methodology for estimating the baseline annual usage - commuting

The Department for Transport (DfT) have funded the creation of a tool to support transport planning, called the Propensity to Cycle Tool (PCT). The PCT allows transport planners to look at where cycling is currently most common, and where it has the greatest potential to grow. However, the PCT uses data at the Middle Super Output Area which is less useful for differentiating between the different routes than if the data were at the Census Output Area level.

We have therefore recreated the model in our own GIS, taking a count of people who would use each route as part of their commuting journey from Census 2011 Travel to Work Origin Destination data at Census Output Area. This method allows us to add in the proposed routes to the network to also include in the analysis. The PCT only includes commuting cyclists, so using the raw data also allows us to include commuting pedestrians for analysis in our own model. The PCT uses fastest route while the Sustrans model uses the shortest route to estimate a route taken. Counts include only trips of 5 miles or less in length and that use the proposed route for 500 metres or more.

The Sustrans model outputs the total number of commuters using each route per day, so the number of commuters cycling or walking is obtained through applying the mode share split⁹ of commuters in Bradford or Calderdale districts ¹⁰. These counts are shown in Table 3 and the commuting journeys routed by the Sustrans model are mapped in Figure 3 below.

Table 3 - Total, cycling and walking commuters using each route daily

Route	Total route users commuting along this route, daily	Estimation of route users commuting by bicycle, daily	Estimation of route users commuting on foot, daily
1: Great Northern Railway Trail	239	2	28
2: Cullingworth to Keighley	874	7	101
3a: Valley floor	917	8	106
3b: Thornton Road	4,789	40	556
4: Queensbury Tunnel to Halifax	2,111	21	237
5: Station Road	41	0	5
6: Queensbury Tunnel	36	0	4

⁶Road network used in analysis is OS OpenRoad edited to include new proposed routes

⁷ A distance deemed to be potentially made by bicycle

⁸ This indicates a significant use of the route

http://www.ons.gov.uk/ons/rel/census/2011-census-analysis/method-of-travel-to-work-in-england-and-wales/rfl-table-ct0015ew.xls - we have confidence in these figures as the figures for all of England (CT0015 / 2011) (3.2% bicycle / 10.9% on foot) are very similar to all England NTS figures (NTS 04049 / 2015) (4.2% bicycle / 10.9% on foot)

¹⁰ Calderdale figures are used for the Queensbury Tunnel to Halifax route, all others use Bradford figures. This assumption is made throughout this report.

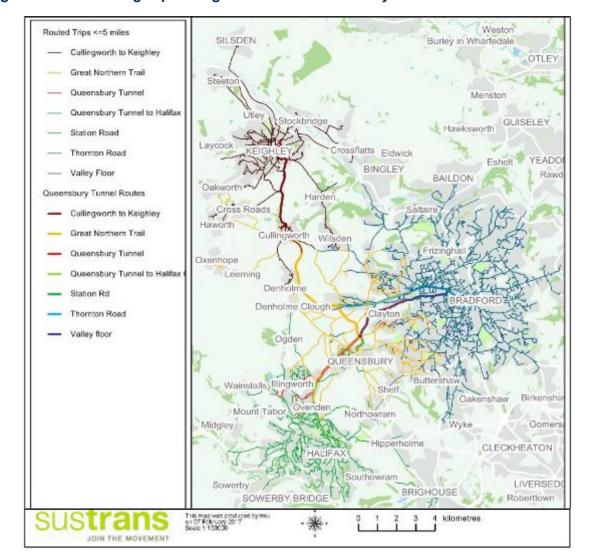


Figure 3 – Commuting trips along each route as routed by the Sustrans model

As the Sustrans model estimates the number of commuting people, the number of annual trips needs to be estimated. In order to do so a number of factors need to be taken into consideration:

- We've assumed that part time workers commute 3 days a week
- Census 2011¹¹ reports that 31% of the workplace population in Yorkshire and Humber are part time workers. This percentage split has been applied to the total number of commuters from the Sustrans model
- We've assumed that 90% of commuters will make a return trip. The total daily trips below is calculated using the number of people from the Sustrans model plus 90% of these to account for return trips
- As the Travel to Work data from the Census is an estimation taken from one day of the year (27th March 2011) seasonality needs to be taken into account. This is done by comparing the data from the Census to a number of cycle and pedestrian counters where the full year of data is available. We can then adjust the values estimated using the Census data to better reflect the typical daily usage across the year

¹¹ https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/workplacepopulationanalysis/ 2014-05-23

- We've calculated that there are 220 annual working days for full time workers, taking annual leave and bank holidays into account. For a part time worker working 3 days a week this equates to 132 days
- We've assumed that the proportion of people who report to cycle or walk to work do so 80% of the time, allowing for a switch in transport mode for the remaining 20%. The number of days cycled or walked below represents 80% of the number of annual working days.

After these factors are applied, annual usage estimates for commuting cyclists and pedestrians are calculated, and combined to produce an estimate of total baseline commuting for each route (Table 4). The individual workings applying these factors to an example route are listed in the Appendix.

Table 4 – Estimation of cycling, walking and total baseline commuting AUE¹²

Route	Estimation of route users commuting by bicycle, daily	Estimation of route users commuting on foot, daily	Estimation of baseline AUE for commuting cyclists	Estimation of baseline AUE for commuting pedestrians	Estimation of baseline commuting AUE
1: Great Northern Railway Trail	2	28	634	7,744	8,378
2: Cullingworth to Keighley	7	101	2,358	28,653	31,011
3a: Valley floor	8	106	2,464	30,202	32,666
3b: Thornton Road	40	556	12,778	157,274	170,051
4: Queensbury Tunnel to Halifax	21	237	6,758	66,774	73,533
5: Station Road	0	5	0	1,373	1,373
6: Queensbury Tunnel	0	4	0	1,091	1,091

Methodology for estimating the baseline annual usage - leisure

Leisure journeys are defined as those for the pleasure of walking or cycling, or keeping fit. The percentage of adults in Bradford or Calderdale who cycle ¹³ or walk ¹⁴ at least once a month for recreational purposes has been applied to the local study population of people living within an accessible distance of each route.

¹² Please note, throughout this report totals listed in tables may not appear to add up, this is due to rounding of numbers

¹³ DfT walking and cycling statistics Table CW0104 -

 $https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536501/cw0104.ods$

¹⁴ DfT walking and cycling statistics Table CW0105 -

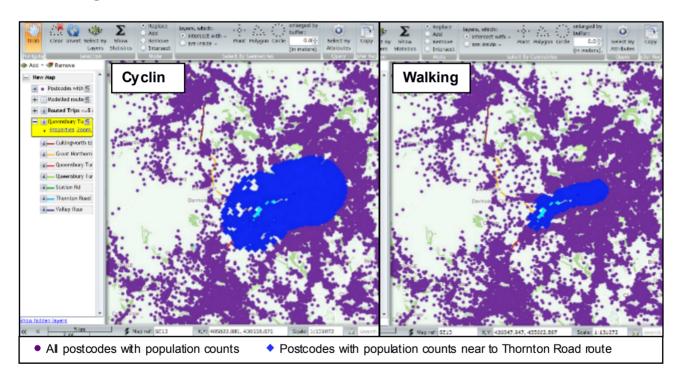
 $https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536499/cw0105.ods$

Factors taken into consideration are:

- We've taken the population within 1.5 miles of each route as accessible for cycling, this is half
 of the average cycling trip distance of 3 miles from the National Travel Survey 15
- We've taken the population within 0.4 miles of each route as accessible for walking, this is half
 of the average walking trip distance of 0.8 miles from the National Travel Survey
- Not everyone making a leisure trip in the area will use the route; we assume 50% usage for off-road routes (more appealing) and 20% usage for on-road routes (less appealing)
- An annual figure is estimated by multiplying the monthly estimates by 12.

