Appendix J: Economic Appraisal Methodology

Definitions

This appendix includes the use of the terms 'corridor', 'alignment', 'route' and 'scenario'. For the avoidance of any doubt:

- **Corridor**: regions between named locations. Corridors contain alignments.
- **Alignment**: intended path along which provision will be provided.
- **Route**: a combination of alignments.
- **Scenario**: a set of conditions used to evaluate the economic performance of a route. A route may be evaluated under multiple scenarios.

J.1. Methodological Overview

The following section outlines the steps and application of a model to examine the likely impact of reopening the Queensbury Tunnel as part of a network of alignments that link Bradford to Halifax (to the south) and Keighley (to the north).

In order to estimate the possible impact of developing the alignments, baseline usage figures for cycling and walking in and around the proposed alignment are sourced from 2011 census using a GIS model as well as from the Propensity to Cycle (PCT), to calculate Annual Usage Estimates (AUEs), which is used as input for the Department of Transport's Capital Fund Uplifts Tool and Active Mode Appraisal Toolkit (AMAT). The Capital Fund Uplift Tool uses total project cost figures, and cycle and walking figures to estimate 3 post-construction usage scenarios which we model in the AMAT.

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

- Estimate baseline annual usage (number of users by mode and journey purpose) for each alignment.
- Combine alignments into 6 routes (listed in Table 30), adjusting for double counting when estimating baseline annual usage for each scenario
- Estimate post intervention annual usage for each route scenario; using past evidence from case studies on the usage impact of similar tunnel schemes and DfT's Capital Fund Uplift Tool as a sensitivity test.
- Estimate the economic value of anticipated benefits against construction and maintenance costs using the AMAT, to obtain Benefit-Cost Ratios (BCRs) for each of the 6 route scenarios.

Each route scenario is sensitivity tested with the two uplift scenarios (12 scenarios evaluated in total)

- Estimate the tourism benefit of the 6 routes, using the Leisure Cycling and Leisure Walking Expenditure Models.
- Demonstrate the potential heritage value of the Queensbury tunnel through switching values analysis.
- Perform sensitivity testing for scenarios involving changes in cost for the tunnel

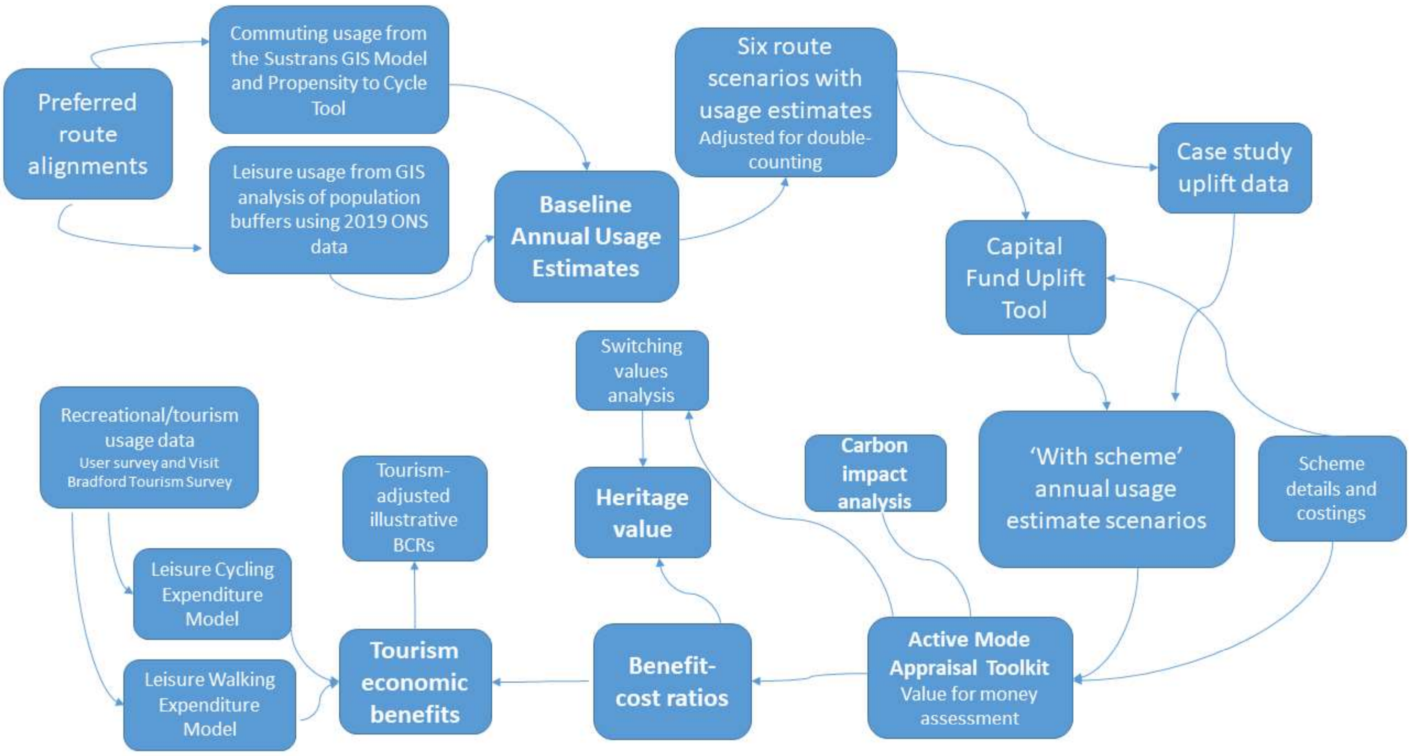

Figure 24: Economic assessment process flowchart

J.2. Estimating baseline annual usage

In order to use the DfTs Capital Fund Uplift Tool, the baseline annual usage estimate (AUE) for each alignment is required. In this (sub-)section the AUE methodology is outlined; this includes estimating annual usage for commuting and leisure journeys (for cyclists and pedestrians) before combining them to obtain a baseline annual usage estimate for each alignment. It should be noted that any estimates of baseline usage have a level of uncertainty inherent. The baseline estimates are based on population data, data from the National Travel Survey, and other assumptions. We used modelling techniques recommended by DfT and Sustrans where possible, and any assumptions that were needed were based on data and past experience.

J.2.1. Methodology for estimating the baseline annual usage – commuting

For the 2017 Queensbury Tunnel study, Sustrans developed a GIS model based on data from the Propensity to Cycle Tool. The Sustrans GIS Model takes into account the people who would use each alignment as part of their commuting journey from Census 2011 Travel to Work Origin Destination data at Census Output Area. The model outputs the total number of commuters using each alignment per day, so the number of commuters cycling or walking is obtained through applying the mode share split[1] of commuters in Bradford or Calderdale districts[2]. Where it was not feasible to use this Sustrans GIS Model output, the Propensity to Cycle Tool (PCT) itself was used to provide usage data for the alignment so that all baseline usage estimates are derived in a comparable way.

The Sustrans GIS model allows us to add in the proposed alignments for inclusion in the analysis, while the PCT only includes commuting cyclists on existing infrastructure. Using the raw data also allows us to include commuting pedestrians for analysis in our model. The PCT uses fastest trip while the Sustrans model uses the shortest trip to estimate a trip taken. Counts include only trips of 5 miles[3] or less in length and that use the proposed alignment for 500 metres[4] or more. These counts are shown in Table 47.

Table 47: Total, cycling and walking commuters using each alignment daily

Corridor	Alignment	Total route users commuting along this alignment, daily	Estimation of Alignment Users commuting by bicycle, daily	Estimation of Alignment Users commuting by foot, daily
Keighley – Station Road	Keighley - Station Road	1,113	9	129
Keighley – Station Road	Station Road[1]	41	0	5
Holmfield - Queensbury	Queensbury Tunnel	36	0	4
Holmfield - Queensbury	Alpine option	36	0	4
Halifax - Holmfield	Greenway option	2,111	21	237
Halifax - Holmfield	Highway option	2,207	19	256
West Bradford	Clayton option	917	8	106
West Bradford	Thornton Road option	4,789	40	556

1: Leisure and commuting use along the Station Road alignment is calculated using different methods, due to the extent of new data available in 2021 compared to Sustrans 2017 report. Where Station Road is not shown separately in a table, it can be assumed that the relevant data is included in the Keighley – Station Road alignment as a whole.

