



Lucy's Mill Bridge: Feasibility Study

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1. Executive Summary

Copperleaf™ Technologies Inc (CLT) responded to a call to get involved in a pro bono accessibility project from the **Operational Research Society** on behalf of the **Friends of Lucy's Mill Bridge (FoLMB)**, a Community Interest Company (CIC) who have been advocating for Lucy's Mill Bridge in Stratford-upon-Avon to be made accessible for both residents and tourists for some time.

Lucy's Mill Bridge is a popular footbridge dating from Shakespearian times which is currently only accessible by steep steps on each side. The bridge is part of a 1.6km Riverside Heritage Trail along the banks of the River Avon. This takes in some of Stratford-upon-Avon's key tourist attractions such as Holy Trinity Church which houses the grave of Shakespeare and his wife Anne Hathaway, as well as the Royal Shakespeare Theatre. It also links with the Historic Spine Trail, on which can be found Shakespeare's school and birthplace. It is a vital link to the town centre for residents of Stratford-upon-Avon however, the bridge is inaccessible to wheelchair users and those with mobility difficulties; families and parents with pushchairs; and cyclists.

The primary aim of the project was to determine whether it is commercially and economically viable to make Lucy's Mill Bridge accessible to all users; or provide a new bridge which will meet the same aim. Four alternative investments were analysed over a 50-year period to 2070:

Investment alternative	Description
1: Do nothing	Do nothing, i.e. everything remains as is. <i>This will provide a baseline against which to measure the other investment alternatives.</i>
2: Access ramps	Addition of Disability Discrimination Act (DDA) compliant accessibility ramps to the existing Lucy's Mill Bridge structure.
3: Access ramps and refurbishment	Addition of DDA compliant accessibility ramps to the existing Lucy's Mill Bridge structure and aesthetic refurbishment of the bridge.
4: New DDA compliant bridge	Construction of a new DDA compliant bridge in addition to Lucy's Mill Bridge.

Table 1 Investment alternatives

A holistic Cost Benefit Analysis (CBA) was carried out to determine the value of each investment alternative. The measures of value were the same across all four alternatives and assessed changes in levels of economic performance; reduced risk of premature death; reduction in accidents and absenteeism from work; journey quality and reduction in congestion for the local Stratford-upon-Avon community due to changes in the underlying levels of accessibility. This study has been made publicly available through the Friends of Lucy's Mill Bridge website.

This accessibility investment would make a significant initial step forwards toward making Stratford-upon-Avon an inclusive and accessible town for both its community and tourists. The CBA analysis shows that there is both a social and economic business case for providing accessibility to Lucy's Mill bridge. Even though the investment has been assessed as a standalone accessibility improvement and not as part of a wider accessibility or transport development strategy, it is still forecast that the investment would provide access for an additional 6.3 million user trips across the bridge over the 48 years to 2070, including a quarter of a million additional mobility user trips.

An accessibility investment to Lucy's Mill bridge, based on accessibility, health and environmental alone is forecast to deliver benefits **1.5 to 2.7 times** that of the costs that would be required to deliver it is based on the 50-year measurement period. The investment is expected to start paying back after **13 to 15 years**. This can be thought about as a pair of balance scales. Payback is the point in time from the initiation of the investment at which the

value of the benefits outweighs the value of the costs and the scales are tipped such that in effect a profit is being realised.

When economic impact to the surrounding area is also considered, the accessibility investment is forecast to deliver benefits of between **34 and 36 times** that of the costs that would be required to deliver it, with the investment expected to payback and effective profit after **1 year**.

The New DDA bridge investment alternative has a lower multiple of benefits to cost and a longer time to deliver an effective profit, as would be expected due to higher Capital costs, but nevertheless still delivers accessibility, inclusion and economic benefit.

Conclusion

The analysis shows that there are clear benefits for national and or regional strategies to implement an accessibility investment in respect of Lucy's Mill Bridge via traditional methods or through consideration of newer and emerging innovative funding and delivery partnership solutions.

Copperleaf's guidance is that the investment alternative 'Lucy's Mill Bridge with Access Ramps and Aesthetic Refurbishment' would be the preferred option. This combines good cost benefit results measured for accessibility, health; and economic benefits, coupled with the qualitative factors related to heritage, public opinion and potential flooding risk. Most importantly it would provide an accessible and attractive key link on a waterway leisure and utility route for both tourists and residents in a key area of the town of Stratford-upon-Avon.

2. Introduction and Background

Copperleaf™ Technologies Inc (CLT) responded to a call to get involved in a pro bono accessibility project from the Operational Research Society on behalf of the Friends of Lucy's Mill Bridge (FoLMB), who are a Community Interest Company (CIC) who have been advocating for Lucy's Mill Bridge in Stratford-upon-Avon to be made accessible for both residents and tourists for some time.

There have been a number of historic feasibility studies carried out and FoLMB have been continually trying to engage with Town, District and County councils as well as community and tourist stakeholder groups. They have carried out bridge count surveys and commissioned architectural design drawings of accessibility ramps, as well as engaging the public through their website and the local press, such as the Stratford Herald.

However, progress has not been forthcoming for them or the community and this project was initiated in order to have consultants professionally assess the investment from an independent and holistic asset management perspective, with the view that the report is made publicly available.

2.1 Accessibility

2.1.1 What is accessibility?

The primary subject of this project is accessibility, the current lack of it at Lucy's Mill Bridge; and what value providing it will bring. When talking about value, over the coming pages it will be seen that value comes in many forms and is provided to different stakeholders. When assessing the value of providing accessibility, Copperleaf have engaged stakeholder groups to assess elements of health, accessibility, environmental, safety and economic benefits to residents and the local community of Stratford-upon-Avon.

Before introducing the project scope fully, it is important to gain an important understanding of what Accessibility means.

“Accessibility usually embodies the special needs of a specific group, such as persons with disabilities. Accessibility is a precondition for an inclusive society for all; and may be defined as the provision of flexibility to accommodate each user's needs and preferences.

[The United Nations] proposes that accessibility be not only a means and a goal of inclusive development but also an enabler of an improved, participative economic and social environment for all members of society.” ^[1]

2.1.2 Why is accessibility important?

The 2030 Agenda for Sustainable Development was a framework adopted by all United Nations Member States in 2015. This provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. It is underpinned by 17 Sustainability Development Goals (SDGs) and these are increasingly being adopted by industry. SDG number 10 is 'Reduce inequalities within and among countries'.^[2]



Figure 1 - UN SDG 10 ^[2]

Unfortunately, there are still many people within society who are marginalised and isolated because of various forms of disability owing to much of our infrastructure, transport and buildings being designed primarily with able bodied persons in mind. The statement from the United Nations paper above captures excellently why it is not only the imperatively correct moral action for society and businesses to redress this balance but that it is a sound decision from an economic and social perspective.

The Purple Pound refers to the spending power of disabled households and is estimated to be worth £249 billion per year in the UK alone, indicating there are excellent commercial business opportunities in respect of disabled people that are going untapped because of issues including lack of, or poor, accessibility. There is some way to go to develop UK infrastructure and systems to improve accessibility which impacts the world of those who currently struggle with access on a daily basis, and to capitalise on the related benefits. It is noted that this project is a very small contribution to much wider opportunities in UK infrastructure that can benefit from advancement and connectivity therefore, this project has been valued in terms of accessibility independently and on its own individual merits. ^[3]

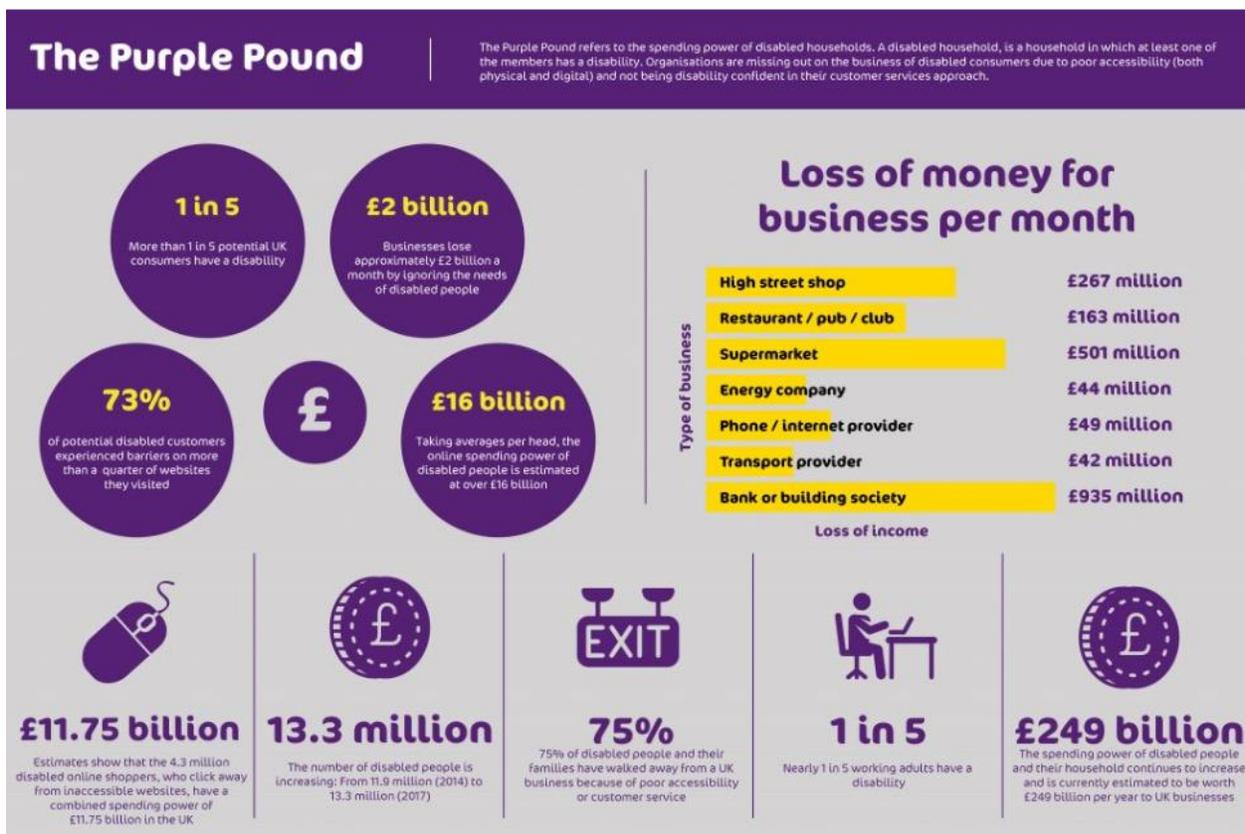


Figure 2 - The Purple Pound Infographic [3]

Additionally, there is a less transparent yet equally important inequality around gender. Although increasing accessibility in respect of pushchair users is likely to impact both men and women (families), it is likely to have a more significant impact on women. Research has shown that men and women's daily travel patterns are different. Whilst men more often make a single journey to work and back in the car, women tend to make more journeys (which are shorter in nature) in order to carry out daily activities. This can include taking children to school, going to work, grocery shopping, etc; and more often than men this involves the use of public transport or walking. This disparity between men and women has been observed across Europe and is more acutely pronounced in families with young children. The result of this is that accessibility issues on walking routes disproportionately and negatively impact women which is out of line with SDG 10's aim of reducing inequalities. [4] [5]

2.2 Introducing the Project

Lucy's Mill Bridge is a popular footbridge dating from Shakespearian times which is currently only accessible by steep steps on each side. The bridge is part of a 1.6km Riverside Heritage Trail (Figure 3) along the banks of the River Avon. This takes in some of Stratford-upon-Avon's key tourist attractions such as Holy Trinity Church (Figure 3, Point 11) which houses the grave of Shakespeare and his wife Anne Hathaway, as well as the Royal Shakespeare Theatre (Figure 3, Point 14). It also links with the Historic Spine Trail, on which can be found Shakespeare's school and birthplace.