The local study population living within an accessible distance of each route for cycling or walking leisure trips is calculated in a GIS program, using Census 2011 population data ¹⁶. A buffer of 1.5 miles for cycling, and 0.4 miles for walking, was applied to each route. The only exception is Queensbury Tunnel, where these buffers were applied to the point at each end of the tunnel rather than the whole tunnel length, as access is not possible at any other point as the tunnel is underground. As shown in Figure 4 the study population is much greater for leisure cycling than leisure walking, due to the larger buffer of accessibility for cycling.

Figure 4 – Population living within an accessible distance of Thornton Road route for cycling and walking for leisure



After these factors are applied, annual usage estimates for leisure cyclists and pedestrians are calculated, and combined to produce an estimate of total baseline leisure use for each route (Table 5). The individual workings applying these factors to each route are listed in tables in the Appendix.

13 June 2017

_

¹⁵ National Travel Survey table NTS 0306 - https://www.gov.uk/government/uploads/system/uploads/attachment data/file/550620/nts0306.xls

¹⁶ Census 2011 Headcounts and Household Estimates for Postcodes in England and Wales

Table 5 – Estimation of cycling, walking and total baseline leisure AUE

Route	Route type & % of leisure journeys using route	Study population accessible for cycling	Study population accessible for walking	Estimation of baseline AUE for leisure cyclists	Estimation of baseline AUE for leisure pedestrians	Estimation of baseline leisure AUE
1: Great Northern Railway Trail	Off road – 50%	50,071	9,206	18,405	30,284	48,689
2: Cullingworth to Keighley	Off road – 50%	57,445	12,900	21,115	42,436	63,551
3a: Valley floor	Off road – 50%	166,181	21,220	61,084	69,805	130,890
3b: Thornton Road	On road – 20%	182,760	37,024	26,871	48,718	75,589
4: Queensbury Tunnel to Halifax	On road – 20%	85,842	16,378	26,542	25,642	52,184
5: Station Road	On road – 20%	34,336	3,617	5,048	4,759	9,808
6: Queensbury Tunnel	Off road – 50%	52,621	1,760	30,009	6,339	36,348

Baseline annual usage estimate

The baseline cycling and walking AUEs are combined to calculate a baseline AUE for each route.

Table 6 - Baseline AUE for each route

Route	Estimation of baseline cycling commuting and leisure AUE	Estimation of baseline walking commuting and leisure AUE	Estimation of baseline AUE
1: Great Northern Railway Trail	19,039	38,028	57,067
2: Cullingworth to Keighley	23,474	71,089	94,563
3a: Valley floor	63,548	63,548 100,007	
3b: Thornton Road	39,649	205,991	245,640
4: Queensbury Tunnel to Halifax	33,301	92,417	125,717
5: Station Road	5,048	6,132	11,181
6: Queensbury Tunnel	30,009	7,430	37,440

5 Estimating post intervention annual usage

Methodology for estimating post intervention annual usage - cycling

The Infrastructure Impact Tool ¹⁷ (IIT) is used to forecast the expected future cycling usage of each route. The IIT is a category model for different infrastructure types developed using data from a portfolio of previous interventions monitored and evaluated by Sustrans. It provides an estimate of the impact that an infrastructure scheme is likely to have on usage. The IIT has been developed in compliance with WebTAG guidance on the use of comparable scheme data for forecasting purposes. The IIT is used to estimate cycling uplift for all routes except Queensbury Tunnel, for which uplift from Bath Two Tunnels is used as guidance. The following four inputs have been used in the IIT to obtain a post implementation AUE for cycling on each route, listed in Table 7.

- Baseline cycling annual usage
- Intervention type each route is classified as either 'Cycle and pedestrian tracks' or 'On-road cycle lanes' based on local knowledge about the majority type of intervention planned for each route 18
- **Urban classification of the scheme location** each route is classified as either 'Urban conurbation (major or minor)', 'Urban city and town' or 'All rural'
- Proportion of leisure users this is calculated for each route as the split between baseline
 cycling usage for commuting or leisure purposes.

Table 7 - Estimated % increase in cycling for each route from the IIT

Route	Baselin e cycling AUE	Intervention type	Urban classification	Proportio n of leisure cyclists	Estimated % increase
1: Great Northern Railway Trail	19,039	Cycle and pedestrian tracks	Rural	97%	173%
2: Cullingworth to Keighley	23,474	Cycle and pedestrian tracks	Rural	90%	173%
3a: Valley floor	63, 548	Cycle and pedestrian tracks	Urban city & town	96%	72%
3b: Thornton Road	39,649	On-road cycle lane ¹⁹	Urban conurbation	68%	15%
4: Queensbury Tunnel to Halifax	33, 301	On-road cycle lane	Urban conurbation	80%	15%
5: Station Road	5,048	On-road cycle lane	Rural	100%	15%
6: Queensbury Tunnel	See Ba	nth Two Tunnels uplift	100%	240%	

¹⁷ Developed by Sustrans' Research & Monitoring Unit (RMU)

15 June 2017

_

¹⁸ 'Pedestrian and cycle bridge' and 'Other intervention types' categories are IIT options that are not relevant for these routes

¹⁹ Please note, the rural/urban location does not affect the uplift for on-road cycle lanes (here for Thornton Road / Queensbury Tunnel to Halifax / Station Road)

Cycling uplift for the Queensbury Tunnel route is considered separately from the IIT as uplift seen from the Bath Two Tunnels route is used as the best estimate guidance instead. Bath Two Tunnels experienced 366% uplift in cycling and 50% uplift in walking, and these figures will be used as the maximum increase in cycling and walking AUE for Queensbury Tunnel. Bath Two Tunnels was the first Sustrans project of its kind and had lots of momentum through events and promotional activity. It also opened up a route between two popular cities, and thereby encouraged a great increase in active travel between the two destinations.

Therefore the middle uplift scenarios based on Bath Two Tunnels are applied for Queensbury Tunnel: 240% cycling uplift, and 30% walking uplift. The range of uplift scenarios for cycling and walking and the resultant post intervention AUEs for Queensbury Tunnel are listed in tables in the Appendix.

Methodology for estimating post intervention annual usage - walking

A similar approach to cycling has been taken to forecast the expected future level of walking of each route, drawing on data from 80+ previous interventions that have been monitored by Sustrans. The post implementation AUE for walking on each route is based on uplift seen in previous interventions, classified by rural/urban location and intervention type (majority on-road or off-road). The walking uplift estimated for each scheme is listed in Table 8.