The Sustrans GIS model estimates the number of commuting people. With this output, we estimate the number of annual trips based on the following assumptions and considerations:

- We have assumed that part time workers commute 3 days a week
- Census 2011 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

[1] http://www.ons.gov.uk/ons/rel/census/2011-census-analysis/method-of-travel-to-work-in-england-and-wales/rft-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 (NTS04049 / 2015) (4.2% bicycle / 10.9% on foot)

[2] Calderdale figures are used for the Queensbury Tunnel to Halifax alignment, all others use Bradford figures. This assumption is made throughout this study.

[3] A distance deemed to be potentially made by cycle

[4] This indicates a significant use of the alignment

- We have assumed that 90% of commuters will make a return trip. The total daily trips below is calculated using the number of people undertaking a commuting trip plus 90% of these to account for return trips
- As the Travel to Wok 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 estimates using the Census data to better reflect the typical daily usage across the year
- We have 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 have assumed that the proportion 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 walking 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 alignment (Table 48).

Table 48: Estimation of cycling, walking and total baseline commuting AUE

Corridor	Alignment	Estimation of alignment users commuting by bicycle, daily	Estimation of alignment users commuting on foot, daily	Estimation of baseline AUE for commuting cyclists	Estimation of baseline AUE for commuting pedestrians	Estimation of baseline commuting AUE
Keighley – Station Road	Keighley - Station Road	9	129	2,992	36,397	39,389
Keighley – Station Road	Station Road[1]	0	5	-	1,373	1,373
Holmfield - Queensbury	Queensbury Tunnel	0	4	-	1,091	1,091
Holmfield - Queensbury	Alpine option	0	4	-	1,091	1,091
Halifax - Holmfield	Greenway option	21	237	6,758	66,774	73,533
Halifax - Holmfield	Highway option	19	256	6,758	66,774	73,533
West Bradford	Clayton option	8	106	2,464	30,202	32,666
West Bradford	Thornton Road option	40	556	12,778	157,274	170,051

1: Leisure and commuting use along the Station Road alignment is calculated using different methods, due to the extent of new data available in 2021 compared to Sustrans 2017 report. Where Station Road is not shown separately in a table, it can be assumed that the relevant data is included in the Keighley – Station Road alignment as a whole.

J.2.2. 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[5] or walk[6] 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.

The following assumptions and considerations are factored in the estimation:

- Trip: A trip is a one-way movement with one main purpose. Your outward and return journeys should be treated as two separate trips[7]. Based on this definition of a trip;
  - We take the population within a 3.6 miles buffer of each alignment as accessible for cycling, this is the average cycling trip distance from the National Travel Survey (NTS9910).
  - We take the population within a 3.6 miles buffer of each alignment as accessible for walking that is more than 1 mile long, this is the average walking trip distance (> 1 mile) from the National Travel Survey (NTS9910)
  - We take the population within a 0.7 miles buffer of each alignment as accessible for walking, this is the average walking trip distance from the National Travel Survey (NTS9910)
- Since not everyone making a leisure trip will use the alignment, we assume 50% usage for off-road alignments (more appealing) and 20% usage for on-road alignments (less appealing). These were based on the lack of suitable infrastructure or other options for recreational walking and cycling along most of the proposed routes, especially in the more rural areas of the route. Much of the population along the route would not have many other options for safe routes for walking or cycling. Also, for many in the area, the proposed routes would in fact be the fastest and safest routes into the nearest town. These numbers are best guess estimates and are not based on counts or surveys but seem reasonable based on Sustrans past experience. For this study, all alignments are considered ‘off road’.
- Annual figure is estimated by multiplying the monthly estimates by 12.

The local study population living within an accessible distance of each alignment for cycling or walking leisure trips is calculated in a GIS model, using Census 2011 population data[8]. A buffer of 3.6 miles for cycling, 3.6 miles for walking distance greater than 1 mile, and 0.7 miles for walking, was applied to each alignment. The only exceptions are for Queensbury Tunnel and Well Heads Tunnel, where 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. The population is much greater for leisure cycling than leisure walking, due to the larger buffer of accessibility for cycling.

[5] DfT walking and cycling statistics Table CW0104 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536501/cw0104.ods
[6] DfT walking and cycling statistics Table CW0105 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/536499/cw0105.ods
[7] Definition of a trip: https://www.gov.uk/government/statistics/national-travel-survey-2020/national-travel-survey-2020-notes-and-definitions
[8] Census 2011 Headcounts and Household Estimates for Postcodes in England and Wales

J.2.3. Methodology for estimating population of route users

Population estimates were calculated within various distances along the walking and cycling network, of a series of route options. Distances along the course of the route options were calculated using the Open Route Service directions algorithm accessed via an API within the ORS plugin within QGIS desktop program. The population estimates were calculated using data from the Office of National Statistics Lower Layer Super Output Area population estimates mid-2019 dataset[9].

Input Data

- ONS Lower Layer Super Output Area population estimates mid-2019
- Queensbury Tunnel combined route options and individual route segments

Processing

- Open Route Service directions algorithm
- ArcGIS Pro
- QGIS

Methodology

1. Identify route options

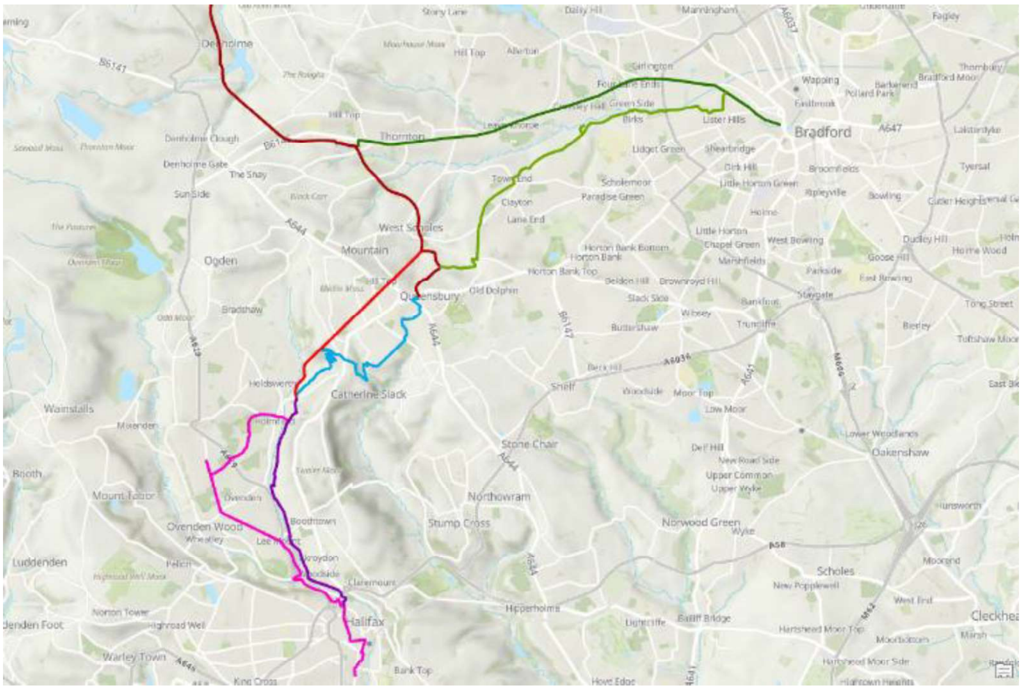

Figure 25: The seven alignments which make up the various route options

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9 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimatesnationalstatistics

2. Generate points at 100 metre intervals along the length of each alignment

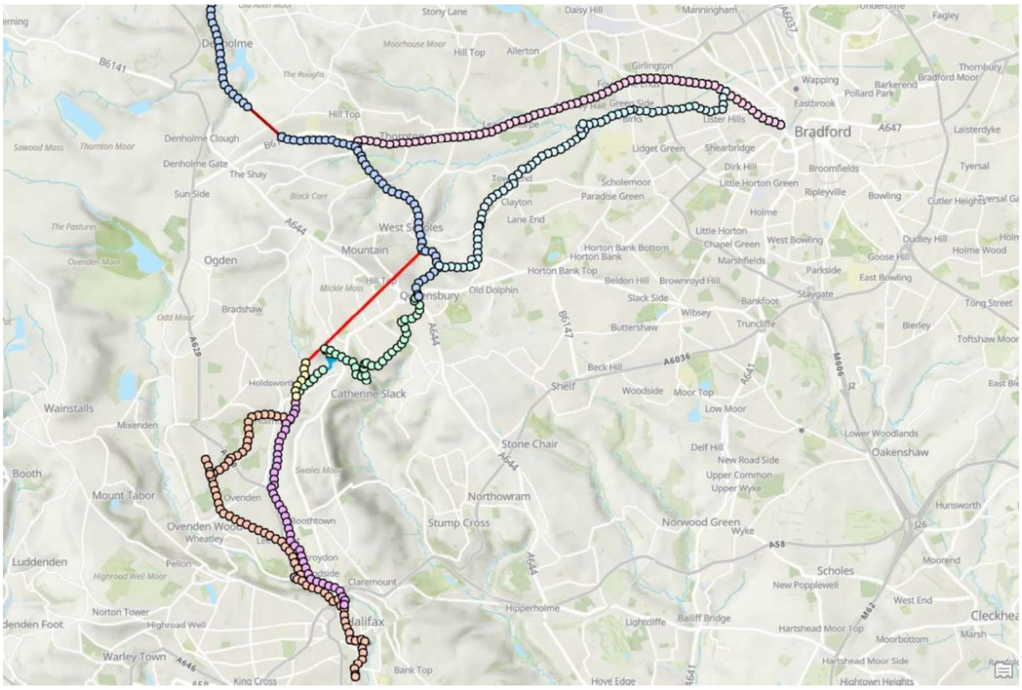

Figure 26: Points created at 100m intervals

3. Run each route option through the ORS directions algorithm separately for each journey scenario to create travel distance isochrones from each of the points along the alignments:

- Short walk – 1,300 metres
- Long walk – 5,800 metres
- Cycling – 5,800 metres

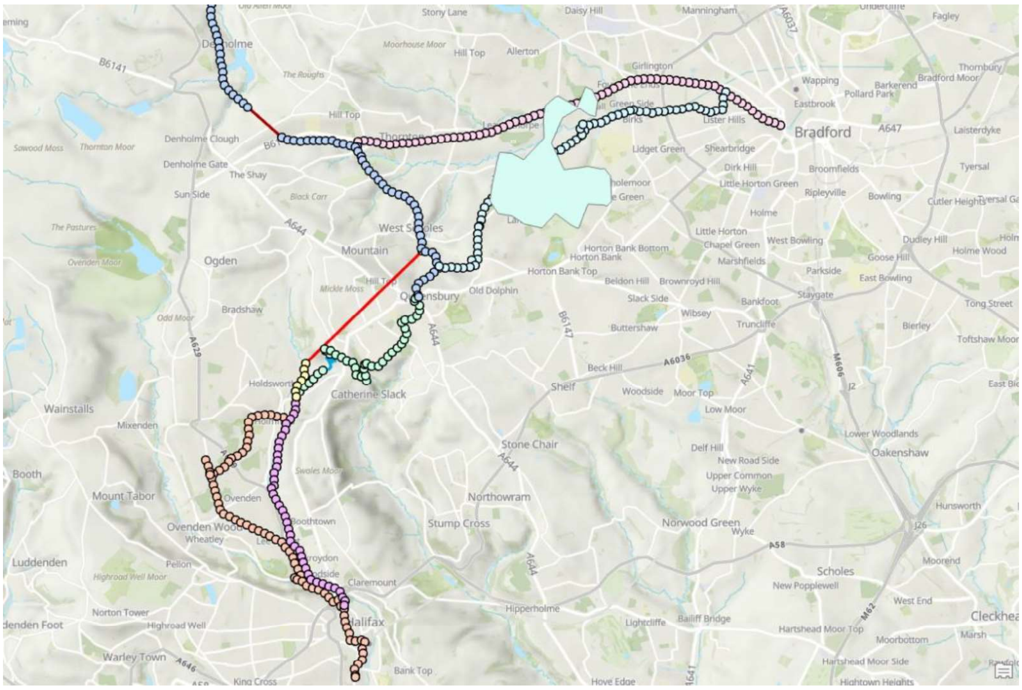

Figure 27: Individual travel time isochrones are created from each point

4. Dissolve the individual isochrones of the three journey scenarios together to create ‘route option buffers’.

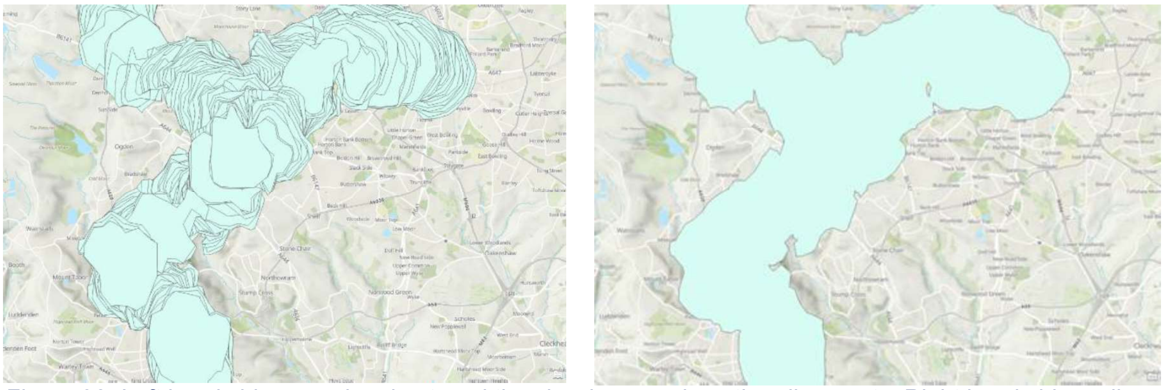

Figure 28: Left hand side – overlapping travel time isochrones along the alignments. Right hand side – alignment isochrones are dissolved to form a single buffer for each route option.

5. Intersect the route option buffers with ONS Output Areas.

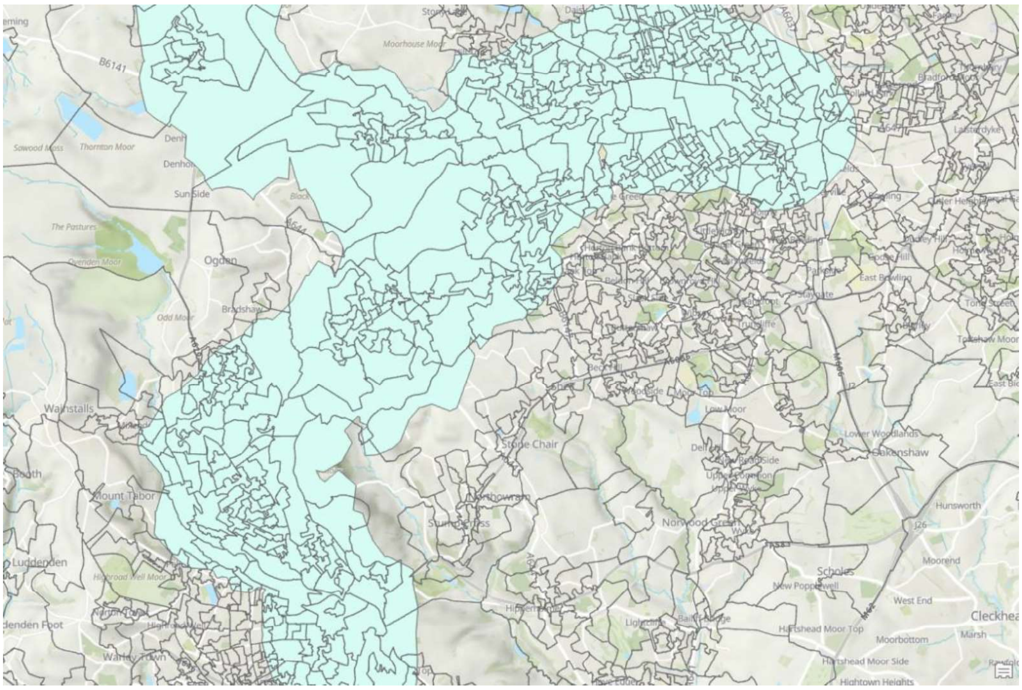

Figure 29: Route option buffer is intersected with the mid-2019 Output Area data

6. Calculate the population by:

- Summing the population of the Output Areas which are entirely within the route option buffer.
- Where the buffer overlaps part of an Output Area, including a percentage of the total population of that Output Area which is in proportion to the percentage of output area which is intersected by the route option buffer. In other words, where only half of the spatial area of an Output Area falls within the route option buffer, only half the population is carried through.