It is a vital link to the town centre for residents of Stratford-upon-Avon however, the bridge (Figure 3, Point 10) is inaccessible to wheelchair users and those with mobility difficulties; families and parents with pushchairs; and cyclists.



Figure 3 - Riverside Heritage Trail

The need for an augmented or additional river crossing in Stratford-upon-Avon was identified within the Stratford-upon-Avon District Local Development Framework over a decade ago.

“The majority of visitors experience Stratford as pedestrians and the focus must be set on easy accessibility to key destinations. Currently, the accessibility of Holy Trinity Church is limited and poorly defined, with the majority of visitors entering the town at the Bridgeway area and then walking along Waterside.

The potential for a new pedestrian and cycle bridge across the Avon just to the south of the existing foot ferry is seen as a positive move. The bridge would be strategically important in improving the level of pedestrian/cycle connection and permeability between the east and west banks of the Avon. Currently this movement is concentrated at the Tramway bridge. The proposed bridge would provide traffic-free pedestrian and cycle access for work, education, shopping and leisure trips into the town for residents south of the River Avon.

A new bridge would increase the route options for visitors parked at the Recreation Ground, providing a more direct connection to the Courtyard Theatre and Holy Trinity Church. A new bridge would create a circular route encouraging visitors and residents alike to explore and enjoy the gardens and open spaces on both sides of the Avon to the south of the Royal Shakespeare Theatre. The bridge would also provide an even wider circular route

allowing visitors to pass through the town centre via the Old Town and Church Street. It is considered that the bridge would have significant benefits for residents and visitors in increasing accessibility to the southern part of the town.

Given the sensitive location, the design of the bridge would need to respect the vistas of the Church and complement the overall environment and setting of the River Avon. Further to the south of the town is Lucy's Mill Bridge directly adjacent to the Seven Meadows road crossing of the Avon. This existing bridge currently provides poor access for disabled people and those with pushchairs. It will continue to be an important part of the town's walking network but as part of a more rural recreational route." [6]

Excerpt from Stratford-on-Avon District Local Development Framework Urban Design Framework for Stratford-upon-Avon, July 2007 (p.41)

2.3 Aim and Objectives

The primary aim of the project is to determine whether it is commercially and economically viable to make Lucy's Mill Bridge accessible to all users; or provide a new bridge which will meet the same aim.

The objectives of the project in order to facilitate the aim are to:

- Determine the key value drivers associated with the project, e.g. benefits associated with economic performance, journey quality and congestion.
- Determine the key costs associated with the project.
- Carry out a holistic cost benefit analysis (CBA) on the provision of an accessible bridge over the River Avon at or near the current location of Lucy's Mill Bridge.
- Assess the economic value of each investment alternative against the baseline of the current 'Do Nothing' approach, to inform future decision making around investment in Lucy's Mill Bridge
- Set out a comparison of the Investment Alternative CBA results with comments.
- List recommendations and further actions.

This feasibility report will not seek to:

- Compare the Investment Alternatives in this report with other external transport schemes.

The investment options that have been considered within the study are detailed in Table 2:

Investment alternative	Description
1: Do nothing	Do nothing, i.e. everything remains as is. <i>This will provide a baseline against which to measure the other investment alternatives.</i>
2: Access ramps	Addition of Disability Discrimination Act (DDA) compliant accessibility ramps to the existing Lucy's Mill Bridge structure.
3: Access ramps and refurbishment	Addition of DDA compliant accessibility ramps to the existing Lucy's Mill Bridge structure and aesthetic refurbishment of the bridge.
4: New DDA compliant bridge	Construction of a new DDA compliant bridge in addition to Lucy's Mill Bridge.

Table 2 - Investment Options

2.4 Approach

An initial site visit was undertaken to become familiar with the area of Stratford-upon-Avon, Lucy's Mill Bridge and its location, as well as take measurements of some of the key features of the bridge.

Following the site visit, a desk top study was carried out including research, data collection and data analysis in the following areas:

- Historic feasibility studies of investment options for Lucy's Mill Bridge;
- Similar industry feasibility studies;
- Population and demographics in the East Midlands, Warwickshire, Stratford-on-Avon District and Stratford-upon-Avon Town;
- Future development in Stratford-upon-Avon which may impact tourism and growth;
- Bridge count surveys;
- Legislation and standards including the Equality Act (2010), Disability and Discrimination Act (1995), Inclusive Mobility, Highways Design Manual for Roads and Bridges.

Material used within this desk top study is referenced in the relevant sections of this report, a full list of references can be found in Section 14.

3. Copperleaf

Copperleaf provides decision analytics to companies managing critical infrastructure. Our enterprise software solution leverages operational and financial data to help our clients make investment decisions that deliver the highest business value. Our software is currently helping manage over \$860B of infrastructure investment globally.

Copperleaf’s software solution is focused on evaluating investments such as the investment options of The Friends of Lucy’s Bridge project. It has a **Value Framework** which allows monetary and non-monetary benefits to be evaluated, as well as known data and elicited (expert judgement) values to be evaluated where data is not available. A CBA of four investment alternatives over a measurement period of 50-years to 2070 has been assessed for Lucy’s Mill Bridge using its **Value Measures** and **Value Models**.

3.1 Copperleaf RAD and Pro Bono Projects

Copperleaf RAD (“Random Acts of Delight!”) is an initiative which enables Copperleaf employees to become involved in supporting causes which are important to them. Any Copperleaf employee can suggest a charitable activity and form a team with colleagues who feel that they can make a difference. It is a fun way to support and give back to local communities and motivate our people to get involved in positive change. Over the years, we have supported the BC SPCA, WaterAid (in conjunction with Anglian Water), children’s charities and more.



Figure 2 – Members of the Copperleaf Europe Team

After a 3-month review of the charitable sector, it became clear that many charitable organizations struggle with how to make the optimal use of their available funds. They simply do not have an easy way to determine where to spend their donations to achieve maximum impact. Therefore, the Copperleaf Team in Europe decided to use their professional skills to collaborate pro bono with charity partners to develop a Copperleaf Value Framework. The team will also be inviting our charity partners to join our Copperleaf Community which will enable them to exchange best practices across industries and sectors. To learn more about Copperleaf’s pro bono offering, please read this blog: <https://www.copperleaf.com/articles/european-rad-initiative/>

4. Context

4.1 History

The original Lucy's Mill bridge was built in 1590 and was a wooden structure supported by stone piers, Figure 4. Two of the bridge's piers were destroyed by a flood in 1867 and the bridge was rebuilt. In 1937, the wooden bridge was replaced by the existing art deco bridge of reinforced concrete, to match the art deco of the Shakespeare Memorial Theatre which opened two years previously. However, some of the historic bridge piers remain and can still be seen today.



Figure 4 - Lucy's Mill Bridge c.1590

4.2 Existing Lucy's Mill Bridge Structure

The existing bridge is 40m long, with three spans supported by two piers situated within the River Avon and two abutments on the riverbanks. The deck has steel beams encased in concrete, with steel parapets that are 1.15m high.

The deck is 1.5m wide between the parapets and is 37.0 above ordnance datum (AOD); with the ground level footways 34.5 AOD. Access to the deck is currently via steep stepped access at both sides: 14 steps, split 9 and 5 with an intermediate landing (North side); and 15 steps single flight (South side). The steps vary between 15.5cm to 17cm in height.

4.3 Ownership and Required Engagement

The bridge is currently owned by Warwickshire County Council (WCC) who are responsible for the maintenance, capital works and asset management planning in respect of the bridge. The Planning Authority is Stratford District Council (SDC).

The Avon Navigation is managed by the Avon Navigation Trust; and the Environment Agency are the Environmental Regulator.

Stakeholders that have been engaged during the course of the project are detailed in Table 3.

Description	Engaged	Comment
Warwickshire County Council	No - See comments	WCC representatives were invited to participate in a Stakeholder workshop on 5 November 2019 to be introduced to progress on the study and feedback on key inputs. Unfortunately, no formal representative was present. WCC were approached for input on asset management costs and data on Lucy's Mill Bridge via Council representatives, unfortunately Copperleaf received no response.
Stratford District Council	Yes	Participated in Stakeholder workshop on 5 November 2019. Provided visibility of initial view of Value Measures with initial discussions around funding position and aims of the project.
Public Engagement	Yes	The Public have been engaged about accessibility options for Lucy's Mill Bridge through the FoLMB website, FoLMB Facebook and Stratford Herald articles. The Public have also previously engaged about the construction of a new bridge in 2006 ^[7] .
Environment Agency	Ongoing	Engagement with the EA is ongoing via Avon Navigation Trust (ANT).
Avon Navigation Trust	Yes	Participated in Stakeholder workshop on 5 November 2019. Provided visibility of initial view of Value Measures with initial discussions around funding position and aims of the project. Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Friends of Lucy's Mill Bridge	Yes	Participated in Stakeholder workshop on 5 November 2019. Provided visibility of initial view of Value Measures with initial discussions around funding position and aims of the project. Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Accessible Stratford-upon-Avon	Yes	Participated in Stakeholder workshop on 5 November 2019. Provided visibility of initial view of Value Measures with initial discussions around funding position and aims of the project. Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Stratford Society	Yes	Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Holy Trinity Church	Yes	Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Stratford Business Forum	Yes	Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Adjoining Landowners	No	Proposed alternatives will mitigate any impact on adjoining landowners. However, potential engagement / consent may be required at planning consent stage.
Royal Shakespeare Company	Yes	Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Stratford Town Trust	Yes	Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Shakespeare's England	Yes	Participated in Stakeholder Engagement workshop on 11 February 2020, providing feedback on value measures including data sources and assumptions.
Sustrans	Yes	Participated in Stakeholder workshop on 5 November 2019. Provided visibility of initial view of Value Measures with initial discussions around funding position and aims of the project. Unable to attend Stakeholder Engagement workshop on 11 February 2020.
Canal & Rivers Trust	Yes	Contacted for advice on cost data for aesthetic refurbishment of Lucy's Mill Bridge – referred to specialist river contractors: Kier.
Kier	Yes	Contacted for advice on cost data for aesthetic refurbishment of Lucy's Mill Bridge. Provided indicative cost quote for the purposes of the study.