Previous interventions are classified as 'Majority rural traffic free' or 'Majority urban traffic free' and filtered accordingly. In line with IIT categories, projects classed as 'Bridges and Tunnels' are removed as they're not representative the routes considered in this appraisal (Queensbury Tunnel uplift is modelled on Bath Two Tunnels).

Majority rural traffic free – 14 previous schemes²⁰ experienced an average walking increase of 30% Majority urban traffic free – 14 previous schemes experienced an average walking increase of 28% On-road route – we assume 0% uplift for pedestrians after constructing an on-road cycle path

Table 8 - Estimated % increase in walking for each route from previous schemes

Route	Baseline walking AUE	Intervention type and rural/urban classification	Estimated % increase		
1: Great Northern Railway Trail	38,028	Majority rural traffic free	30%		
2: Cullingworth to Keighley	71,089	Majority rural traffic free	30%		
3a: Valley floor 100,007		Majority urban traffic free	28%		
3b: Thornton Road	205,991	On-road route	0%		
4: Queensbury Tunnel to Halifax	92,417	On-road route	0%		
5: Station Road	6,132	6,132 On-road route			
6: Queensbury Tunnel	See Batl	30%			

²⁰ One scheme was removed as an outlier, after experiencing 296% uplift

16 June 2017

_

Post intervention annual usage estimate for each route

The post intervention cycling and walking AUEs are combined to calculate a post intervention AUE for each route (Table 9). The individual workings to calculate the post intervention AUE for each route are listed in tables in the Appendix.

Table 9 – Estimated post intervention AUE for each scheme

Route	Baseline cycling AUE	Baseline walking AUE	Post intervention cycling AUE	Post intervention walking AUE	Estimated post intervention AUE
1: Great Northern Railway Trail	19,039	38,028	51,990	49, 437	101,427
2: Cullingworth to Keighley	23,474	71,089	64,101	92,415	156,516
3a: Valley floor	63,548	100,007	109,055	128,009	237,064
3b: Thornton Road	39,649	205,991	45,692	205,991	251,683
4: Queensbury Tunnel to Halifax	33,301	92,417	38,376	92,417	130,793
5: Station Road	5,048	6,132	5,817	6,132	11,949
6: Queensbury Tunnel	30,009	7,430	102,031	9,660	111,690

6 Combining multiple routes into scenarios

Until now we have considered each route individually rather than considering each scenario (a combination of multiple routes). This has allowed us to model estimated uplift for each route based on the individual characteristics of each route. If we considered scenarios from the very start, the unique characteristics of each route would have lost as we would have had to apply assumptions about the overall scenario to estimate uplift. Now we have AUEs for each route we can combine them into scenarios, which will then be appraised using the Sustrans RMU WebTAG Appraisal Tool, to model the expected monetized impacts. However, when combining routes together into scenarios we need to remove any overlap of users counted on more than one route.

Accounting for double counting – baseline AUEs

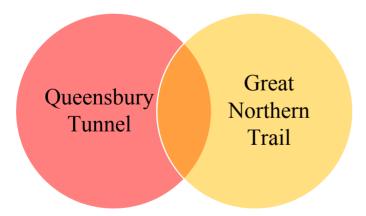
Commuting trips

We know from the Sustrans GIS model outputs that 456 of the 9,007 users (5%) counted commuting along all seven routes commuted along at least two of the routes, so would be double counted when simply totalling the users from multiple routes in each scenario. We've established that 0.8% of commuting trips per person per year in Bradford are made by bicycle, and 11.6% of commuting trips are on foot⁹. By removing 5% of these 0.8% and 11.6% of cycling and walking commuting trips respectively, we can account for double counting.

Leisure trips

The overlap in leisure trips is affected by the study population living within an accessible distance of each route. For routes where catchment areas overlap (e.g. Queensbury Tunnel and Great Northem Railway Trail, shown below in Figure 5), the population in this overlapping area (the orange section of Figure 5) will be double counted when simply totalling the users from multiple routes in each scenario. The same GIS program and method can be used to calculate the study population living within an accessible distance for cycling or walking of each scenario and the difference between the populations calculated from the summed routes and scenarios indicates the amount of double counting to be accounted for.

Figure 5 – Example of double counting of the population between routes when combined into scenarios



Accounting for double counting - post intervention AUEs

The post intervention AUE outputs produced by the IIT are not split by commuting or leisure. We therefore apply the ratio of commuting and leisure trips that make up the total cycling or walking post intervention AUE, before applying the same principles as outlined to account for double counting at baseline.

Post intervention annual usage estimate for each scenario

The total baseline and post intervention AUEs before and after double counting has been accounted for, are listed in Table 10 below. The individual workings applying these factors to each route are listed in tables in the Appendix.

Table 10 – Baseline and post intervention AUEs before and after double counting is accounted for ²¹

Scenario		Baseline AUE before double counting accounted for	Post intervention AUE before double counting accounted for	Baseline AUE after double counting accounted for	Post intervention AUE after double counting accounted for	
Including tunnel	A	1 + 2 + 3a + 4 + 6	478,341	737,490	425,256	638,429
tuimei	В	1+2+3b+4+6	560,426	752,109	517,676	682,313
С	С	1+2+4+6	314,786	500,426	276,368	425,219
	D	3a + 4 + 6	326,712	479,547	298,465	429,061
	E	3b + 4 + 6	408,797	494,166	392,702	468,433
Excluding tunnel	F	1+2+5	162,810	269,892	140,631	227,065
tuimei	G	3a + 5	174,736	249,013	163,672	230,848
	Н	3b + 5	256,821	263,633	252,838	259,288
1	I	1 + 2 + 3a + 5	326,365	506,956	289,317	439,964
	J	1 + 2 + 3b + 5	408,450	521,576	380,580	481,031
	K	1+5	68,247	113,376	57,798	90,658

Sensitivity testing

Each scenario has been sensitivity tested, showing the range of post intervention AUEs that would be expected from a range of baseline AUEs and levels of uplift. Table 11 shows the sensitivity testing for Scenario A, showing the range of post intervention AUEs that could be expected from a range of lower and higher baseline AUEs and uplifts as a result of the intervention. The figure used in this appraisal is the central figure of 638,429 highlighted in grey, and post intervention AUEs range from 487,500 to 807,500.

²¹ Some users will only be on each route for a small proportion of the distance as commuting journeys were counted when using the route for a minimum of 500m

Table 11 - Sensitivity testing example: Scenario A

The results of this sensitivity testing for each scenario are listed in tables in the Appendix.

Scenario A: 1 + 2 + 3a + 4 + 6		Baseline AUE					
		375,000	400,000	425,256	450,000	475,000	
æ	30%	487,500	520,000	552,833	585,000	617,500	
as f on	40%	525,000	560,000	595,359	630,000	665,000	
crease result of terventi	50%	562,980	600,512	638,429	675,576	713,108	
% incl re intel	60%	600,000	640,000	680,410	720,000	760,000	
•	70%	637,500	680,000	722,936	765,000	807,500	

7 Costs

The estimated costs for each route are outlined in Table 12 below, having been provided by Sustrans staff from previous feasibility studies, or engineering studies of Queensbury Tunnel.