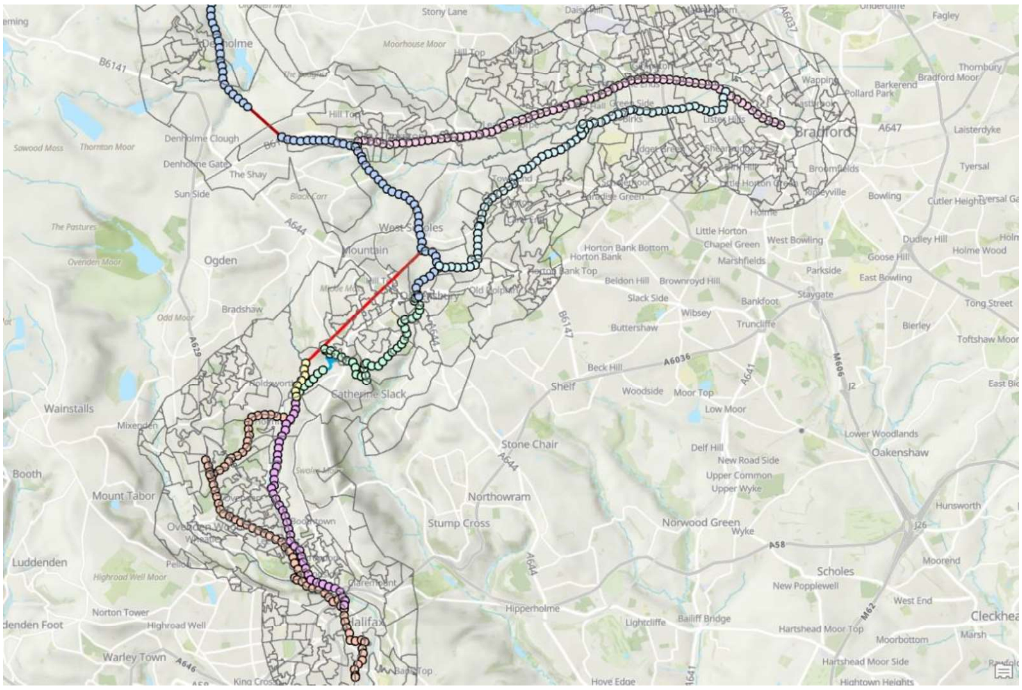

Figure 30: Populations within the intersected Output Areas are summed to create the overall population

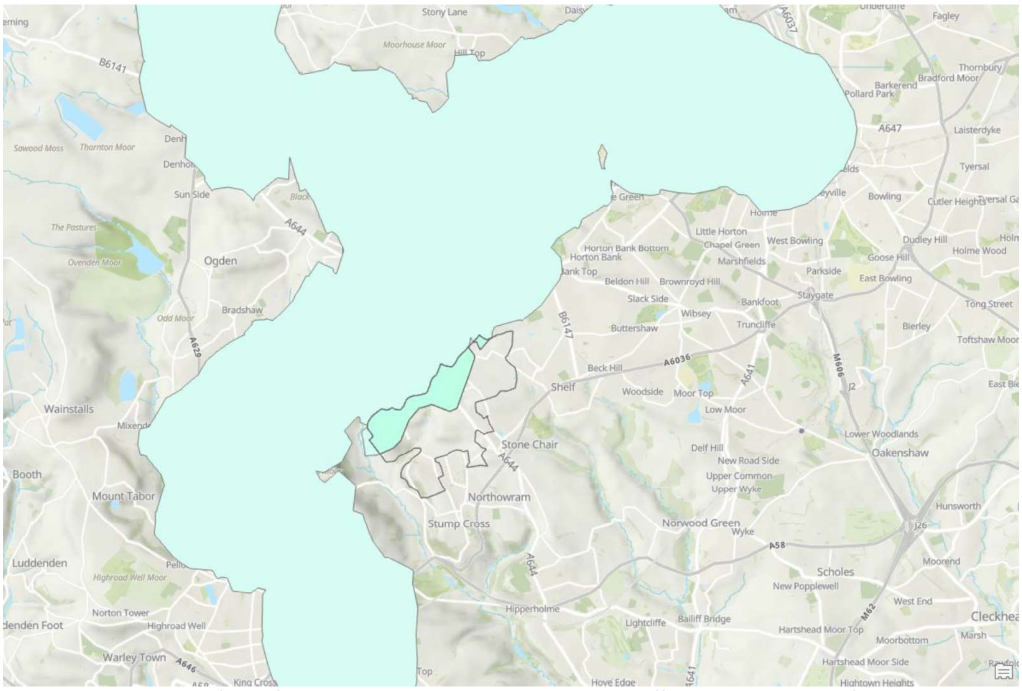

Figure 31: Where only part of the Output Area is intersected by the buffer, a proportion of the population is included

J.2.4. Combined annual usage estimates

After these factors and above methodology 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 alignment (see Table 49).

Table 49: Estimation of cycling, walking and total baseline leisure AUE

Corridor	Alignment	Route type and % of leisure journeys using alignment	Study population accessible for cycling	Study population accessible for walking	Estimation of baseline AUE for leisure cycling	Estimation of baseline AUE for leisure pedestrians	Estimation of baseline AUE
Keighley – Station Road	Keighley - Station Road	Off road – 50%	309,520	361,116	167,141	1,165,681	**1,332,822**
Holmfield - Queensbury	Queensbury Tunnel	Off road – 50%	228,316	243,365	154,113	785,583	**939,696**
Holmfield - Queensbury	Alpine option	Off road – 50%	223,735	241,795	120,817	780,514	**901,331**
Halifax - Holmfield	Greenway option	Off road – 50%	171,031	203,585	138,535	834,290	**972,825**
Halifax - Holmfield	Highway option	On road – 20%	171,828	220,301	55,672	361,118	**416,790**
West Bradford	Clayton option	Off road – 50%	403,403	481,043	217,838	1,552,806	**1,770,644**
West Bradford	Thornton Road option	On road – 20%	403,089	487,050	87,067	628,879	**715,947**

J.2.5. Baseline Annual Usage Estimate

The baseline cycling and walking AUEs are combined to calculate the baseline AUEs for each alignment. These AUEs are based on modelled data, rather than walking and cycling counts. It would not be possible to carry out walking and cycling counts in the area as the infrastructure under investigation does not currently exist, therefore these estimates are based on modelled data. As such, there is considerable uncertainty in these estimates. In particular, there is uncertainty around the assumption that between 20-50% of cycling and walking trips for people within 3.6 miles of the scheme would take place along the proposed routes.

Table 50: Baseline AUE for each alignment

Corridor	Alignment	Estimation of baseline cycling commuting and leisure AUE	Estimation of baseline walking commuting and leisure AUE	Estimation of baseline AUE
Keighley – Station Road	Keighley - Station Road	170,133	1,202,078	**1,372,211**
Keighley – Station Road	Station Road[1]	0	1,373	**1,373**
Holmfield - Queensbury	Queensbury Tunnel	154,113	786,674	**940,787**
Holmfield - Queensbury	Alpine option	120,817	781,605	**902,422**
Halifax - Holmfield	Greenway option	145,294	901,064	**1,046,358**
Halifax - Holmfield	Highway option	62,431	427,893	**490,323**
West Bradford	Clayton option	220,302	1,583,007	**1,803,309**
West Bradford	Thornton Road option	99,845	786,153	**885,998**

1: Leisure and commuting use along the Station Road alignment is calculated using different methods, due to the extent of new data available in 2021 compared to Sustrans 2017 report. Where Station Road is not shown separately in a table, it can be assumed that the relevant data is included in the Keighley – Station Road alignment as a whole.

J.3. Combining multiple alignments into routes

Once the baseline AUEs are developed for each individual alignments, the next stage of analysis is carried out on combinations of alignments referred to as routes. Considering the alignments individually initially allowed for the estimation of annual usage based on the alignments' characteristics. In this next step we combine the individual alignment AUEs for each route and remove any overlap of users who may be counted on more than one alignment (i.e. double counting).