Table 3 - Stakeholder Engagement

4.4 Location

The bridge is part of a 1.6km Riverside Heritage Trail along the banks of the River Avon. This takes in some of Stratford-upon-Avon's key tourist attractions such as Holy Trinity Church which houses the grave of Shakespeare and his wife Anne Hathaway, as well as the Royal Shakespeare Theatre. It also links with the Historic Spine Trail, on which Shakespeare's school and birthplace can be found.

Lucy's Mill Bridge also offers a key link to Stratford-upon-Avon town centre for the eastern residential area of the town. Plans to build a new Marina will also increase tourism to the south east of Stratford and south side of the bridge, increasing the number of people likely to be crossing the bridge to enter the town centre and tourism destinations. Increase in bridge demand owing to the new Marina has been considered in this analysis given anticipated number of berths (250) and associated tourism data.

There is a recreation ground to the east of the river which is on the south side of the bridge. An athletics stadium with fitness centre is currently under proposal which would be situated in the north east of the recreation ground. If this goes ahead, this could also potentially increase the number of people cycling and walking to and from this facility using Lucy's Mill bridge in the future. Increase in demand due to the athletics stadium has *not* been included in the analysis due to lack of data to inform robust analysis.

There are a number of cycle routes, traffic free paths and greenways either side of Lucy's Mill Bridge, highlighted in Figure 5. It is noted that currently no cycling is officially permitted within the recreation ground as these paths are currently designated as footpaths. However, many people have been observed to cycle across the recreation ground and use Lucy's Mill Bridge as a crossing point, albeit with the difficulty of carrying bikes up and down the stepped access.

Another common route for cyclists to cross the river is the Tramway Bridge which is pedestrianised. This can be extremely busy during weekends and times of high tourism. The other alternative crossings in the vicinity are the road bridges Clopton Bridge, adjacent to the Tramway Bridge; and the Seven Meadows Bridge, adjacent to Lucy's Mill Bridge. Both are extremely busy with vehicular traffic. The Seven Meadows Bridge whilst adjacent to Lucy's Mill Bridge is remote from the Riverside path and has no footpath.

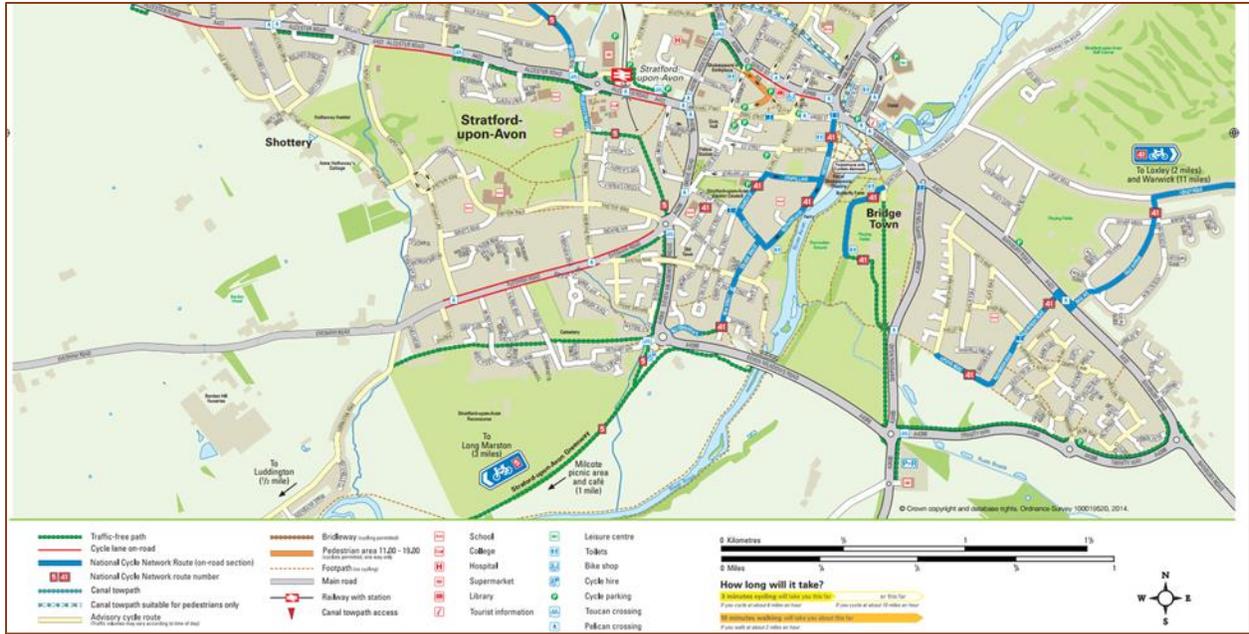


Figure 5 - Cycle network, traffic free paths, Greenway and footpaths in locality of Lucy's Mill Bridge [8]

4.5 Flood Risk

Stratford-upon-Avon and in particular the area around Lucy's Mill Bridge are at Medium / High risk of Flooding according to the UK's Long-Term UK Flood Risk Map, Figure 6. [9]

High risk means that each year this area has a chance of flooding of greater than 3.3%, taking into account the defences in the area. Medium risk means each year the area has a chance of flooding of between 1% and 3.3%.

Current and future flood risk levels will be a key consideration when considering options relating to the construction of new structures, or alterations to existing structures which may have an adverse impact on the local water table or flood plain. For this reason, engagement should be sought with both the Environment Agency and the Avon Navigation Trust in respect of the options under consideration. This project assumes no significant impact will be made by any of the investment alternatives, with the access ramps of Investment Alternative 2 and Investment Alternative 3 being placed outside of the riverbed and the potential new DDA bridge in Investment Alternative 4 completely spanning the river. However, given the extent of the flood risk potential in the area, it is recommended that the advice of the Environment Agency is sought prior to any final decision being made and the design stage entered.

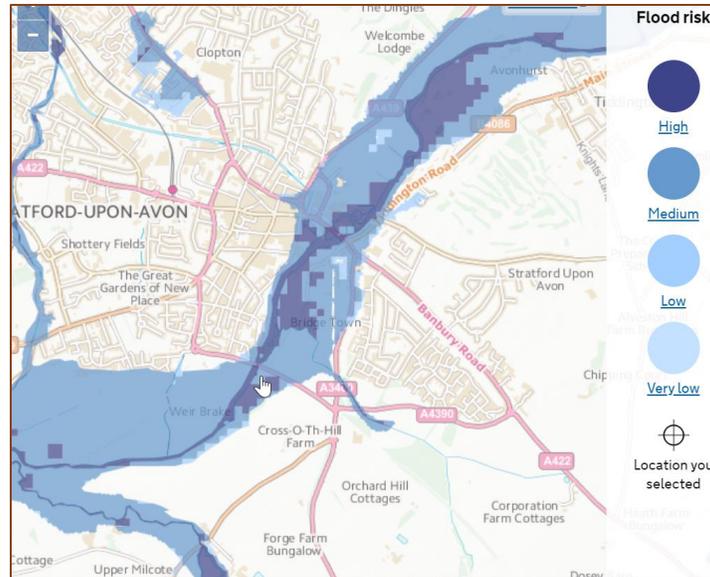


Figure 6 -UK Long Term Flood Risk Map, Stratford-upon-Avon Area [9]

4.6 Population Statistics

Population statistics for Stratford-upon-Avon are set out in Table 4.

Description	Number / %
Population of Stratford-upon-Avon, Total (extrapolated to 2017)	29,025
Population of Stratford-upon-Avon 65 years or older (2017)	6,204
Population of Stratford-upon-Avon aged 0-4 years old (2017)	1,519

Table 4 - Population statistics, Stratford-upon-Avon (extrapolated to 2017 from Census data) [10] [11]

Initially residential growth was set to be 0.98% per year for every year during the CBA measurement period. The 0.98%pa growth rate was calculated from census survey data differentials. However, this growth rate was challenged as being high in the Stakeholder Engagement workshop.

The residential growth rate was revised following stakeholder engagement to be 1.66% per year from 2011 to 2031. This was calculated based on population and housing development forecast data for Stratford-upon-Avon from the Stratford-on-Avon District Core Strategy. It has been assumed that the population will remain stable from 2031 onwards and so the residential growth rate will be 0% per year from 2031 onwards. Full calculations can be found in Appendix IV. [12]

4.7 Tourism Statistics

The key figures in Figure 7 have been taken from the Economic Impact of Tourism, Stratford Town (2016) ^[13]:

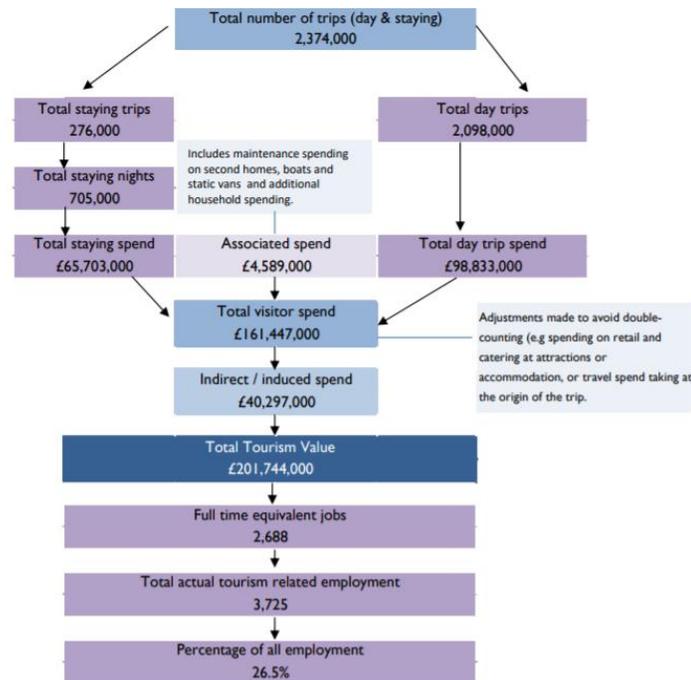


Figure 7 - Economic Impact of Tourism, Stratford Town (2016) ^[13]

The three key surveys used to measure volume and expenditure from tourism trips are the GB Tourism Survey (for domestic overnight trips), the International Passenger Survey (IPS) for visits from overseas, and the GB Day Visitor Survey (GBDVS), which measures tourism day visits. Table 5 and Table 6 show a summary of the key tourism data that will be used to measure value within the project.