Table 12 - Estimated costs for each route

Route name	Estimated cost	Details
1: Great Northern	£1,344,000	Costs estimated at: off-road track - £300,000 / crossing of Thornton Road - £100,000 / optimism bias - 40%.
Railway Trail		Plus refurbishment of Well Heads Tunnel (including path and lighting provision) - £784,000 (including optimism bias – 40%)
2: Cullingworth to Keighley	£1,050,000	Exact alignment is not confirmed but costs estimated at: off-road track - £750,000 / optimism bias - 40%
3a: Valley floor	£2,505,227	Cost from a May 2016 Sustrans feasibility study
3b: Thornton Road	£10,739,146	Cost from a May 2016 Sustrans feasibility study – the sections between Bradford City Centre and Thornton Road, and between the Ring Road and Thornton will cost about the same
4: Queensbury Tunnel to Halifax	£4,620,000	This is an estimate based on recent high quality on highway schemes, of £1 million per km. This route is estimated at 4.62km long
5: Station Road	£150,000	-
6: Queensbury Tunnel	£4,300,000 to £35,400,000	The variation in these costs is due to two different estimates for refurbishment of the Queensbury Tunnel; a QTS estimate of £4.3 million ³ and a Jacobs estimate of £35.4 million ² The midpoint of these two estimates is £19,850,000

The costs for each route can be combined to estimate the costs for each scenario. As shown in Table 12 there are a range of costs for route 6, reopening Queensbury Tunnel. Table 13 lists the total cost for each scenario, listing a minimum, mid, and maximum cost for each scenario which contains the Queensbury Tunnel. Please note that the 'min' scenarios in this report do not relate to the more conventional scenarios of a 'do nothing' approach.

Each scenario will be run through the Sustrans RMU WebTAG Appraisal Tool multiple times, to appraise each scenario based on the range of estimated costs outlined in this section.

Table 13 – Estimated costs for each scenario, using a range of costs for Queensbury Tunnel

Scenario			Min cost	Mid cost	Max cost
Including tunnel	A	1 + 2 + 3a + 4 + 6	£13,819,227	£29,369,227	£44,919,227
tuillei	В	1 + 2 + 3b + 4 + 6	£22,053,146	£37,603,146	£53,153,146
	С	1+2+4+6	£11,314,000	£26,864,000	£42,414,000
	D	3a + 4 + 6	£11,425,227	£26,975,227	£42,525,227
	E	3b + 4 + 6	£19,659,146	£35,209,146	£50,759,146
Excluding tunnel	F	1+2+5	-	£2,544,000	-
tuillei	G	3a + 5	-	£2,655,227	-
	Н	3b + 5	-	£10,889,146	-
	ı	1 + 2 + 3a + 5	-	£5,049,227	-
	J	1 + 2 + 3b + 5	-	£13,283,146	-
	K	1+5	-	£1,494,000	-

8 Estimating the economic value of benefits and BCRs of seven scenarios

Other inputs used in our economic appraisal

In addition to baseline and post intervention AUEs, other inputs required for the Sustrans RMU WebTAG Appraisal Tool include:

- Trip frequency
- Trip distance
- Proportion of users not using a car for any part of their journey
- Proportion of users who could have used a car for their journey but have chosen not to.

These inputs were taken from several different sources. Trip frequency has been derived from the DfT's Walking and Cycling Statistics, scaling up figures for all adults who cycle ¹³ or walk ¹⁴ from West Yorkshire and applying these percentages to our population. Trip distance is calculated in WebTAG from journey purpose information. The percentage of users not using a car is assumed to be 100% and the proportion of users who could have used a car but chose not to is calculated by the IIT based on data taken from previous interventions monitored and evaluated by Sustrans.

The values used in each of these variables have been kept consistent between baseline and post intervention, in order to measure the effect of an uplift in AUE only. Although many of these variables might be expected to change between baseline and post intervention it is difficult to make accurate estimations as to the level of changes expected here. The outputs given should therefore be considered conservative, as they are not considering the likely positive impact of these other variables changing between baseline and post intervention.

Benefit Cost Ratios (BCR)

Table 14 shows the estimated economic impact, including health benefits, for each of the different scenarios of AUE uplift over a 30 year appraisal period. The benefit to cost ratio for each scenario is included under the 'BCR' column.

The economic benefits for a cycle network including the reopening of Queensbury Tunnel range from £7.4 million to £26.8 million, with a BCR of 0.2 to 1 up to 2.3 to 1. The economic benefits for a cycle network without the reopening of the tunnel range from £1.9 million to £19.3 million, with a BCR of 0.2 to 1 up to 3.8 to 1.

Scenario A is the only scenario to achieve a positive BCR when the minimum³, middle estimate, and maximum² predicted costs for Queensbury Tunnel are used. Three scenarios with the tunnel stand out as having the greatest impact; these are A min, D min and C min.

- A min is a combination of four routes and Queensbury Tunnel and has a total estimated economic benefit of £26.8 million, including an estimated health benefit of £11.1 million. With a cost over 30 years of £11.6 million this gives a BCR of 2.3 to 1.
- D min is a combination of two routes and Queensbury Tunnel and has a total estimated economic benefit of £17.8 million, including an estimated health benefit of £6.4 million. A cost over 30 years of £9.1 million gives a BCR of 2.0 to 1.
- C min is a combination of three routes and Queensbury Tunnel and has a total estimated economic benefit of £17.4 million, including an estimated health benefit of £7.2 million. With a cost over 30 years of £9.1 million this gives a BCR of 1.9 to 1.

Table 14 – Estimated economic & health benefits for each scenario, using a range of costs for Queensbury Tunnel

Sce	nario	Cyclists	Pedestrians	Total Health Benefits (HEAT)	Total Be nefits	Cost (over 30 years)	BCR
Jel	A min	£20,581,518	£6,186,506	£11,133,000	£26,768,024	£11,587,962	2.3:1
tunnel	A mid	£20,581,518	£6,186,506	£11,133,000	£26,768,024	£19,037,438	1.4:1
Including	A max	£20,581,518	£6,186,506	£11,133,000	£26,768,024	£ 26,486,915	1.0:1
Inclu	B min	£16,885,748	£3,676,360	£7,343,000	£20,562,108	£19,492,665	1.1:1
	B mid	£16,885,748	£3,676,360	£7,343,000	£20,562,108	£26,942,142	0.8:1
	B max	£16,885,748	£3,676,360	£7,343,000	£20,562,108	£34,391,618	0.6:1
	C min	£14,060,345	£3,333,008	£7,170,000	£17,393,353	£9,102,110	1.9:1
	C mid	£14,060,345	£3,333,008	£7,170,000	£17,393,353	£16,551,587	1.1:1
	C max	£14,060,345	£3,333,008	£7,170,000	£17,393,353	£24,001,064	0.7:1
	D min	£14,772,973	£3,074,509	£6,442,000	£17,847,483	£9,084,219	2.0:1
	D mid	£14,772,973	£3,074,509	£6,442,000	£17,847,483	£16,533,695	1.1:1
	D max	£14,772,973	£3,074,509	£6,442,000	£17,847,483	£23,983,173	0.7:1
	E min	£6,457,879	£986,974	£2,904,000	£7,444,853	£16,988,779	0.4:1
	E mid	£6,457,879	£986,974	£2,904,000	£7,444,853	£24,438,255	0.3:1
	E max	£6,457,879	£986,974	£2,904,000	£7,444,853	£31,887,732	0.2:1
Jel	F	£6,801,279	£3,154,597	£4,913,000	£9,955,875	£ 2,660,828	3.7:1
tunn	G	£7,101,402	£2,981,054	£4,089,000	£10,082,456	£2,643,081	3.8:1
nding	Н	£1,308,230	£580,964	£231,000	£1,889,194	£10,547,641	0.2:1
Excluding	I	£13,158,007	£6,149,371	£8,945,000	£19,307,378	£5,146,823	3.8:1
	J	£9,260,923	£3,288,945	£4,774,000	£12,549,868	£13,051,383	1.0:1
	K	£3,457,641	£1,279,334	£2,594,000	£4,736,975	£1,569,995	3.0:1