J.3.1. 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 alignments commuted along at least two of the alignments. This proportion would be double counted if the users from multiple alignments are added up. 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 foot. 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 alignment. For alignments where catchment areas overlap, the population in this overlapping area (see Figure 28) will be double counted when simply totalling the users from multiple alignments in each route. The same GIS program and method can be used to account for double counting, using the following process:

- We sum the population with access to individual alignments (1)
- We calculate the population with access to the route as a whole, using the dissolved buffers around each route (2)
- Subtracting (2) from (1) provides the amount of double counting to be accounted for.

Double counting figures from all routes were then averaged together to determine a single double counting correction factor to use for all routes.

Table 51: Accounting for double counting – baseline AUEs (cycling and walking trips)[10]

Route	Total Baseline Cycling trips	Total Baseline Walking trips	Total Scenario Baseline AUE
Most Advantageous & Attractive (Queensbury Tunnel Option)	613,525	2,673,474	**3,286,998**
Most Advantageous & Attractive (Alpine Option)	589,551	2,671,091	**3,260,642**
Next preferred (Queensbury Tunnel Option)	496,686	2,102,872	**2,599,558**
Next preferred (Alpine Option)	472,713	2,100,490	**2,573,203**

Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	350,296	1,505,960	**1,856,256**
Low Cost & Quickest to Deliver (Alpine Option)	326,322	1,503,578	**1,829,900**

The baseline AUEs for the routes (see Table 51) are then taken forward as an input in the Capital Fund Uplift Tool.

J.4. Estimating post intervention annual usage

J.4.1. Methodology for estimating post intervention annual usage – cycling and walking

Data from case studies were used to derive an average uplift. This data is based on infrastructure projects that have been monitored by Sustrans. The following criteria were used in selecting the relevant case studies:

- Pre- and post-intervention usage data needed to be available, either from manual counts or automatic counters.
- Interventions should include either cycle and pedestrian tracks, greenways or large infrastructure projects (such as bridges or tunnels). Uplifts for the greenway alignments were derived from the cycle and pedestrian tracks case studies. Uplifts for the tunnel alignments were derived from the large infrastructure schemes (e.g. tunnels and bridges).
- Interventions should take place in MSOAs that are similarly classified as those through which the proposed routes pass. Interventions from Urban Major Conurbations were not included.

The Capital Fund Uplift Tool was used as a sensitivity test to compare uplifts and BCRs to those found using the case studies. The tool estimates the increase in weekday cycling and walking trips from new infrastructure. This estimation is based on inputs for scheme cost, evaluation of evidence for cost-effectiveness of past spending by infrastructure type and estimates for the relative cost-effectiveness of spending by area[11]. The Capital Fund Uplift Tool is used to estimate cycling and walking uplift for all the route routes. The following key inputs have been used in the Capital Fund Uplift Tool to obtain estimates for number of cycling and walking trips per weekday with the proposed intervention.

- Local authority
- Total scheme cost (£, 2021 prices)
- Walking trips per weekday without the intervention (AUEs divided by number of working days in a year, minus weekends and bank holidays = 250 days)
- Cycling trips per weekday without the intervention (AUE divided by number of working days in a year, minus weekends and bank holidays = 250 days)

[11] See DfTs 2021/22 Capital Fund Value for Money Guidance

- A breakdown of scheme cost by infrastructure type; cost was shared between cycling and walking infrastructure.

The Capital Fund Uplift Tool produces a Low, Medium, and High uplift for each proposed intervention and then recommends which uplift to use based on the Intrinsic Cycling/Walking Potential for the local authority in which the intervention is proposed. For Bradford, the Capital Fund Uplift Tool recommends using the Low uplift for cycling and the Medium uplift for walking. The recommended uplifts were used for this analysis.

Routes that contained the Queensbury Tunnel alignment were split between the tunnel and the greenway alignments for purposes of generating uplifts. Uplifts for the Queensbury Tunnel alignment were only calculated once, as the alignment and cost for the tunnel do not change between route options.

Table 52: Average uplifts for major infrastructure interventions (tunnels) and cycling and walking paths (greenways).

Intervention type	Mode	Without- to with-intervention percentage average	Range
Tunnel	**Cycling**	216%	94-867%
	Walking	178%	70-574%
Greenway	**Cycling**	541%	77-2,952%
	Walking	179%	61-754%

Table 53: Daily usage uplifts generated by using the Case Study data and the Capital Fund Uplift Tool

Route	Cycling		Walking	
	Case Studies	Capital Fund Uplift Tool	Case Studies	Capital Fund Uplift Tool
Queensbury Tunnel	1,332	2,358	5,579	5,796
Most Advantageous & Attractive (QT option, greenway alignments only)	10,875	3,725	16,495	21,032
Most Advantageous & Attractive (Alpine option)	5,094	3,900	19,018	23,236
Next Preferred (QT option, greenway alignments only)	8,347	2,758	12,409	16,825
Next Preferred (Alpine option)	4,084	3,433	14,955	20,922
Low Cost & Quickest to Deliver (QT option, greenway alignments only)	5,179	1,809	8,135	11,480
Low Cost & Quickest to Deliver (Alpine option)	2,819	2,455	10,705	15,340

J.4.2. Active Mode Appraisal Toolkit (AMAT) analysis

A separate version of the AMAT is created for each route based on the uplifts generated from the Case Study averages and the Capital Fund Uplift Tool. The AMAT was developed by the Department for Transport to allow scheme promoters to simply and robustly appraise the value for money of walking and cycling schemes. It quantifies some of the key benefits from active travel including improved health and lower workplace absenteeism, environmental and congestion benefits from reduced car miles and journey quality benefits from safer and more pleasant travel.

The following inputs have been used in the AMATs to obtain Benefit Cost Ratio (BCR) of each route. All default inputs are maintained, with the exception of optimism bias:

- Appraisal period: This represents the number of years over which the benefits of the intervention are assumed to occur, the default is 20 years
- Local area type: Types include, London, Inner and Outer Conurbation; Other Urban; or Rural
- Number of cycling/walking trips **without** the proposed intervention: AUEs converted to average trips per weekday assuming on average 250 weekdays per year excluding bank holidays.
- Number of cycling/walking trips **with** the proposed intervention: The forecasted uplift in cycling and walking due to a scheme.
- How much of an average cycling/walking trip will use the intervention: An estimate for the percentage of an average cycling or walking trip which is on the scheme itself.
- Total intervention cost: An estimate for the upfront costs of delivering the scheme and any on-going maintenance and renewal costs for the scheme's assumed life (typically 20 years).
- Cost information and optimism bias – costs and optimism bias used for each route are shown in Table 32.

Benefit Cost Ratios (BCR)

The estimated BCRs are judged according to the value for money categories described in the 2013/14 Highways Agency technical note[12] (see Table 54).

Table 54: Value for money categories[13]

Value for money category	Benefit-cost ratio
Very High	4 or higher
High	2 to 4
Medium	1.5 to 2
Low	1 to 1.5
Poor	0 to 1
Very Poor	Less than 0

[12] 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

[13] See DfTs 2021/22 Capital Fund Value for Money Guidance

The estimated economic impact in the form of BCRs is calculated over a 20 year appraisal period and include benefits and costs from the following:

- Congestion benefit – Reduced vehicle kilometres results in reduced congestion for road users
- Infrastructure maintenance – Reduced vehicle kilometres results in reduced damage to done to road surfaces etc.
- Accident – Reflects the effect of reducing vehicle kilometres on road safety. It is not the direct benefit of increased cycle safety.
- Local air quality – Reduced vehicle kilometres results in reduced amount of pollutants emitted.
- Noise – Reduced vehicle kilometres results in reduced amount of noise produced on roads.
- Greenhouse gases – Reduced vehicle kilometres results in reduced in greenhouse gas emissions.
- Reduced risk of premature death – Due to increased physical activity.
- Absenteeism – Due to increased physical activity.
- Journey ambience – Improved experience due to cycle lanes, showers, reduced crowding etc.
- Indirect taxation – Reduced vehicle kilometres reduced tax revenue e.g. fuel duty.
- Government costs

For the routes including the Queensbury Tunnel, AMATs were produced separately for the Tunnel alignment and the greenway alignments using the uplift numbers in Table 53, with the costs split between the two sections as detailed in Table 32 and Table 33. The PVB and PVC from each section were then combined, and the BCR for the route as a whole was calculated using the formula:

$$BCRcombined = \frac{PVBtunnel + PVBgreenway}{PVCtunnel + PVCgreenway}$$

Table 55: AMAT outputs for the Tunnel alignment and greenway alignments for each scenario.