Description	Number days spent in Stratford-upon-Avon per year (2016)	Number days spent in Stratford-upon-Avon per year (2017 extrapolated)
Overnight Trips	276,000	286,488
Additional Overnight Trips for 250 Marina Berths (no. of nights)	N/A	**247,793
Daytime Trips	*2,098,000	2,098,000
Total Overnight (no. of nights)	N/A	1,000,028

* Economic Impact Report 2016 shows slight decrease of -0.7% from 2015 to 2016. As we will project for 50 years and only have data for 2 years, this has been assumed to be a flat profile ^[13]

**170 berths in 2009 Economic Impact Assessment for Stratford --> 19,000 Overnight Trips (boat moorings) p.7. 1,198,000 overnight trips --> 6,324,000 days. Then ratio applied to account for increase by 250 berths for the new Marina. ^[14]

Table 5 - Annual overnight and daily trips to Stratford-on-Avon ^[13] ^[14]

Spend	2016 spend (£)	2017 spend (£) allowing for inflation
Per Day	47.11	48.33
Per Overnight Trip (per night)	93.20	95.62

Table 6 - Spend data for trips to Stratford-on-Avon ^[13]

Initially, Tourism growth rates of 6.7%pa for overnight tourist trips and 0%pa for day tourist trips were used in analysis over the 50 years to 2070. These were taken from the Economic Impact Report of Tourism, Stratford Town (2016). However, during Stakeholder Engagement workshops these rates were discussed as being high and unrepresentative of long-term year on year tourism growth rates given the tourism strategy for the area. Tourist and community group representatives noted that there are targets to grow tourism in focussed ways but also in balance with keeping Stratford-upon-Avon the small market town that draws tourists in the first place. It was therefore decided that to model a scenario with a tourist growth assumption of 0% would be reasonable given the long-term measurement period of 50 years.

The weighted average spend per day across night and day tourists at 2017 is £63.59. This will be discussed further in Section 9.8 on Economic Performance.

It was also initially assumed that tourism spend growth would be as detailed in the Economic Impact Report of Tourism, Stratford Town. However, given the above discussion on tourism growth, it was deemed more appropriate that tourism spend should be grown with inflation. This has been assumed to be an annual rate of 2.6%pa for 2017, 2.3%pa for 2018 and 1.7%pa for 2019 and onwards, based on Office for National Statistics, Consumer Price Indices, CPIH. ^[15]

4.8 Disability Population

Key information has been taken from Sport England’s: Mapping Disability Report ^[16], including:

- Out of England’s population of 53 million, 18.4 million or 34.9% have a long-standing disability or illness, of which 9.4 million or 17.6% have a long standing and *limiting* disability or illness.
 - A long-standing disability or illness is defined to be anything that is, or is likely to be, experienced over a long period of time (12 months+).
 - A long-standing and limiting disability or illness is defined to be impairments or health problems that limit or restrict activities in any way, in different areas of life. It should always be considered long-standing.
- Overall, there is a slightly higher proportion of disabled females than males in the population 55.4% to 44.4%.
- 10% of disabled people experience visual impairment (50% of these also experience mobility issues).
- 5-7% of disabled population estimated to be wheelchair users.
- 36% of disabled people have mobility issues.
- 12% have breathing problems.
- Proportion of disabled people in East Midlands 18.6%. ^[16]

Applying the above information to the population of Stratford-upon-Avon in Table 4, the populations of categories of disabled persons in Stratford-upon-Avon which are pertinent to bridge accessibility in Table 7 can be derived.

Category Description	Category Accessibility Assumption	Number	Calculation
Population of Stratford-upon-Avon	N/A	29,025	(see Section 4.6)
Disabled people in Stratford-upon-Avon (see East Midlands)	N/A	5,399	29,025 x 18.6%
Wheelchair users	Can't cross Lucy's Mill Bridge currently	324	*6% x 5,399
Visually impaired	Can't cross Lucy's Mill Bridge currently**	540	10% x 5,399
Mobility issues (no double counting)	Can't cross Lucy's Mill Bridge currently	1,350	(36% - 6% - 5%) x 5,399

*The average of the 5-7% range from the Sport England Report has been assumed

**assumes visually impaired can't cross or would find alternative route currently due to steep steps, but would be able to / want to cross with access ramps

Table 7 - Derivation of disabled populations relevant to bridge crossing accessibility

5. Previous Feasibility Studies

5.1 Historic Lucy's Mill Bridge Feasibility Studies

There have been two historic feasibility studies carried out in November 2006 and March 2008, which considered options to refurbish or replace Lucy's Mill Bridge. These were deemed to be unfeasible by Warwickshire County Council (WCC), the current owners of the bridge, due to key issues such as requiring the purchase of private land; or key technical constraints. ^{[17] [18]}

5.2 Historic New Bridge Proposals, 2006

In 2006, proposals and designs for a new bridge in-between the Tramway Bridge and Lucy's Mill Bridge were asked for and public opinion surveys were conducted. In minutes of a meeting held on 8 December 2006, Stratford District Council further recorded:

"Consideration was given to the proposed pedestrian/cycle bridge project in the light of the outcome of the consultation exercise undertaken by the Warwickshire County Council (WCC). In considering this item, the Executive had before it the Minutes of the meeting of the Avon Area Community Committee held on 30 November 2006 where the following recommendation was agreed: -

Following the public consultation, it is evident that a significant number of respondents are not in favour of a pedestrian/cycle bridge across the Avon, as presently suggested. This Committee resolves not to give any support to the development of the suggested scheme. Further, this Committee requests that the District Council urges Warwickshire County Council to consider upgrading the present bridge at Lucy's Mill to meet the needs of all." ^[2]

Opposition of the 2006 new bridge scheme was largely due to negative public opinion around location and the protection of the views of Holy Trinity Church and the historic river setting, which lies between the Tramway Bridge and Lucy's Mill Bridge. It is clear that given the heritage and tourism status of Stratford-upon-Avon that impact on the public, public perception and impact on the tourism trade is paramount:

"This Council [SDC] believes that the opinion of local residents should be the deciding factor when a decision on a possible new bridge across the Avon, in Stratford, is taken.

Should the opinion of local residents be in doubt, a referendum or a poll of local residents.....[should be held]" ^[7]

5.3 Making Lucy's Mill Bridge Accessible, 2008

Warwickshire County Council's response to the Hawkes Edwards architectural concept sketches of proposed access ramps adjoining to the existing Lucy's Mill Bridge structure in previous feasibility studies noted that this option had looked to address many of the constraints associated with renovating the bridge in the above historic feasibility studies. However, WCC also commented that there was still restriction of Capital funds and they required to see more in the way of whole life cost (WLC) holistic cost benefit analysis, including growth projections and comparison against other transport projects. This feasibility assessment seeks to provide a holistic cost benefit analysis, however comparison against other transport projects is outside of scope for this project. ^[18]

6. Cost Benefit Analysis

Within this independent feasibility study carried out by Copperleaf, four investment alternatives, including a ‘Do Nothing’ alternative will be analysed over a 50-year period to 2070. A holistic cost benefit analysis will be carried out to determine the value of each investment alternative. The measures of value (Table 10) will be the same across all four alternatives and will consider aspects of improvements in Economic Performance, Journey Quality, Accident, Absenteeism, Reduction in Risk of Premature Death and Congestion for the local community.

A measurement period of 50-years for investment in a structure such as a bridge or transport network is best practice to fully account for the benefits the upfront Capital investment in such an asset will bring throughout the course of its lifetime. Discounted payback period will be presented for each investment alternative. Further discussion on this can be found in Section 11.

Comparison with other external transport projects will not form part of the project, but this feasibility study will be publicly available to stakeholders to allow them to complete this analysis.

6.1 Investment Alternative Options

A reminder of the investment options that have been considered within the study are shown in Table 8.

Investment alternative	Description
1: Do nothing	Do nothing, i.e. everything remains as is. <i>This will provide a baseline against which to measure the other investment alternatives.</i>
2: Access ramps	Addition of Disability Discrimination Act (DDA) compliant accessibility ramps to the existing Lucy’s Mill Bridge structure.
3: Access ramps and refurbishment	Addition of DDA compliant accessibility ramps to the existing Lucy’s Mill Bridge structure and aesthetic refurbishment of the bridge.
4: New DDA compliant bridge	Construction of a new DDA compliant bridge in addition to Lucy’s Mill Bridge.

Table 8 - Investment Alternatives

One of the alternatives in this feasibility assessment considers the building of a new, fully compliant DDA bridge. This is to act as a comparator against the two alternatives which include adding access ramps to Lucy’s Mill Bridge.

There are two points of note here:

1. Whilst the access ramps to Lucy’s Mill Bridge will be fully DDA compliant, the deck of the existing bridge will not be, as it is a heritage asset. In order to make the deck width and parapet height DDA compliant, significant structural work would be required, including to the bridge piers. As well as impacting a bridge which is seen as a heritage asset, this would also affect the bridge’s footing in the river and therefore also its impact on the floodplain, all of which is undesirable.
Therefore, the investment alternatives to Lucy’s Mill Bridge will be carried out assuming that the bridge deck width and parapet height remain as they are.