The majority of scenarios without the tunnel reach a positive BCR, and three stand out as having the greatest impact; scenarios G, I and F.

• Scenario G is a combination of two routes (Bradford to Queensbury via the valley floor) with a very low estimated cost over 30 years of £2.6 million. The total estimated economic benefit of £10.1 million, including an estimated health benefit of £4.1 million, gives a BCR of 3.8 to 1.

- Scenario I is a combination of four routes (developing a network from Bradford to Keighley via Queensbury) with an estimated cost over 30 years of £5.1 million. With a total estimated economic benefit of £19.3 million, including an estimated health benefit of £8.9 million this also gives a BCR of 3.8 to 1.
- Scenario F is a combination of three routes (developing a network from Queensbury to Keighley) with a very low estimated cost over 30 years of £2.7 million. With a total estimated economic benefit of £10.0 million, including an estimated health benefit of £4.9 million this gives a BCR of 3.7 to 1.

It's also evident that the off-road route 3a along the valley floor from Bradford to the Queensbury triangle returns higher BCRs than scenarios that include the on-road route 3b along Thornton Road.

An example of the distribution of benefits over a 30 year appraisal period if the estimated uplift was reached (for scenario A min) can be seen in Chart 1 below. An example of the full list of health and economic benefits for cyclists and pedestrians returned from the Sustrans RMU WebTAG Appraisal Tool for scenario A min is in the Appendix.

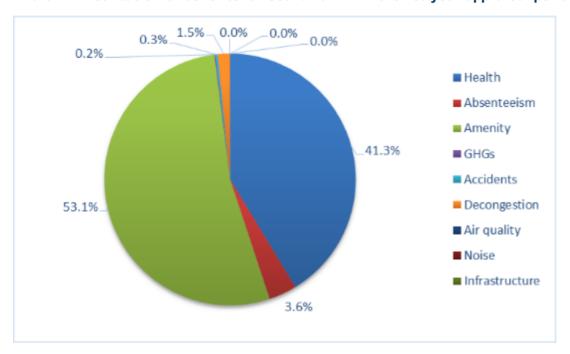


Chart 1 - Distribution of benefits for scenario A min over 30 year appraisal period

Tourism model

Sustrans' Cycle Route Economic Impact Model, referred to here as the tourism model, was developed in 2007 by Sustrans in conjunction with the University of Central Lancashire to estimate the economic impact of cycle tourism, calculating a total annual spend and a 'spend per head' for all recreational users. We take this approach rather than looking at specific attraction in the area, of which there are many along the proposed routes, such as:

- Bronte heritage, especially around Thornton
- Significant railway heritage in the Trail route itself, as well as various railway museums and the Keighley and Worth Valley Railway

The inputs for the model primarily come from tourism-specific Route User Intercept Surveys (RUIS), with outputs including the total annual spend and a 'spend per head' for all recreational users. It also calculates the number of FTE roles supported by this level of expenditure.

Unfortunately there have been no RUIS undertaken near to any of the proposed schemes, however it's possible to take the average spend per head from previous analysis undertaken by Sustrans across 22 sites on the National Cycle Network (NCN)²².

Table 15 - Average spend per head - leisure and tourist cycling from 22 sites on the NCN

	Average spend per head (range)
Leisure	£7.06 - £15.97
Tourist	£20.03 - £27.66

Table 15 indicates that cycle tourists typically spend substantially more than home based leisure cyclists. In 2014, 184 million cycle trips on the NCN (53% of the total) were for either leisure purposes or from a holiday base²³.

Conservatively assuming that 50% of trips saw the minimum spend per head of £7.06 calculated in Table 15 above, we can estimate the amount that leisure and tourist cycling on the NCN contributes to the economy each year. This methodology can be applied to post intervention usage figures for the Queensbury Tunnel as a way of demonstrating what potential tourism spend could look like for this section of the scheme. Figures for Queensbury Tunnel are used as an example here as evidence from previous interventions shows that the tunnel element of a scheme is likely to attract a high amount of tourism; £360,168 per year.

Table 16 - Estimated spend by cycle tourists at Queensbury Tunnel

	Queensbury Tunnel post intervention AUE	% of post intervention cy		n cyclists		
	102,031	10%	30%	50%	70%	90%
Estimated annual tourism spend	-	£72,034	£216,101	£360,168	£504,235	£648,302

Benefit Cost Ratios (BCR) including tourism benefits

These tourism benefits are not WebTAG compliant and are therefore not included in the WebTAG derived BCRs listed Table 14 above. However, we can give a more holistic estimation for the economic impact of each scenario by combining the estimated cycle tourist spend over the 30 year appraisal period with the WebTAG outputs. Table 17 lists the BCRs for each scenario that includes the tunnel, when tourism benefits are combined with benefits from the Sustrans RMU WebTAG Appraisal Tool.

The following assumptions have been made:

- Cycle tourist spend has been applied only to scenarios including Queensbury Tunnel, as this
 is the section of route expected to draw in cycle tourists due to its heritage and history
- Current estimated annual tourism spend of £360,168 has been multiplied by 30 to get the estimated benefits of £10,805,041 over the 30 year appraisal period.

²² Sustrans (2015) Economic impact of cycle tourism and leisure cycling on the NCN.doc (internal document)

²³ Sustrans (2014) 2012.2013.survey.comparisons.final v1.1.xlsx (internal document)

When tourism benefits are included, the BCRs for each scenario including the Queensbury Tunnel increase, considerably in some cases. The three scenarios that return the highest BCRs are again A min, D min, and C min.

- A min is a combination of four routes and Queensbury Tunnel and has a total estimated economic benefit of £37.6 million including tourism benefits, giving a BCR of 3.2 to 1.
- D min is a combination of two routes and Queensbury Tunnel and has a total estimated economic benefit of £28.7 million including tourism benefits, and relatively low costs, also giving a BCR of 3.2 to 1
- C min is a combination of three routes and Queensbury Tunnel and has a total estimated economic benefit of £28.2 million including tourism benefits, giving a BCR of 3.1 to 1.