Scenario	PVB (£'000s)	PVC (£'000s)
Most Advantageous and Attractive (greenways)	£117,726.15	£20,610.02
Next Preferred (greenways)	£89,958.35	£19.979.47
Low Cost (greenways)	£56,507.33	£13,802.33
Tunnel only alignment (greenways)	£16,026.92	£26,782.27

Table 56: Final AMAT Outputs

Most Advantageous & Attractive (Queensbury Tunnel Option)				
	PVB (£'000s)	PVC (£'000s)	BCR	VfM Category
Case Studies	£ 133,753.07	£47,392.28	2.82	High
Capital Fund Uplift Tool	£ 90,701.57	£47,401.59	1.91	Medium
Most Advantageous & Attractive (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 68,623.09	£ 25,086.99	2.74	High
Capital Fund Uplift Tool	£ 55,771.88	£ 23,591.54	2.36	High
Next Preferred (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 105,985.27	£ 46,761.73	2.27	High
Capital Fund Uplift Tool	£ 77,035.57	£ 46,768.54	1.65	Medium
Next Preferred (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 52,700.03	£ 24,551.79	2.15	High
Capital Fund Uplift Tool	£ 65,438.64	£ 24,550.64	2.67	High
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 72,534.25	£ 40,584.60	1.79	Medium
Capital Fund Uplift Tool	£ 60,801.42	£ 40,588.19	1.50[1]	Low
Low Cost & Quickest to Deliver (Alpine Option)				
	PVB (£'000s)	**PVC (£'000s)**	**BCR**	**VfM Category**
Case Studies	£ 36,980.13	£ 18,537.63	1.99	Medium
Capital Fund Uplift Tool	£ 48,189.58	£ 18,536.51	2.60	High

1. Rounded up from 1.49, hence Low

The BCRs for each route option and each uplift scenario are presented in

Table 56 in the 'BCR' column. BCRs range from 1.50 to 2.82, ranging in VfM categories from low to high. Only one scenario is in the low range. The Most Attractive and Next Preferred scenarios which include the Queensbury Tunnel resulted in higher BCRs when using the case study uplift data compared to the Alpine option. The Capital Fund Uplift Tool resulted in higher BCRs for the Alpine option. When using the case study uplifts, the highest BCR for options including the tunnel and options including the Alpine zig-zag come from the Most Advantageous and Attractive scenarios (2.82 and 2.74, respectively). When using the Capital Fund Uplift Tool, the Most Advantageous and Attractive scenario including the tunnel had the highest BCR (1.91) for the options including the tunnel. The Next Preferred option including the Alpine zig-zag had the highest (2.67) for the Alpine scenarios.

The BCRs are dependent on the overall change in usage from baseline. As there exists uncertainty in the baseline usage numbers as described previously, there is also some uncertainty in the overall BCR. The modelling and BCRs presented represent a central tendency; as seen in previous usage data, many schemes over- or underperform when compared to the average change in usage. For the BCR to decrease enough for the Most Advantageous and Attractive scenario to fall into the Poor VfM category (< 1), baseline usage would have to decrease by a factor of 2.8 (with the associated reduction in uplift).

Quantifying the risk of such a decrease in usage is difficult, as the baseline usage numbers are a projection for routes that do not yet exist. To quantify the risk, we would need to create baseline counts for other similar routes using the described methodology based on the NTS and population data, then compare the projections to actual counts. To do so would be well beyond the scope of the project.

To compare the benefits for each additional user, the number of additional users was determined by comparing the 'with scheme' forecasted usage estimates with their baseline equivalents for walking and cycling.

Table 57: Additional users per scenario

Scenarios		'Without scheme' AUE (cycling)	'Without scheme' AUE (walking)	'With scheme' - AUE (cycling)	'With scheme' - AUE (walking)	Additional riders (cycling)	Additional users (walking)	Additional users per year (walking and cycling)
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	613,525	2,673,474	2,958,542	4,779,165	2,345,018	2,105,691	4,450,709
	Capital Fund Uplift Tool			1,355,549	5,939,016	742,024	3,265,542	4,007,567
Most Advantageous & Attractive (Alpine Option)	Case Studies	589,551	2,671,091	1,273,430	4,754,543	683,879	2,083,451	2,767,331
	Capital Fund Uplift Tool			974,932	5,808,931	385,381	3,137,840	3,523,221
Next Preferred (Queensbury Tunnel Option)	Case Studies	496,686	2,102,872	2,326,447	3,341,990	1,829,760	1,239,117	3,068,878
	Capital Fund Uplift Tool			1,113,908	4,630,557	617,222	2,527,684	3,144,906
Next Preferred (Alpine Option)	Case Studies	472,713	2,100,490	1,021,059	3,738,872	548,347	1,638,382	2,186,729
	Capital Fund Uplift Tool			858,291	5,230,587	385,578	3,130,097	3,515,675
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	Case Studies	350,296	1,505,960	1,534,475	2,689,315	1,184,179	526,331	2,367,534
	Capital Fund Uplift Tool			876,627	3,551,097	1,183,356	2,045,137	2,571,468
Low Cost & Quickest to Deliver (Alpine Option)	Case Studies	326,322	1,503,578	704,856	2,676,368	378,534	1,172,791	1,551,324
	Capital Fund Uplift Tool			613,760	3,835,012	287,438	2,331,434	2,618,872

The value per additional rider was determined using the present value benefits estimated from the AMAT and dividing by the additional user (walking and cycling) in each scenario.

Table 58: Route comparison – value per additional user

Scenarios		Additional users per year (walking and cycling)	Present Value Benefits (£'000)	Value per additional user, £ / user
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	4,450,709	£ 133,753.07	£ 30.05
	Capital Fund Uplifts Tool	4,007,567	£ 90,701.57	£ 22.63
Most Advantageous & Attractive (Alpine Option)	Case Studies	2,767,331	£ 68,623.09	£ 24.80
	Capital Fund Uplifts Tool	3,523,221	£ 55,771.88	£ 15.83
Next Preferred (Queensbury Tunnel Option)	Case Studies	3,068,878	£ 105,985.27	£ 34.54
	Capital Fund Uplifts Tool	3,144,906	£ 77,035.57	£ 24.50
Next Preferred (Alpine Option)	Case Studies	2,186,729	£ 52,700.03	£ 24.10
	Capital Fund Uplifts Tool	3,515,675	£ 65,438.64	£ 18.61
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	Case Studies	2,367,534	£ 72,534.25	£ 30.64
	Capital Fund Uplifts Tool	2,571,468	£ 60,801.42	£ 23.64
Low Cost & Quickest to Deliver (Alpine Option)	Case Studies	1,551,324	£ 36,980.13	£ 23.84
	Capital Fund Uplifts Tool	2,618,872	£ 48,189.58	£ 18.40

J.5. Full Results – Additional Impact Analysis

J.5.1. Sensitivity testing

Various sensitivity tests were performed to observe how the BCR would change under various circumstances. For the purposes of the sensitivity testing, the Most Advantageous and Attractive option including the tunnel with the case study uplifts was used as the benchmark case.

Delayed construction and inflation costs

Construction may be delayed due to potential legal challenges or other unforeseen circumstances. The effect of delaying construction for two years on the BCR of the Most Attractive and Advantageous options were analysed in the AMAT. Nominal costs were adjusted for inflation using 2.1% assumed general inflation.

In addition to performing sensitivity testing for a construction delay using the average inflation assumed in the AMAT, testing was also performed assuming a higher rate of inflation at 4% to account for the current general inflation above and beyond the AMAT assumptions, both for an on-time construction start and a 2-year delay.

Table 59: Effects of a 2-year construction delay

Construction delay	PVB (£'000)	PVC (£'000)	BCR	Difference from benchmark
Benchmark	£133,753.10	£47,392.28	2.82	
On time w/ 4% inflation	£133,753.07	£49,003.39	2.73	-0.09
2-year delay	£128,766.56	£46,407.53	2.77	-0.05
2-year delay w/ 4% inflation	£128,776.56	£48,723.94	2.64	-0.18

Tunnel cost variance

To account for possible cost differences for the tunnel (both over- and underestimates), AMATs were produced for the circumstances of +30% tunnel cost and -30% tunnel cost. These were then compared to the benchmark case.