The primary reasons for Lucy’s Mill Bridge structure, namely the bridge deck width not achieving full DDA compliance is due to the bridge being a heritage asset coupled with safeguarding flood risk in the area in respect of local residents, the heritage trail and tourism impact. Therefore, as the decision to not widen Lucy’s Mill Bridge is not driven by cost or complexity, the Equality and DDA Act legislation is being applied as far as possible and with reasonability. Further details on legislation can be found in Appendix I. ^[19] ^[20]

- Proposal of an alternative which considers a new fully DDA compliant bridge is conceptual and included for CBA completeness. As there are no definitive plans for a new bridge at this time, costs have been inferred from similar projects and no location for this bridge has been specified.

Figure 8 shows the investment and investment alternatives configuration in Copperleaf's C55 software.

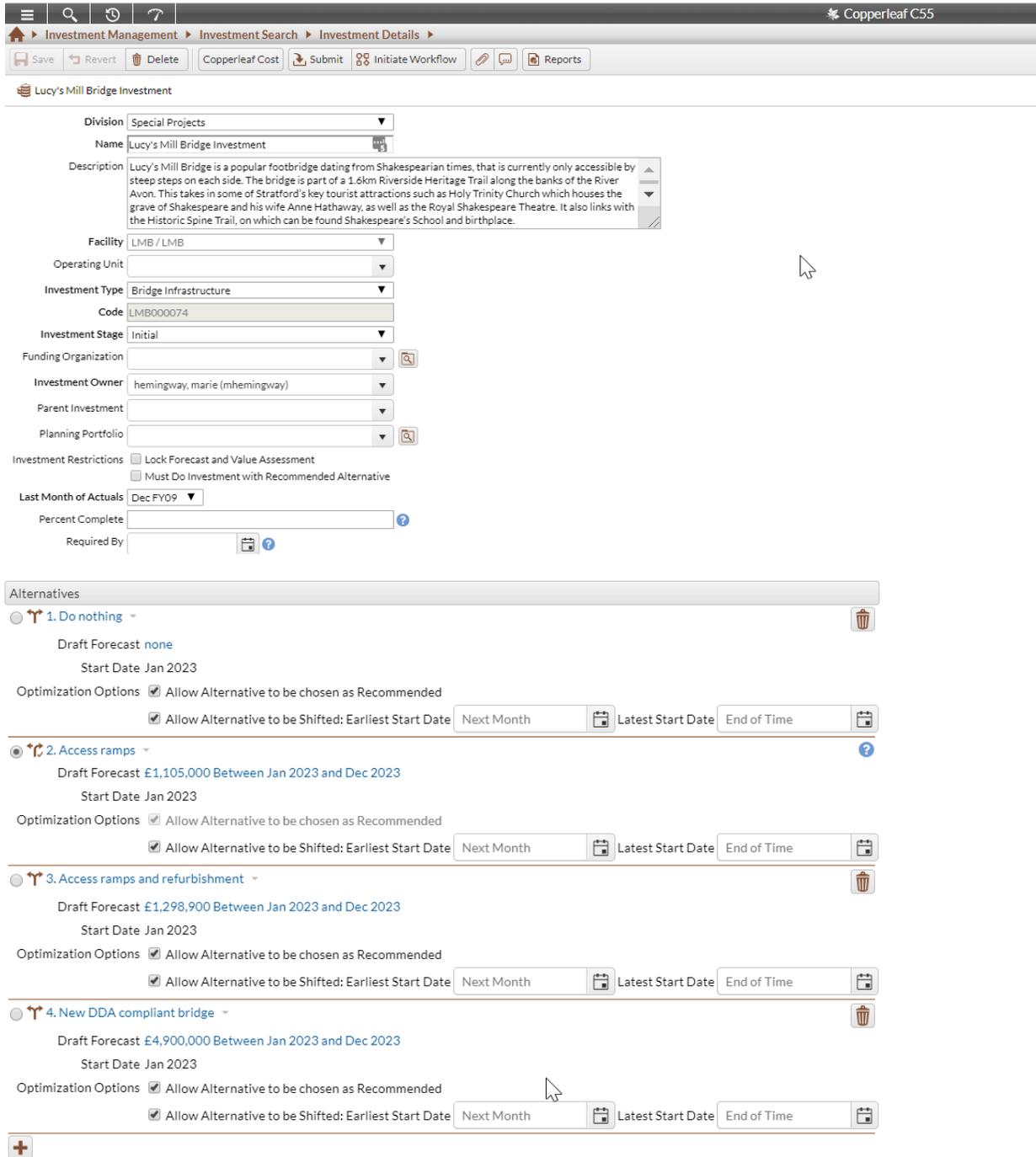


Figure 8 - Copperleaf C55 Investment and Investment Alternatives

7. Legislation

Throughout the project key aspects of legislation and regulation have been referred to, including:

- The Disability Discrimination Act 1995. ^[19]
- Highways Design Manual for Roads and Bridges; Part 8 – Design Criteria for Footbridges. ^[21]
- Transport Scotland: Roads for All. Good Practice Guide for Roads. ^[22]
- Inclusive Mobility, Department for Transport. A guide to best practice on improving access to public transport and creating a barrier-free pedestrian environment. ^[23]

For a full list of references, please see the Reference Section, Section 14.

8. Costs

This section details the costs associated with the investment alternatives: capital costs (CAPEX) and operational costs such as maintenance (OPEX). Therefore, taking a total expenditure (TOTEX) view as is best practice in asset management.

8.1 CAPEX Costs

The Capital Expenditure (CAPEX) costs of each of the investment alternatives are detailed in Table 9.

Capital costs details in Section 8.1.1 and Section 8.1.2 are based on singular quotes received and those in Section 8.1.3 on a desk study of feasibility studies of similar investments. Further details are provided within each section. Whilst these costs are representative for cost benefit analysis purposes, any investment taken forward should be taken forward to a competitive quotation and tender process and the costs detailed below should be viewed in this context.

8.1.1 Access Ramp Costs

A preliminary costing for the construction of Access Ramps adjoining to Lucy's Mill Bridge was provided by Faithful and Gould, Chartered Quantity Surveyors in November 2017, with specialist engineering elements have been discussed with bridge subcontractor, CTS Engineering. This initial cost estimation amounted to £841,160, excluding VAT and professional fees and that the width of the access ramps is 2 metres (see Appendix I, 12.1).^[30]

Investment Alternative date is assumed to be at 2023 for this feasibility study. Therefore bringing this cost estimate forward to 2023 with the national CPI index by applying the yearly increase rate of 2.3% for 2018, 1.7% for 2019 and assuming a rate of 1.7% for future years; as well as applying VAT of 20% indicates a cost estimation of c. £1,105,000 undiscounted for constructing Access Ramps in 2023.^[15]

8.1.2 Aesthetic Refurbishment Costs

Referred by the Canal & River Trust, the specialist contractor Kier have provided indicative costs for aesthetic refurbishment costs for Lucy's Mill Bridge. This includes specialist contractors, flotation equipment and welfare facilities. It has been assumed that works would be sequential to the construction of the access ramps and would be carried out in summer. The indicative cost quotation was provided in 2020 prices, Costs as at 2023 of £257,400 have been allowed for in the analysis based on the initial quote from Kier, allowing for additional rope work insurance costs of £1,000, annual CPIH inflation increases of 1.7%pa and VAT of 20%.^[31]

8.1.3 New DDA Compliant Bridge Cost Estimate

Research on similar projects has been carried out and the cost estimate for construction of a new DDA compliant bridge has been taken from WSP and Parsons Brinckerhoff's Walnut Footbridge Feasibility Options Report (May 2016). A cost estimate of £4.9 million has been assumed as this is the average of the three options selected in this report, weighted by span of bridge to be applicable to Lucy's Mill Bridge. This similarly captures national CPI index increases from the 2016 to the date of proposed investment, in 2023.^{[32] [15]}

Taking an average of these three options takes account of the uncertainty around different types of styles and materials of new bridges. It should also be noted that defining a location of the new bridge has not formed part of the scope of this feasibility assessment.

Option	Description	CAPEX Costs, incl VAT At 2023 undiscounted (£000s)	Assumed Timing of Cost
1: Do nothing	Do nothing, i.e. everything remains as is. <i>This will provide a baseline against which to measure the other investment alternatives.</i>	0	N/A
2: Access ramps	Addition of Disability Discrimination Act (DDA) compliant accessibility ramps to the existing Lucy's Mill Bridge structure.	1,105 ^[30]	2023
3: Access ramps and refurbishment	Addition of DDA compliant accessibility ramps to the existing Lucy's Mill Bridge structure and aesthetic refurbishment of the bridge.	1,362 ^{[30][31]}	2023
4: New DDA compliant bridge	Construction of a new DDA compliant bridge in addition to Lucy's Mill Bridge.	4,900 ^[32]	2023

Table 9 Investment Alternatives CAPEX Costs and Timing

8.2 Operational Costs (OPEX)

It is assumed that:

- Superficial / Cursory inspections will be carried out on a yearly basis.
- General / Visual inspections will be carried out on a bi-annual basis.
- Principal inspections will be carried out on a 6-yearly basis and may require river access or drone technology.

Operational costs account for maintenance and any interim refurbishment which may be required, the following activities and frequencies have been assumed:

- General maintenance – yearly drainage cleaning, graffiti removal etc.
- Steelwork / parapet painting – touching up every 10 years, full re-paint every 25 years.
- Replacement of waterproofing and surfacing, every say 25 years.
- Replacement of structural elements such as bearings, expansion joints etc, every say 50 years.

Taking this into account, maintenance costs have been accounted for on a yearly basis to the amount of c. £12,160 as at 2023 for a New Bridge, increasing each year in-line with CPIH. This has been determined from research of a similar feasibility study for a river spanning bridge, weighted by span of bridge to be applicable to Lucy's Mill Bridge. ^{[15], [32]}

Additional costs of c.£25,000 (2023 prices) have been allowed per activity that requires river access. This accounts for floating craft and rope insurance costs and has been taken indicative costs provided by Kier. All other costs including labour have been assumed to be included in the maintenance cost allowance above. ^[31]

8.2.1 How have maintenance costs been applied to each investment alternative?

It has been assumed that:

- The **New DDA bridge investment alternative** will incur maintenance costs of £12,160 per year starting at 2023. This has been increased yearly in-line with CPIH. Given this is a new bridge, an allowance of costs

for two instances of river access has been allowed for over the period to 2070. This has been amortised as yearly costs, starting as c.£1,320 in 2023 and increasing in-line with CPIH.