It should be noted that this estimate is for cyclists only as the research behind the model is not applicable to pedestrians. It has been estimated that a considerable number of pedestrians would also use this route who would also likely have a significant spend in the local area.

Table 17 – Estimated economic and tourism benefits for each scenario for scenarios including Queensbury Tunnel, using a range of costs for Queensbury Tunnel

Sce	nario	WebTAG benefits	Tourism benefits	Total WebTAG benefits (over 30 years)	WebTAG costs (incl. maintenance over 30 years)	BCR
Je!	A min	£26,768,024	£10,805,040	£37,573,065	£11,587,962	3.2:1
tunnel	A mid	£26,768,024	£10,805,040	£37,573,065	£19,037,438	2.0:1
Including	A max	£26,768,024	£10,805,040	£37,573,065	£ 26,486,915	1.4:1
Inclu	B min	£20,562,108	£10,805,040	£31,367,149	£19,492,665	1.6:1
	B mid	£20,562,108	£10,805,040	£31,367,149	£26,942,142	1.2:1
	B max	£20,562,108	£10,805,040	£31,367,149	£34,391,618	0.9:1
	C min	£17,393,353	£10,805,040	£28,198,394	£9,102,110	3.1:1
	C mid	£17,393,353	£10,805,040	£28,198,394	£16,551,587	1.7:1
	C max	£17,393,353	£10,805,040	£28,198,394	£24,001,064	1.2:1
	D min	£17,847,483	£10,805,040	£28,652,524	£9,084,219	3.2:1
	D mid	£17,847,483	£10,805,040	£28,652,524	£16,533,695	1.7:1
	D max	£17,847,483	£10,805,040	£28,652,524	£23,983,173	1.2:1
	E min	£7,444,853	£10,805,040	£18,249,894	£16,988,779	1.1:1
	E mid	£7,444,853	£10,805,040	£18,249,894	£24,438,255	0.7:1
	E max	£7,444,853	£10,805,040	£18,249,894	£31,887,732	0.6:1

Direct job creation

A 2013 Sustrans' RMU study²⁴ examined the level of jobs sustained by the construction of walking and cycling routes; every time a project or scheme spends money in the local and wider economy, jobs are created. Using data from four infrastructure projects (three years of Community Links in Scotland, and the Valley Cycle Network in Wales) the number of direct and indirect jobs that were supported could be estimated.

The study found that:

- 5.8 direct jobs are supported or sustained for every £1 million of investment in sustainable transport infrastructure (an additional 6.9 jobs are indirect and induced for every £1 million)
- 0.7 FTE direct jobs are supported or sustained for every km of route constructed (an additional 0.9 FTE jobs are indirect and induced for every km)

With the opening of the Queensbury Tunnel and a network of routes including extending and joining to the NCN, a considerable number of jobs could be created for the community.

The impact of a new cycling network and the reopening of Queensbury Tunnel will extend beyond that possible to measure through the Sustrans RMU WebTAG Appraisal Tool and tourism benefits, and direct job creation can also be taken into consideration when considering the economic impact of the proposals. Job creation figures need to be treated with caution, and for this reason have not been combined with the estimated economic benefits from the Sustrans RMU WebTAG Appraisal Tool and the tourism model to calculate the BCRs for each scenario.

Increased population

It is anticipated that the population will increase in the area local to Queensbury Tunnel over the coming years. For example, there is a need to allocate more houses in Bradford District as part of Bradford Council's Local Plan, adding several thousand more houses in Queensbury, Thornton, Denholme, Cullingworth and Keighley. It should be noted that this is likely to impact on increased usage along the routes, as it may contribute to increased demand for commuting journeys and travel to school, as well as the potential for increased leisure trips.

²⁴ Sustrans Jobs Study (July 2013)

9 Summary

This report has presented a number of estimations for the impact of reopening Queensbury Tunnel as a cycle route and combining this with the development of a wider cycling network. A range of scenarios for the increase in walking and cycling have been modelled through taking the following considerations into account as part of the economic appraisal process:

- Estimating baseline annual usage (number of users and journey purpose) for each route
- Estimating post intervention annual usage for each route, from past evidence on the impact of interventions on usage of similar routes
- Combine routes into 11 scenarios, accounting for double counting when estimating baseline and post intervention annual usage for each scenario
- Determining costs
- Estimating the economic value of benefits and BCRs of the 11 scenarios, split by inclusion or exclusion of the tunnel

It has become apparent that the difference in scheme type and estimated cost for each scheme has created a difference in benefit to cost ratios for each proposal. Scenarios containing the off-road valley floor route 3a between Bradford and Queensbury triangle have consistently higher BCRs than the on-road Thornton Road route 3b. Due to the uncertainty surrounding the cost of reopening the tunnel this analysis has considered scenarios for developing a network of cycling routes both with and without Queensbury Tunnel.

Our analysis has found the scenarios that return the highest BCRs are scenario G and scenario I (Table 14).

- Scenario G looks to develop an off-road route from Bradford (along the valley floor) to
 Queensbury village and excludes the tunnel. This scenario returns a BCR of 3.8 to 1 with a
 cost over 30 years of £2.6 million. This cost is relatively low in comparison to other scenarios
- Scenario I also excludes the tunnel, and looks to develop a network from Bradford (along the valley floor) to Keighley, via Queensbury village. This scenario also returns a BCR of 3.8 to 1 with a cost over 30 years of £5.1 million
- Table 22 and Table 23 also show that scenarios G and I, in relation to other scenarios, have a
 relatively high percentage of cycling (96% and 94%) and walking (70% and 67%) leisure trips.

The scenarios that return the highest BCRs that includes the tunnel are scenarios A min, D min and C min (Table 14).

- Scenario A min (when the cost for the tunnel itself is at its lowest estimate) has a BCR of 2.3 to 1 and a cost over 30 years of £11.6 million. Table 10 shows that scenario A min observes the second highest post intervention AUE (638,429) which would be expected as this scenario is a combination of four different route sections as well as Queensbury Tunnel
- The scenario to return the second highest BCR that includes the tunnel is scenario D min with a BCR of 2.0 to 1, followed by scenario C min with a BCR of 1.9 to 1
- These BCRs include health benefits but do not include the impact of cycle tourists and job creation over the routes.

Estimates for tourism benefits are not WebTAG compliant, but for this appraisal have been combined with benefits calculated by the Sustrans RMU WebTAG Appraisal Tool to give a more

holistic estimation of the economic impact of scenarios including the tunnel, the route which is expected to draw in cycle tourists due to its heritage and history.

- When these BCRs are reviewed, scenarios G, I and F (all without the tunnel) still return the highest BCR at 3.8 to 1 (G and I) and 3.7 to 1 (F).
- However, three routes that include the tunnel produce competitive BCRs; A min and D min both at 3.2 to 1, and C min at 3.1 to 1 (Table 17).

It should be taken into consideration that the most favourable BCRs mentioned above are achieved when considering the minimum costs for Queensbury Tunnel. Table 14 demonstrates that if costs were to exceed the minimum the same positive level of BCR would not be achieved.