Table 60: Cost over- and underrun analysis

Cost scenario	PVB (£'000)	PVC (£'000)	BCR	Difference from benchmark
Benchmark	£133,753.07	£47,392.28	2.82	
+30% Tunnel cost	£133,753.07	£54,626.32	2.45	-0.37
-30% Tunnel cost	£133,753.07	£40,159.32	3.33	+0.51

In addition to the sensitivity testing, the cost overrun needed to decrease the BCR into lower VfM categories were also calculated. The baseline falls into the High VfM, so the overruns needed to decrease the category of the BCR to Medium, Low, and Poor were determined. This sensitivity test was performed on both Most Attractive and Advantageous route options.

Table 61: Cost overrun needed to change VfM category

New VfM Category	PVB (£'000)	Projected PVC (£'000)	BCR	Difference in PVC (£'000)	Overall % PVC increase	Tunnel % PVC increase
Most Attractive and Advantageous – Tunnel option						
Medium	£133,753.07	£66,876.53	2	£19,484.25	41.11%	80.77%
Low	£133,753.07	£89,168.71	1.5	£41,776.43	88.15%	173.19%
Poor	£133,753.07	£133,753.07	1	£86,360.79	182.23%	358.02%

Most Attractive and Advantageous – Alpine option					
New VfM Category	**PVB (£'000)**	**Projected PVC (£'000)**	**BCR**	**Difference in PVC (£'000)**	**Overall % PVC increase**
Medium	£68,623.09	£34,311.55	2	£9,224.56	36.77%
Low	£68,623.09	£45,748.73	1.5	£20,661.74	82.36%
Poor	£68,623.09	£68,623.09	1	£43,536.10	173.54%

Tunnel design life

The baseline analysis assumes a 20-year design life. As the tunnel is a durable structure with a current lifespan of much longer than 20 years, an AMAT was produced that assumed a design life of 60 years. Baseline annual maintenance costs were extended to correlate to a 60-year design life. No changes were made to the design life of the greenway alignments.

Table 62: Tunnel design life analysis

Asset life	PVB (£'000)	PVC (£'000)	BCR	Difference in PVB (£'000)	Difference in PVC (£'000)
20 years (benchmark)	£133,753.07	£47,392.28	2.82		
60 years	£162,426.02	£47,651.19	3.41	£28,672.96	£258.91

Extended tunnel alignment

For the benchmark analysis, only the alignment including the Queensbury Tunnel used the "Tunnel" data from the case study data to generate uplifts; all other alignments used the "Greenways" data to generate their uplifts. The analysis excluded other alignments from the "Tunnel" section of the route because the other alignments could be viewed as a separate network on their own. The sections north of the tunnel and south of the tunnel could be used for active travel without going through the tunnel. Sensitivity testing was performed to show changes in BCR when extending the "Tunnel" section to the alignments immediately north and south of the Queensbury Tunnel. South of the tunnel includes the two Halifax to Holmfield alignments, and north includes the Keighley to Station Road alignment. Given the high tourism and heritage potential of the tunnel, this approach may better capture the usage of the routes specifically for access to the tunnel, although it does ignore the use of the alignments outside of the tunnel for local travel.

Table 63: Extended tunnel segment sensitivity testing results

Scenario	PVB (£'000)	PVC (£'000)	BCR	Difference from benchmark
Tunnel only (benchmark)	£133,753.07	£47,392.28	2.82	
Extended tunnel to north and south	£95,734.57	£47,624.70	2.01	-0.81
Extended tunnel to north only	£113,861.30	£44,316.59	2.57	-0.25

J.5.2. Tourism model

In addition, the economic impact of cycling tourism is estimated. Sustrans' Cycle Route Economic Impact Model, referred to here as the *tourism model*, was first developed in 2007 by Sustrans in conjunction with the University of Central Lancashire, and is used to estimate a total annual spend and a 'spend per head' for all recreational users. The model has since been updated and a comparable version for walking has been created. They models are now referred to as the Leisure Cycling and Leisure Walking Expenditure Models.

The inputs for the tourism model primarily come from specific recreational usage-related questions asked in a user survey, 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. The output from the tourism model is in terms of expenditure and jobs supported; separated into leisure cycling expenditure (LCE) and leisure walking expenditure (LWE). The jobs supported output is based on the employment that is supported by the level of tourism expenditure that might be anticipated for the estimated number of tourist trips being made on the routes (e.g. in hospitality, accommodation, food service industries, etc.).

Unfortunately there have been no user surveys undertaken in the vicinity of any of the proposed routes/corridors, so proxy survey data from a comparable location has been used. Proxy survey data captured in 2018 from a site on the Spen Valley Greenway in Bradford was used in combination with data from the 2019 Visit Bradford tourism survey to provide the necessary model inputs. The Spen Valley Greenway data was chosen due to it being the nearest survey site to the Queensbury Tunnel proposed routes with recent survey data (i.e. within the last 5 years) and the necessary recreational usage questions to provide inputs for the model. Data from the 2019 Visit Bradford Tourism Survey was used to derive the inputs for home-based vs holiday usage based on the responses given on what type of trip each visitor was making.

Table 64 Recreational expenditure (LWEM and LCEM) and jobs supported

Most Advantageous & Attractive (Queensbury Tunnel Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£1,385,204.48	£7,493,360.49	£8,878,564.96	30	164	194
Capital Fund Uplift Tool	£634,727.83	£9,311,935.46	£9,946,663.29	14	204	218
Most Advantageous & Attractive (Alpine Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£808,004.83	£7,041,148.15	£7,849,152.98	18	154	172
Capital Fund Uplift Tool	£329,850.44	£8,853,666.61	£9,183,517.05	7	194	201
Next preferred (Queensbury Tunnel Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£1,089,253.96	£5,891,921.52	£6,981,175.48	24	129	153
Capital Fund Uplift Tool	£521,537.16	£7,662,707.33	£8,184,244.49	11	168	179
Next preferred (Alpine Option)						
	LCEM Expenditure	**LWEM Expenditure**	**Total Tourism Expenditure (LWEM + LCEM)**	**Jobs Supported (LCEM)**	**Jobs Supported (LWEM)**	**Jobs Supported (LWEM + LCEM)**
Case Studies	£897,314.94	£7,382,563.28	£8,279,878.23	20	162	182
Capital Fund Uplift Tool	£329,850.44	£8,853,666.61	£9,183,517.05	7	194	201

Low Cost & Quickest to Deliver (Queensbury Tunnel Option)						
	LCEM Expenditure	LWEM Expenditure	Total Tourism Expenditure (LWEM + LCEM)	Jobs Supported (LCEM)	Jobs Supported (LWEM)	Jobs Supported (LWEM + LCEM)
Case Studies	£718,448.72	£4,216,638.17	£4,935,086.88	16	92	108
Capital Fund Uplift Tool	£410,441.20	£5,567,844.81	£5,978,286.01	9	122	131
Low Cost & Quickest to Deliver (Alpine Option)						
	LCEM Expenditure	LWEM Expenditure	Total Tourism Expenditure (LWEM + LCEM)	Jobs Supported (LCEM)	Jobs Supported (LWEM)	Jobs Supported (LWEM + LCEM)
Case Studies	£661,690.76	£5,693,910.71	£6,355,601.47	15	125	140
Capital Fund Uplift Tool	£253,767.13	£6,764,801.80	£7,018,568.93	6	148	154

Benefit Cost Ratios (BCR) including tourism benefits

Tourism expenditure is not valued in the Active Mode Appraisal Toolkit (AMAT). The proposed routes around Queensbury Tunnel are expected to attract tourism-related usage, as seen with past schemes of a similar nature such as the Monsal and Tissington Trails in Derbyshire and Bath Two Tunnels scheme.

To provide a holistic estimate for the economic impact of each scenario, illustrative BCRs are derived which show the Benefit-Cost Ratios from AMAT as well as the estimated leisure cycling and walking expenditure. The Present Value Benefit (PVB) is added to the total tourism expenditure (i.e. LWEM + LCEM) (Table 65), and divided by the Present Value Cost (PVC) calculated in the AMAT. It should be noted that the tourism expenditure represents a cashable benefit, which is different to the monetised impacts derived in AMAT. In reality, these values should not be added together as they represent different types of economic value. The below table is for illustrative purposes only.