- The **Lucy's Mill Bridge Access Ramps investment alternative** will incur maintenance costs of 150% of the new bridge alternative as it is over 70 years since it was structurally rebuilt to its current form. As such, maintenance costs of c.£18,240 have been assumed in 2023 increasing yearly with CPIH. As the bridge is older, four instances of river access have been allowed for. This has been amortised as yearly costs, starting as c.£2,630 in 2023 and increasing in-line with CPIH.
- The **'Do Nothing' investment alternative** has been assumed to be the same as above, with a slight reduction in maintenance costs to 145% to account for the fact that there will be no access ramps to maintain.
- Carrying out refurbishment in 2023 as part of the **Lucy's Mill Access Ramps with Aesthetic Refurbishment investment alternative** will reduce future maintenance requirements as surface protection will be improved. Therefore, future maintenance has been lowered to 130% of that of the new bridge. There is also the opportunity for WCC to undertake structural refurbishment that may be required whilst river access is mobilised, so the number of instances requiring river access from 2024 to 2070 has been reduced to three in this case.

This results in maintenance costs of c.£15,810 have been assumed in 2023 increasing yearly with CPIH; and costs associated with river access costs starting as c.£1,970 in 2023 and increasing in-line with CPIH.

The regular costs of maintenance above have been based on the costs provided by Kier and a previous feasibility which are referenced at the appropriate points in the text. The assumptions for increases and decreases in maintenance costs are heuristic based on engineering and asset management experience and judgement.

9. Value Functions and Measures

9.1 Value Measure and Value Functions introduction

To value the costs and benefits over the next 50 years for each of the four investment alternatives, an appropriate and consistent set of measures for investment evaluation were determined and validated using the following approach:

1. Research was carried out on similar footbridge feasibility studies along with consideration of the particular context of Stratford-upon-Avon and the location of Lucy's Mill Bridge. This considered Stratford-upon-Avon as a tourist town; and Lucy's Mill Bridge location on a tourist trail, within a recreation ground which forms a strategic connection point between two halves of the town.
2. Stakeholder engagement was undertaken to test the validity of each of the Value Measures shortlisted as well as the derivation of their values. This included review of data sources, resultant values and projections, etc. Details of stakeholder engagement can be found in Section 4.3.

Where possible, Value Measures have been monetised using the UK Government databook: WebTAG. This provides all of the appraisal and modelling values referred to in the transport analysis guidance (TAG). ^{[24] [25] [26]}

The Value Measures considered for the appraisal of the investment alternatives within this feasibility study are shown in Table 10.

Value Measure	Value Model	Measure Type	Measure Description
Bridge Projected Demand Pedestrians	Bridge Demand	Count (intermediary VM)	Projected bridge demand over time for pedestrians.
Bridge Projected Demand Cyclists	Bridge Demand	Count (intermediary VM)	Projected bridge demand over time for cyclists.
Bridge Projected Demand Accessibility	Bridge Demand	Count (intermediary VM)	Projected bridge demand over time for those with accessibility issues.
Bridge Projected Demand Pushchairs	Bridge Demand	Count (intermediary VM)	Projected bridge demand over time for pushchairs.
CAPEX Costs	Investment Cost	Cost	Capital Investment Cost of investment alternative.
Risk of Premature Death	Health	Benefit	Impact of change in active travel on premature death (mortality), monetised.
Absenteeism	Health	Benefit	Impact of change in active travel on absenteeism, monetised.
Accident	Health	Benefit	Impact of change on reduction in casualties, monetised.
Journey Ambience	Journey Quality		Impact of change on journey quality, monetised.
Congestion	Mode Shift	Benefit	Impact of change on reduction in congestion, monetised.
Economic Performance	Economic Performance	Benefit	Impact of change in user demand on Economic Performance of Stratford-upon-Avon Community.

Table 10 - Value Measures

A **Value Function** is a combination of value measures used to measure the value of an investment alternative. During this feasibility study, Copperleaf have used two Value Functions:

1. An **Accessibility Value Function, shown in Figure 9.**

This includes the value measures: TOTEX costs; and the value measures that capture the benefits related to accessibility, health and environmental benefit, namely Reduced Risk of Premature Death, Decrease in Absenteeism, Accidents, Congestion and the increase in Journey Quality.

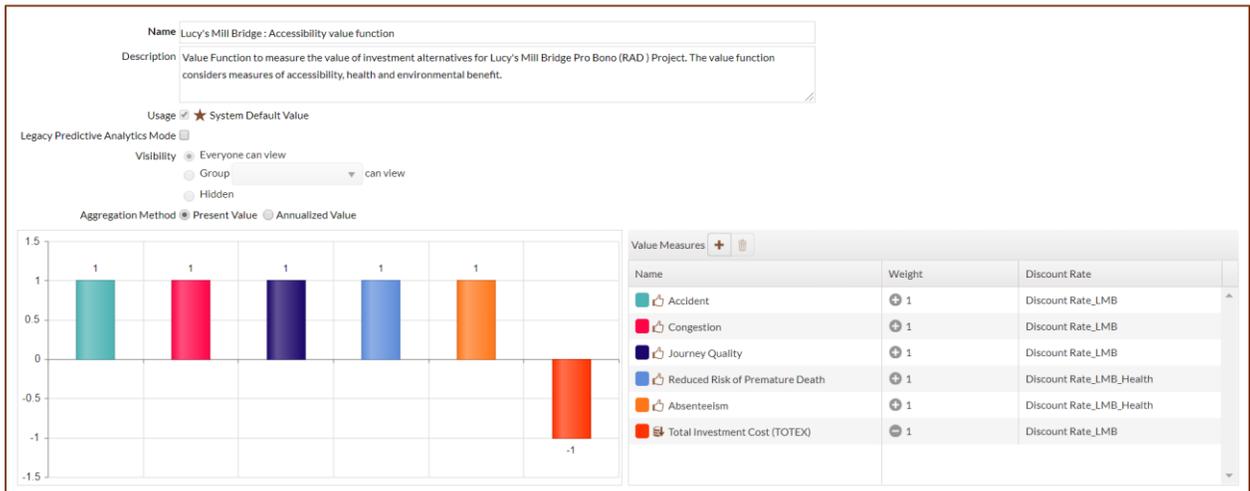


Figure 9 - C55 accessibility value function

2. A **Community Value Function, as shown in Figure 10.**

This includes all of the value measures within the Accessibility Value Function, but also includes Economic Performance. This is the measure of economic impact for local businesses and the community associated with forecast user trips across Lucy's Mill Bridge or the new fully compliant DDA bridge. There is no referenceable data to determine accurately what proportion of this economic impact will be driven by the bridge investment, but given the bridge forms a strategic crossing in the town and calculations have been performed on a bottom-up basis, it is not unreasonable that a significant proportion of this could be attributed to the bridge crossing improvements.

Apart from the marina extension, no tourist growth or change in use assumptions have been made in respect of tourists or regarding the way the town uses the area around the recreation ground and circular river trail, which is likely to support that calculations presented in this study are conservative.

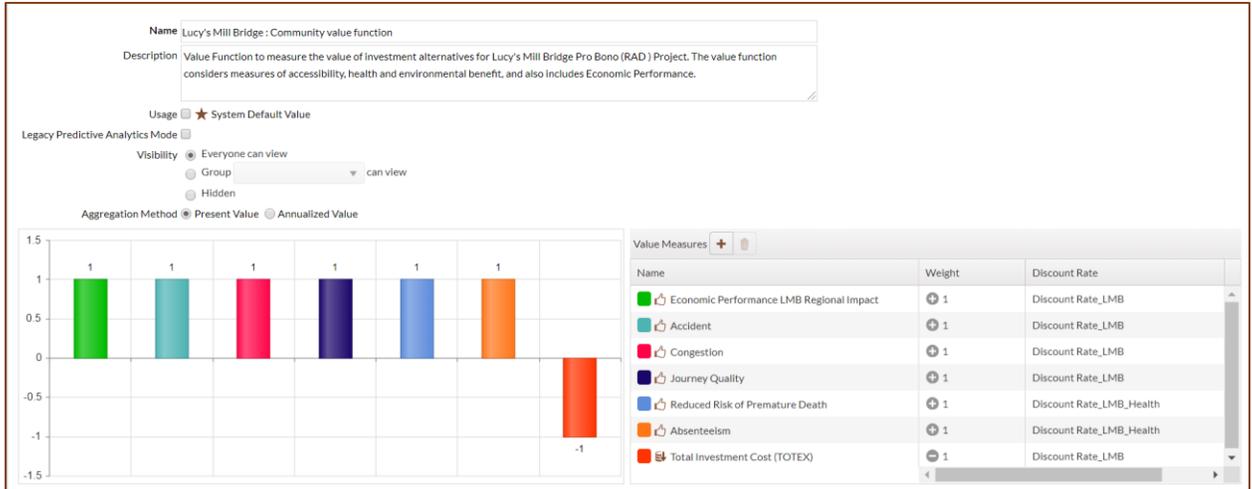


Figure 10 - C55 community value function

9.2 Bridge Projected Demand Value Measures

Baseline bridge demand was determined from an analysis of Lucy's Mill Bridge surveys carried out during October and November 2017. [27]

Following the analysis of the bridge survey data, there was insufficient data to show diurnal profiling as may have been expected with peaks in the morning, lunchtime and evening. Therefore, an average profile of bridge uses per hour was applied assuming the bridge was in use for 10 hours of the day. Note that the unit of bridge demand is referred to as 'uses per day' which reflects that a single bridge user may use the bridge on multiple occasions. This methodology was applied within each of the bridge user categories of Pedestrians, Cyclists, Users with Accessibility Issues; and Users with Pushchairs. It should also be noted that the bridge surveying was also carried out in autumn; this likely captures both lower than representative tourism and residential bridge demand and should therefore be considered conservative. [28]

Section 9.2.1 contains a summary of the results of the October / November 2017 bridge survey data analysis for each bridge user category.

Section 9.2.2 details the methodology and assumptions used to calculate Baseline (no investment) and Outcome (after investment alternative) Projected Bridge Demand for each category of user.

9.2.1 October / November 2017 Bridge Survey Results

Bridge uses refers to user trips across the bridge. That is 1 'bridge use' represents 1 person in that user category crossing the bridge once (one-way).

The bridge survey count produced the following flat average results:

Time of the week	Count (bridge uses/hr)	Count (bridge uses/day[10hr])
Weekday	100	1,003
Weekend	213	2,132

Table 11 - Baseline Bridge Survey Count Oct/Nov 2017

For the above survey count, the following proportions of bridge user categories were observed:

Bridge User Category	Observed Weekday Proportion	Observed Weekend Proportion
Pedestrians	95.89%	96.25%
Cyclists	3.38%	3.03%
Users with Accessibility Issues	0.09%	0.09%
Users with Pushchairs	0.64%	0.64%

Table 12 - Baseline Bridge Survey User Category Proportions

Furthermore, for growth rate of bridge demand, the following baseline data for residential and tourist population and growth rates have been taken using information in Sections 4.6 & 4.7.