It's necessary to consider all impacts presented here as conservative and only covering a small area over which the full range of benefits might be expected. Estimations however do point towards a positive impact and high value for money⁴ for some modelled scenarios noted above. Based on evidence collected from comparative case studies such as Bath Two Tunnels, it is reasonable to expect this.

10 Appendix

Commuting trips

The table below outlines the steps taken to calculate a baseline annual usage estimate (AUE) for commuting cyclists and pedestrians along route 1, Great Northern Railway Trail, based on the Sustrans model. This process was followed for all other routes

Table 18 - Baseline AUE workings for commuting cyclists and pedestrians, route 1 (Great Northern Railway Trail)

Work pattern (mode)	No. of people (from Sustrans model)	Total daily trips	Median daily trips – adjusted for seasonality	Days cycled/ walked	AUE
Full-time (cyclist)	1	3	3	176	528
Part-time (cyclist)	1	1	1	106	106
Full-time (pedestrian)	19	36	35	176	6,160
Part-time (pedestrian)	9	16	15	106	1,584
Total	30	Baseline Commuting AUE			8,378

Leisure trips

The table below outlines the steps taken to calculate a baseline annual usage estimate (AUE) for leisure cyclists and pedestrians along each route.

Table 19 - Baseline AUE workings for leisure cyclists and pedestrians for each route

Route	Mode	% of local population taking recreational trips (from DfT LAW&CS)	No. of local population taking recreational trips	Frequency	50% of trips (if off-road route)	20% of trips (if on-road route)
1 - off	Cycling	6.1%	50,071	Monthly	1,534	-
road				Annual	18,405	-
	Walking	54.8%	9,206	Monthly	2,524	-
				Annual	30,284	-
2- off	Cycling	6.1%	57,445	Monthly	1,760	-
road				Annual	21,115	-
	Walking	54.8%	12,900	Monthly	3,536	-
				Annual	42,436	-
3a - off	Cycling	6.1%	166,181	Monthly	5,090	-
road				Annual	61,084	-
	Walking	54.8%	21,220	Monthly	5,817	-
				Annual	69,805	-

3b - on	Cycling	6.1%	182,760	Monthly	-	2,239
road				Annual	-	26,871
	Walking	54.8%	37,024	Monthly	-	4,060
				Annual	-	48,718
4 - on	Cycling	12.9%	85,842	Monthly	-	2,212
road				Annual	-	26,542
	Walking	65.2%	16,378	Monthly	-	2,137
				Annual	-	25,642
5 - on	Cycling	6.1%	34,336	Monthly	-	421
road				Annual	-	5,048
	Walking	54.8%	3,617	Monthly	-	397
				Annual	-	4,759
6 - off	Cycling	6.1%	52,621	Monthly	2,501	-
road				Annual	30,009	-
	Walking	54.8%	1,760	Monthly	528	-
				Annual	6,339	-

Uplift scenarios for Queensbury Tunnel

A range of uplift scenarios for cycling and walking and the resultant post intervention AUEs for Queensbury Tunnel are tested in the tables below. The upper limits are based on uplift observed at Bath Two Tunnels, and the middle uplift highlighted in grey has been used throughout this appraisal.

Table 20 - Testing uplift in cyclists for Queensbury Tunnel

% increase scenario	Baseline cycling usage	Annual additional cycle trips	Annual post intervention cycling usage
360%		108,032	138,041
300%		90,027	120,036
240%	30,009	72,022	102,031
180%		54,016	84,025
120%		36,011	66,020

Table 21 – Testing uplift in pedestrians for Queensbury Tunnel

% increase scenario	Baseline walking usage	Annual additional walking trips	Annual post intervention walking usage
50%		3,715	11,145
40%		2,972	10,402
30%	7,430	2,229	9,659
20%		1,486	8,916
10%		743	8,173

Accounting for double counting in baseline and post intervention AUEs

The tables below outline the steps taken to account for double counting in cyclist and pedestrian AUEs at baseline and post intervention.

Table 22 – Accounting for double counting in baseline cyclists

Scen	ario	Commuting trips	Commuting trips minus double counting	Leis ure tri ps	Leisure trips minus double counting	Total baseline cycling trips	% Commuting trips	% Leis ure tri ps
	Α	12,214	12,209	157,156	117,773	129,983	9%	91%
	В	22,528	22,518	122,943	96,186	118,704	19%	81%
ling	С	9,750	9,746	96,072	69,653	79,399	12%	88%
Including tunnel	D	9,222	9,218	117,635	94,521	103,739	9%	91%
호크	Е	19,536	19,528	83,423	70,542	90,069	22%	78%
	F	2,992	2,991	44,569	32,387	35,378	8%	92%
tunnel	G	2,464	2,463	66,133	55,667	58,130	4%	96%
-	Н	12,778	12,772	31,920	28,875	41,647	31%	69%
Excluding	ı	5,456	5,454	105,653	79,775	85,228	6%	94%
cclu	J	15,770	15,763	71,440	57,084	72,847	22%	78%
ш	K	634	633	23,453	14,779	15,413	4%	96%

Table 23 – Accounting for double counting in baseline pedestrians

Scen	ario	Commuting trips	Commuting trips minus double counting	Leis ure tri ps	Leisure trips minus double counting	Total baseline walking trips	% Commuting trips	% Leis ure tri ps
	Α	134,464	133,674	174,507	161,600	295,274	45%	55%
	В	261,536	259,999	153,419	138,972	398,971	65%	35%
Including tunnel	С	104,262	103,650	104,702	93,319	196,969	53%	47%
clud	D	98,067	97,491	101,787	97,235	194,726	50%	50%
독교	E	225,139	223,816	80,699	78,816	302,632	74%	26%
	F	37,770	37,548	77,479	67,705	105,253	36%	64%
tunnel	G	31,574	31,389	74,565	74,154	105,542	30%	70%
	Н	158,646	157,714	53,477	53,477	211,191	75%	25%
Excluding	I	67,971	67,572	147,285	136,517	204,089	33%	67%
cclu	J	195,043	193,897	126,197	113,836	307,733	63%	37%
ш	K	9,117	9,063	35,044	33,322	42,385	21%	79%

Table 24 – Accounting for double counting in post intervention cyclists and pedestrians

Scen	ario	Сус	lists	Pedes	trians	
		Commuting & leisure trips	Commuting & leisure trips minus double counting	Commuting & leisure trips	Commuting & leisure trips minus double counting	
	Α	365,553	282,537	371,937	355,892	
	В	302,190	248,874	449,920	433,439	
Including tunnel	С	256,498	194,609	243,928	230,610	
clud	D	249,462	204,790	230,085	224,271	
호크	E	186,099	163,576	308,068	304,857	
	F	121,908	91,400	147,984	135,665	
tunnel	G	114,872	97,462	134,141	133,387	
	Н	51,509	48,095	212,124	211,193	
ding	ı	230,963	178,005	275,993	261,959	
Excluding	J	167,600	141,192	353,976	339,839	
Ä	K	57,807	37,305	55,569	53,353	

Sensitivity testing

The baseline AUE and uplift as a result of intervention for each scenario has been sensitivity tested, and the results are listed below. The figures used in this appraisal are the central figures highlighted in grey.