With the added tourism benefit, the highest BCR is 3.05 (judged as '*high*' in terms of value for money) which is derived from the Most Advantageous and Attractive options using the Alpine Zig-zag with the Case Study uplift. The highest BCR when including the Queensbury Tunnel is 3.01 and comes from the Most Advantageous and Attractive option.

Table 65 Calculating BCRs that include tourism benefit

Most Advantageous & Attractive (Queensbury Tunnel Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	Change in BCR
Case Studies	£133,753.07	£47,392.28	£8,878.56	£142,631.63	3.01	0.19
Capital Fund Uplift Tool	£90,701.57	£47,401.59	£9,946.66	£100,648.23	2.12	0.21
Most Advantageous & Attractive (Alpine Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	
Case Studies	£68,623.09	£25,086.99	£7,849.15	£76,472.24	3.05	0.31
Capital Fund Uplift Tool	£55,771.88	£23,591.54	£9,183.52	£64,955.39	2.75	0.39

Next preferred (Queensbury Tunnel Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	
Case Studies	£105,985.27	£46,761.73	£5,010.02	£110,995.29	2.37	0.11
Capital Fund Uplift Tool	£77,035.57	£46,768.54	£5,874.77	£82,910.34	1.77	0.13
Next preferred (Alpine Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	
Case Studies	£52,700.03	£24,551.79	£5,942.74	£58,642.77	2.39	0.24
Capital Fund Uplift Tool	£65,438.64	£24,550.64	£6,592.52	£72,031.16	2.93	0.27
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	
Case Studies	£72,534.25	£40,584.60	£3,541.74	£76,075.99	1.87	0.09
Capital Fund Uplift Tool	£60,801.42	£40,588.19	£4,291.24	£65,092.66	1.60	0.11
Low Cost & Quickest to Deliver (Alpine Option)						
	PVB (£'000s)	PVC (£'000s)	Total Tourism Expenditure (LWEM + LCEM) £'000s	Total Benefits (AMAT, LWEM, LCEM) - £'000s	LWEM & LCEM BCRs	
Case Studies	£36,980.13	£18,537.63	£4,561.67	£41,541.80	2.24	0.25
Capital Fund Uplift Tool	£48,189.58	£18,536.51	£5,038.38	£53,227.96	2.87	0.27

Comparing BCRs and LWEM & LCEM BCRs

In all the scenarios the inclusion of tourism benefits resulted in an increase in the BCRs; the increase ranged from 0.19 - 0.39. Note: Sums that do not seem to add up are due to decimals that were rounded off.

Table 66 Comparison between AMAT BCRs and BCRs that include tourism benefits

Scenarios		AMAT BCRs	AMAT BCR + Tourism benefit	Difference
Most Advantageous & Attractive (Queensbury Tunnel Option)	Case Studies	2.82	3.01	0.19
	Capital Fund Uplift Tool	1.91	2.12	0.21
Most Advantageous & Attractive (Alpine Option)	Case Studies	2.74	3.05	0.31
	Capital Fund Uplift Tool	2.36	2.75	0.39
Next preferred (Queensbury Tunnel Option)	Case Studies	2.27	2.42	0.15
	Capital Fund Uplift Tool	1.65	1.82	0.17
Next preferred (Alpine Option)	Case Studies	2.15	2.48	0.34
	Capital Fund Uplift Tool	2.67	3.04	0.37
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)	Case Studies	1.79	1.91	0.12
	Capital Fund Uplift Tool	1.50	1.65	0.15
Low Cost & Quickest to Deliver (Alpine Option)	Case Studies	1.99	2.34	0.34
	Capital Fund Uplift Tool	2.60	2.98	0.38

J.5.3. Heritage benefit

The Queensbury Tunnel structure is expected to have a significant heritage value because of its industrial heritage. This potential heritage value is external to the monetised impacts included in AMAT, but an important aspect of the business case for the tunnel as a walking and cycling route which would provide access to its industrial heritage for users.

To demonstrate the potential impact of including this heritage value in the cost-benefit assessment, two 'heritage BCR' scenarios have been modelled using switching values analysis. This models the heritage value of the Queensbury Tunnel by estimating what it would be equivalent to (in terms of present-value benefits) to adjust the AMAT BCRs to a certain level. This calculation is only applied to the scenarios including Queensbury Tunnel, as these are the scenarios where heritage value should form part of the value-for-money analysis.

The scenario for modelling the potential heritage value involve modelling one BCR scenario:

What would the additional benefit in terms of heritage be equivalent to if the BCRs were rounded up to the next VfM category?

This scenario uses the AMAT BCRs as a starting point and rounds up to the next VfM category[14].

The calculation then works out what the net Present Value Benefit would be at this increased BCR scenario. BCRi denotes the BCR scenario for the switching value analysis. The following equations illustrate how the heritage value is derived.

$$BCRi = \frac{Present\ Value\ Benefits + Heritage\ Value}{Present\ Value\ Costs}$$

$$Heritage\ Value = (BCRi\ x\ Present\ Value\ Costs) - Present\ Value\ Benefits$$

The heritage value from the switching values analysis is then divided by the population figures derived from the GIS modelling that determined the population buffers around the routes as part of the baseline usage estimate derivation to test whether this level of heritage value is credible.

The original AMAT outputs for Present Value Benefits, Present Value Costs and BCRs are in

Table 56. Table 67 shows the results of the switching values analysis for the three scenarios which involve Queensbury Tunnel.

Based on the BCR scenario modelled below using both the case study and Capital Fund Uplift Tool uplifts, the per-trip heritage value of the Queensbury Tunnel ranges from £13.00 to £33.00 across the nine usage scenarios. The maximum heritage value of £33.00 is ascribed to the Next Preferred scenario with uplifts from the case studies. This range of values is credible and demonstrates that if

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14 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918479/value-for-money-framework.pdf

heritage value were included in the value for money assessment, there are grounds to consider the out-turn BCRs as being higher than the AMAT BCRs if these heritage benefits are included.

Table 67 Heritage value – switching values analysis

Most Advantageous & Attractive (Queensbury Tunnel Option)					
		Switching values: If BCR was rounded up to the next VfM category			
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ trip (£)**
Case Studies	2.82	4.00	£189,569.13	£55,816.06	£24.50
Capital Fund Uplift Tool	1.91	2.00	£94,803.18	£4,101.61	£13.00
Next Preferred (Queensbury Tunnel Option)					
		Switching 1: If BCR was rounded up			
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ trip (£)**
Case Studies	2.28	4.00	£187,046.94	£81,061.67	£33.00
Capital Fund Uplift Tool	1.65	2.00	£93,537.08	£16,501.51	£16.28
Low Cost & Quickest to Deliver (Queensbury Tunnel Option)					
		Switching 1: If BCR was rounded up to next VfM category			
	Original BCR	**BCR 1**	**PVB 1 (£'000s)**	**Net PVB (Heritage benefit) (£'000s)**	**PVB/ trip (£)**
Case Studies	1.80	2.00	£81,169.20	£8,634.96	£19.22
Capital Fund Uplift Tool	1.50	2.00	£81,176.37	£20,374.95	£18.33

J.5.4. Carbon impact

The analysis of the carbon impact of the various usage scenarios was carried out using the greenhouse gas emissions output from the Active Mode Appraisal Toolkit. The estimated tonnes of CO_2 saved was derived from the AMAT greenhouse gas emissions output and the cash value per tonne of CO_2 from TAG Databook A3.4.

The cash value of carbon per tonne of CO2 was taken as an average from the central values in TAGA3.4 for the years relevant to the appraisal period (2021 to 2040). This is equivalent to £85.85 per tonne of CO_2.

Table 68 Carbon impact analysis – all scenarios

Most Advantageous & Attractive - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£291.09	3,390.73
Uplift Tool	£166.58	1,940.39

Most Advantageous & Attractive - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£97.37	1,134.24
Uplift Tool	£57.60	670.99

Next Preferred - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£230.09	2,680.16
Uplift Tool	£143.44	1,670.80

Next Preferred - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£90.91	1,058.90
Uplift Tool	£108.31	1,261.67

Low Cost/Quickest to Deliver - Queensbury Tunnel Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£155.77	1,814.41
Uplift Tool	£117.88	1,373.16

Low Cost/Quickest to Deliver - Alpine Option Scenarios	Greenhouse gas (AMAT - in £'000s)	Tonnes of CO2e
Case Studies	£63.70	741.95
Uplift Tool	£80.72	940.20