Population Type	Extrapolated Populations (2017)	Compound Growth assumption*
Residential	29,025	1.66%pa to 2031; 0%pa after 2031
Tourist (day trips)	2,098,000	0%pa
Tourist (overnight stays, No. of nights)	752,235	0%pa

**See Section 4.6 and Section 4.7*

Table 13 - Baseline Populations and Assumed Growth Rates

9.2.2 Overall Methodology and Assumptions

Baseline Bridge Demand

The Baseline Bridge Demand takes the bridge count survey data as at 2017 and projects this forward over a 50-year period until 2070 using a monthly growth rate.

Pedestrian bridge count numbers have been assumed to grow in-line with the weighted average residential and tourism growth rates and this has been applied on a monthly basis.

Accessibility, Cyclists and Pushchair user bridge counts have been assumed to grow in-line with residential growth and this has again been applied on a monthly basis.

Outcome Bridge Demand

Outcome Bridge Demand for the 'Do Nothing' is exactly the same as its Baseline Bridge Demand, for all years from 2017 through to 2070. This acts as the base against which to measure all of the other investment alternatives.

The Outcome Bridge Demand for the other user categories (Accessibility, Cyclists and Pushchair users) match their Baseline Bridge Demand up until year 2023 when there is a step change due to an increase in expected users in each of these categories due to the impact of increasing accessibility.

The Department for Transport's WebTAG methodology has been used to monetise benefits. Underpinning this is the assessment of the change in 'active modes' of movements in each of the user categories, i.e. demand over time. This has been assessed before and after accessibility investments. The forecasting methodology of Wardman, Tight and Page (2007) has been used to determine the increase in attractiveness of cycling after investment; as well as approximate the increase in demand for other user categories after investment. This has been used to determine an improvement factor (multiplier) which is to be applied to the Baseline Bridge Demand, for all years from 2023 to 2070. ^[29]

A summary of the average bridge count for each user category in 2017 to be used for Baseline and Outcome Bridge Demand projection is shown in Table 14, as well as corresponding Improvement Factors. Further details can be found in Appendix II.

User Category	Average Demand in 2017 (Bridge uses/10hrs)	Improvement Factor to be applied in 2023 due to accessibility investments
Pedestrians	1,273	1.1
Cyclists	43	3.3
Mobility Users	1	11.7
Pushchairs	8	11.5

Table 14 - Summary of Baseline Demand and Outcome Improvement Factors

Figure 11 shows baseline bridge demand for the 'Access Ramps' Investment Alternative in Copperleaf's C55 software.

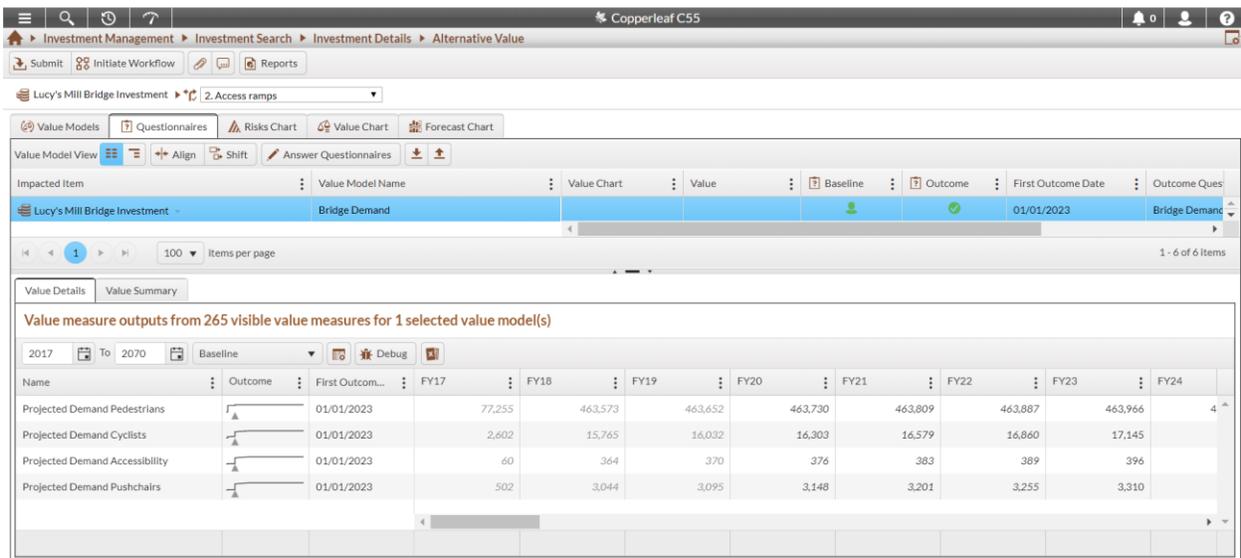


Figure 11 - Projected Baseline Bridge Demand in Copperleaf's C55 Software

Figure 12 shows the questionnaire in Copperleaf’s C55 software where the bridge survey count data is entered as an input to baseline bridge demand.

Questionnaire	Value
1. Enter Weekly Bridge Demand Pedestrians (Daily)	962
2. Enter Weekend Bridge Demand Pedestrians (Daily)	2,052
3. Enter Weekly Bridge Demand Cyclists (Daily)	34
4. Enter Weekend Bridge Demand Cyclists (Daily)	65
5. Enter Weekly Bridge Demand Pushchairs (Daily)	6
6. Enter Weekend Bridge Demand Pushchairs (Daily)	14
7. Enter Weekly Bridge Demand Mobility Issues (Daily)	1
8. Enter Weekend Bridge Demand Mobility Issues (Daily)	1

Figure 12 - Questionnaire input for baseline bridge demand in Copperleaf's C55

9.3 Reduced risk of premature death (Health)

The World Health Organisation produced the Health Economic Assessment Tool (HEAT) to support its own economic assessment of the health benefits of walking and cycling. It was found that even small changes in activity could provide substantial benefit or disbenefit. ^[24]

The Department for Transport’s WebTAG’s active mode tool combines a literature review in 2016 and the WHO HEAT components to produce a comprehensive measure of the benefits of walking and cycling activity on reduced risk of death. ^[24]

For an investment that increases active users, the relative risk of all-cause mortality would be reduced. This is monetised by estimating the number of deaths avoided, converting to Years of Life Lost (YLLs) and then multiplying by the value of a Quality-Adjusted Life Year (QALY). This methodology has been applied to all user groups for the Lucy’s Mill Bridge assessment. ^{[24] [25]}

The reduction in the relative risk of premature death due to physical inactivity is calculated for new users (walkers and cyclists) using the time spent active on the new route and frequency of new trips. ^[24]

9.4 Absenteeism (Health)

World Health Organisation research has shown that physical activity programmes involving 30 minutes of exercise a day reduce short-term sick leave. WebTAG guidance notes that for each employee who takes up physical exercise for 30 minutes a day for 5 days a week as a result of a walking or cycling intervention, the annual benefit to employers is likely to be (on average) at least 0.4 days gross salary costs.

Reductions in short term absence from work can result from the improved levels of health of those who take up physical activity as a result of a walking or cycling intervention. This impact on absenteeism can be monetised using the Department for Transport's WebTAG methodology; and this methodology has been applied to all user groups for each of the investment alternatives in the Lucy's Mill Bridge feasibility assessment. ^{[24] [25]}

9.5 Accident (Health)

The Department for Transport's WebTAG active mode toolkit methodology has been used to monetise the reduction in accidents due to each of the investment alternatives. This models the benefit of the decreased number of expected accidents and resulting casualties (fatal and non-fatal) due to the accessibility investment alternatives.

The benefit is monetised with values for the prevention of casualties and accidents. This assumes that users of the new 'scheme', i.e. the accessible crossing over the Avon, have changed mode from vehicles or riding cycles on-road to cycles off-road or pedestrians off-road on the accessible route. ^{[24] [25]}

The monetised value is based on the marginal external costs (MEC) model and is based on the change in external costs due to a vehicle being removed from the system due to a change in traveller mode. This element of the calculation looks at changes in external costs relating to accident costs. ^{[24] [25]}

9.6 Congestion benefit

The Department for Transport's WebTAG active mode toolkit methodology has been used to monetise the reduction in congestion due to each of the investment alternatives. This estimates and monetises the value of the reduction in congestion in the local area, assuming that the change in users of the new 'scheme', i.e. the accessible crossing over the Avon have changed mode from vehicles to cycles or pedestrians off-road on the accessible route. The monetised value is based on the marginal external costs (MEC) model and combines the benefit of savings in fuel costs and journey times. ^{[24] [25] [33]}

9.7 Journey Ambience

The Department for Transport's WebTAG active mode toolkit methodology has been used to monetise the increase in Journey Quality as a result of the investment alternatives associated with Lucy's Mill Bridge. This accounts for the perceived physical and social environment for travellers and users of travel routes. It includes aspects such as accessibility, lighting, security such as CCTV, signage, congestion, journey times and ability. These factors are aspects which may impact travellers decisions about which routes and which modes of travel to take.

Journey quality is an important consideration in scheme appraisal for cyclists and walkers. It includes fear of potential accidents and therefore the majority of concerns about safety (e.g. segregated cycle tracks greatly improve journey quality over cycling on a road with traffic). Journey quality also includes infrastructure and environmental quality on a route.

The guidance for WebTAG notes that there is increasing research in the field of Journey Quality and that it is increasingly being robustly incorporated into feasibility assessments. ^{[24] [25]}

9.8 Economic Performance

Tourism is an integral part of the local economy of Stratford-upon-Avon. The potential Economic Performance has been calculated for the Baseline and Outcome of each investment alternative, with the benefit being assessed as any positive increase of (Outcome – Baseline) over the 50-year period to 2070.

Economic Performance is measured as follows:

- Baseline Economic Performance = Baseline Bridge Demand x Spend

Where the weighted spend per bridge user trip and weighted spend growth per year are detailed below.

- Outcome Economic Performance = Outcome Bridge Demand x Spend

Where Outcome Bridge Demand takes account of the increase in demand (number of bridge uses) due to the impact of accessibility investments, as detailed in APPENDIX II.