Table 25 - Sensitivity testing: Scenario A

	Scenario A: 1 + 2 + 3a + 4 + 6		Baseline AUE						
1+2+3			400,000	425,256	450,000	475,000			
<u>s</u> _	30%	487,500	520,000	552,833	585,000	617,500			
of of tion	40%	525,000	560,000	595,359	630,000	665,000			
reas sult	50%	562,980	600,512	638,429	675,576	713,108			
inci a re nter	60%	600,000	640,000	680,410	720,000	760,000			
% :=	70%	637,500	680,000	722,936	765,000	807,500			

Table 26 - Sensitivity testing: Scenario B

Scenario B: 1 + 2 + 3b + 4 + 6		Baseline AUE					
		468,000	493,000	517,676	543,000	568,000	
of nt	12%	524,160	552,160	579,797	608,160	636,160	
% crease as a sult of ervent ion	22%	570,960	601,460	631,564	662,460	692,960	
ž š <u>ti</u>	32%	616,838	649,789	682,313	715,691	748,642	

42%	664,560	700,060	735,100	771,060	806,560
52%	711,360	749,360	786,867	825,360	863,360

Table 27 - Sensitivity testing: Scenario C

	Scenario C: 1 + 2 + 4 + 6		Baseline AUE					
1+2-			251,000	276,368	301,000	326,000		
as	34%	302,840	336,340	370,333	403,340	436,840		
<u>9</u> 5 6	44%	325,440	361,440	397,970	433,440	469,440		
ea sul e r	54%	347,722	386,187	425,219	463,117	501,582		
incr a res nterv	64%	370,640	411,640	453,244	493,640	534,640		
% ° -	74%	393,240	436,740	480,881	523,740	567,240		

Table 28 - Sensitivity testing: Scenario D

	Scenario D: 3a + 4 + 6		Baseline AUE					
3a +			273,000	298,465	323,000	348,000		
as	24%	307,520	338,520	370,097	400,520	431,520		
Fi of Se	34%	332,320	365,820	399,943	432,820	466,320		
icreas result erve n	44%	356,514	392,453	429,061	464,331	500,270		
<u>`</u>	54%	381,920	420,420	459,636	497,420	535,920		
% °. =	64%	406,720	447,720	489,483	529,720	570,720		

Table 29 - Sensitivity testing: Scenario E

	Scenario E: 3b + 4 + 6		Baseline AUE					
3b +			368,000	392,702	418,000	443,000		
as	9%	373,870	401,120	428,045	455,620	482,870		
fi of se	14%	391,020	419,520	447,680	476,520	505,020		
su ve	19%	409,147	438,968	468,433	498,610	528,431		
¥	24%	425,320	456,320	486,950	518,320	549,320		
% :=	29%	442,470	474,720	506,585	539,220	571,470		

Table 30 - Sensitivity testing: Scenario F

	Scenario F: 1 + 2 + 5		Baseline AUE					
1+2			116,000	140,631	166,000	191,000		
as 	41%	128,310	163,560	198,289	234,060	269,310		
o o o	51%	137,410	175,160	212,352	250,660	288,410		
icreas result erventi	61%	146,930	187,296	227,065	268,027	308,392		
漢 <u>a</u> 크	71%	155,610	198,360	240,478	283,860	326,610		
% ". =	81%	164,710	209,960	254,541	300,460	345,710		

Table 31 - Sensitivity testing: Scenario G

	Scenario G: 3a + 5		Baseline AUE					
3a			139,000	163,672	189,000	214,000		
<u>s</u> _	21%	137,940	168,190	198,044	228,690	258,940		
se a t of	31%	149,340	182,090	214,411	247,590	280,340		
icreas result ervent	41%	160,789	196,050	230,848	266,571	301,832		
= = = = = = = = = = = = = = = = = = =	51%	172,140	209,890	247,145	285,390	323,140		
% <u>=</u>	61%	183,540	223,790	263,513	304,290	344,540		

Table 32 - Sensitivity testing: Scenario H

	Scenario H: 3b + 5		Baseline AUE					
3b			228,000	252,838	278,000	303,000		
as	1%	205,030	230,280	255,366	280,780	306,030		
<u>5</u> 5 6	2%	207,060	232,560	257,895	283,560	309,060		
ea E	3%	208,179	233,816	259,288	285,092	310,730		
= = = = = = = = = = = = = = = = = = =	4%	211,120	237,120	262,951	289,120	315,120		
% ° . =	5%	213,150	239,400	265,480	291,900	318,150		

Table 33 - Sensitivity testing: Scenario I

Scenario I:		Baseline AUE					
1+2+	· 3a + 5	239,000	264,000	289,317	314,000	339,000	
as	32%	315,480	348,480	381,898	414,480	447,480	
<u>o</u> 5 o	42%	339,380	374,880	410,830	445,880	481,380	
icreas result ervent	52%	363,447	401,465	439,964	477,500	515,517	
= = = = = = = = = = = = = = = = = = =	62%	387,180	427,680	468,693	508,680	549,180	
% ⁻ =	72%	411,080	454,080	497,625	540,080	583,080	

Table 34 - Sensitivity testing: Scenario J

Scenario J:		Baseline AUE					
1+2+	3b + 5	330,000	355,000	380,580	405,000	430,000	
as	16%	382,800	411,800	441,473	469,800	498,800	
<u>o</u> 5 <u>o</u>	21%	399,300	429,550	460,502	490,050	520,300	
ncreas result erventi	26%	417,101	448,700	481,031	511,897	543,495	
i≒ a ž	31%	432,300	465,050	498,560	530,550	563,300	
% °. =	36%	448,800	482,800	517,589	550,800	584,800	

Table 35 - Sensitivity testing: Scenario K

Scenario K:		Baseline AUE					
1 -	+ 5	38,000	48,000	57,798	68,000	78,000	
<u>s</u> -	37%	52,060	65,760	79,183	93,160	106,860	
increase a a result of nterventior	47%	55,860	70,560	84,963	99,960	114,660	
	57%	59,604	75,290	90,658	106,660	122,346	
	67%	63,460	80,160	96,522	113,560	130,260	
% ⁻ -=	77%	67,260	84,960	102,302	120,360	138,060	

Health and economic benefits

An example of the health and economic benefits returned from the Sustrans RMU WebTAG Appraisal Tool for scenario A min is below.

Table 36 - Summary of benefits, scenario A min

	Value (£, total over 30 year appraisal period)					
Benefit	Cyclists	Pedestrians	Total			
Health	£6,312,000	£4,821,000	£11,133,000			
Absenteeism	£793,634	£173,798	£967,433			
Amenity	£13,146,941	£1,165,981	£14,312,922			
GHGs	£38,144	£2,983	£41,128			
Accidents	£69,017	£5,398	£74,415			
Decongestion	£380,669	£29,773	£410,442			
Air quality	£3,310	£259	£3,569			
Noise	£3,310	£259	£3,569			
Infrastructure	£3,310	£259	£3,569			
Indirect Taxation	-£168,819	-£13,203	-£182,022			
Total	£20,581,518	£6,186,506	£26,768,024			