A weighted spend per day per every trip across the bridge has been assumed to be £12.72 at 2017. This is based on:

1. Weighted-average tourist spend per day in 2017 of £63.59 (Section 4.7)
2. Assumed resident spend per trip across the bridge of $1/3 \times £63.59 = £21.20$
3. Assumed that 70% of bridge trips are leisure based and therefore non-spend generating
4. Of the 30% of bridge trips which are spend generating, it is assumed that 50% are residents and 50% are tourists

Assumption 2 above can be backed up by information in the Stratford-on-Avon District Core Strategy. However, assumptions 3 and 4 are heuristic.

Spend growth has been assumed to be in line with inflation. This has been assumed to be an annual rate of 2.3% for 2018 and 1.7%pa for 2019 and onwards, based on CPIH. ^[15]

9.9 Qualitative Factors

There are a number of factors that should be considered but have not been able to be fully quantified. These are detailed in this section.

9.9.1 Bridge Flow and Capacity

As Lucy's Mill Bridge structure is not being widened and the bridge deck is staying at 1.5 metres wide, this is smaller than a new fully DDA compliant bridge. As previously discussed, this may cause some restrictions for pedestrians combined with wheelchairs and cyclists. It is discussed in Section 12 that suitable mitigations such as appropriate signage, e.g. give way and cycle dismount should be considered.

However, another consideration is future demand capacity and whether the bridge will be able to support this. Appendix III details bridge capacity calculations derived from flow rates in regulations and indicates that projected demand in 2070 will be supported (see Appendix III for further details and assumptions).

9.9.2 Heritage

As detailed in Section 4.1, Lucy's Mill Bridge is a heritage asset existing from the time of Shakespeare and forms part of a heritage trail in Stratford-upon-Avon. It is embedded within the history and tourism of the

town. It is not possible to fully quantify the benefits of this to the town and community and the power of public opinion and sentiment that is felt for the bridge.

9.9.3 Floodplain

Lucy's Mill Bridge is located in an area of Medium / High risk of Flooding. Investment alternatives to Lucy's Mill bridge assume that no structural changes will be made to the existing bridge and therefore no construction will take place within the riverbed.

Construction of a new bridge may require construction of piers within the riverbed, unless the bridge entirely spans the river.

It is recommended that before any work commences that the Environment Agency are fully engaged to determine the full impact appraisals in respect of the flood risk and to obtain necessary consents.

As noted previously, analysis within this study has assumed that none of the investments will impact the floodplain.

9.9.4 New Bridge Site

As discussed in Section 5.1, previous feasibility studies have raised strong negative public opinion about the siting of a new bridge in Stratford-upon-Avon. This feasibility study does not offer a solution or opinion on where to site a new bridge. It assumes that an agreeable location site would be found and therefore no negative impacts have been incorporated into the CBA assessment for the new bridge option in respect of this.

9.9.5 Cycle Network

Currently cycling is not permitted across Lucy's Mill Bridge, although many users do carry their bicycles across. There are cycle routes either side of the bridge (see Section 4.4), so consideration should be given to connecting these cycle routes. Based on current user profiling, analysis in this report has assumed cyclists will use the bridge crossing, dismounting across the bridge.

9.9.6 Aesthetic Refurbishment

It is likely that there will be a small additional benefit due to the improved appearance in the bridge after aesthetic refurbishment due to the attraction of higher numbers of users of the bridge route. However, it was not possible to quantify this within the constraints of the project. A quantifiable analysis of the effects of aesthetic refurbishment on future maintenance costs has however been made (see Section 9.2.2).

10. Discount Rates

Discount rates in-line with the Department for Transport's WebTAG methodology have been applied to all costs and benefits. ^[24] ^[25]

A discount rate of 1.5% has been applied for all years for Health benefits, i.e. benefits associated with the Value Measures: Reduced Risk of Premature Death and Absenteeism.

For all other benefits and costs, a discount rate of 3.5% has been applied for the 30 years to 2050 and 3.0% thereafter.

10.1 Why discount values?

In the analysis, all costs and benefits have been applied at the relevant dates. Discount rates have been applied to both costs and benefits, so that CBA results are presented in present day (2020) prices.

For those unfamiliar with such discounting techniques, it may for example initially look like there is a disparity between the Costs presented in the CBA results and those discussed in Section 8, in that the CBA Results costs may present lower than expected – this is due to the effect of discounting. Discounting is carried out so that investment alternatives can be assessed on a comparable basis using net present values (NPV) and payback periods. This is much like annual earning ratios (AERs) are used to compare savings accounts and annual percentage rate (APRs) are used to compare borrowing products, such as credit cards or mortgages.

Example:

A discount rate can be thought of in a similar way to an interest rate. The value of money is typically worth more in the future than it is today. Think about savings accounts – you expect to receive an interest in a savings account. For example, if you had £100 today and you invested this in a savings account with an interest rate of 2% per year, in a year's time, you would have £102.

Discounting is in effect just the reverse of this. Imagine you are planning to make a theoretical accessibility investment alternative in 1 years' time that will cost £102, but you want to value it in today's prices. If the discount rate is 2% per year, then today's value of that investment will be £100.

11. Cost Benefit Results

Copperleaf have used analytical software C55 to analyse the cost benefit of the four investment alternatives for Lucy's Mill Bridge over the 50-year period to 2070.

A measurement period of 50-years for investment in a structure such as a bridge or transport network is considered best practice to fully account for the benefits the upfront Capital investment in such an asset will bring throughout the course of its lifetime.

Whilst this is best practice, there are increasing challenges being brought around the length of CBA measurement periods by regulators in industry due to uncertainties around the future. This includes uncertainty around the future of use; funding; the impact of climate change and population growth; as well as political and financial frameworks.

The rates of advances in technology, innovation, and interplay with national and regional policy and funding mechanisms will also likely have key parts to play in how national and district transport and infrastructure initiatives develop and are funded. However, there is an increasing emergence of more innovative and socially responsible means of accessing money for such investments, from grants to crowdfunding.

With this much uncertainty around the future, whilst results have been presented using an industry best practice 50-year measurement period, a discounted payback period has also been presented to indicate when each investment alternative would be expected to start paying back, i.e. when the accrued benefits outweigh the costs that are incurred. This has been done on a discounted basis.

The capital and operational costs for each of the investment alternatives vary, but the quantifiable monetary benefits associated with accessibility investment have been assessed to be the same. This is because the investment alternatives are being assessed in terms of accessibility, health, environment and economic value; and maximum bridge capacity for Lucy's Mill Bridge has been assessed to not be compromised over the value measurement period (see Appendix IV).

Whilst aesthetic refurbishment will add additional attractiveness to the bridge, the main driver for increased use is improved accessibility. However, the quantifiable benefits of aesthetic refurbishment on future maintenance costs have been included (see Section 8.2).

Results have also been presented with and without the associated economic impact to the local community. This is so that readers of the report can more easily see and visualise the impact of accessibility, health and environmental benefits in isolation, but then also these in combination with the associated economic benefits to Stratford-upon-Avon.

11.1 CBA results: Accessibility Value Function

Figure 13 shows the Value Chart for the Access Ramps investment alternative in Copperleaf's C55 software.

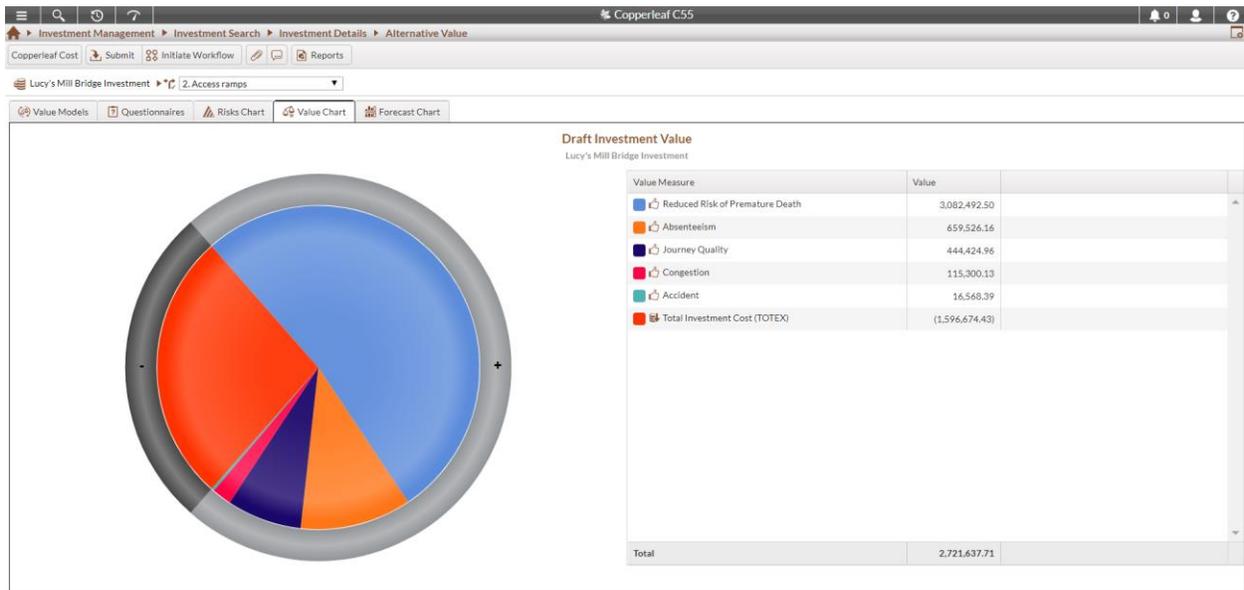


Figure 13 - Copperleaf C55 Value Chart

Table 15 shows the Results of the Cost Benefit Analysis using the Accessibility Value Function. This looks at capital and operation costs (TOTEX), as well as accessibility, health and environmental benefits.

As the Lucy's Mill bridge investment has been assessed individually as opposed to part of any wider accessibility investment schemes, the 'Do Nothing' alternative has been taken as a baseline and benefits have been measure as increases or decreases against this baseline, which is why benefits for Do 'Nothing' present as zero in Table 15 and Table 16.

In 2020 Prices (£000s)	Do Nothing	Access Ramps to LMB	Access Ramps to LMB & Aesthetic Refurb	New DDA Bridge
Reduced Risk of Premature Death	0	3,082	3,082	3,082
Absenteeism	0	660	660	660
Accident	0	17	17	17
Congestion Benefit	0	115	115	115
Journey Quality	0	444	444	444
TOTEX COSTS	(598)	(1,597)	(1,715)	(4,748)
TOTAL BENEFITS	0	4,318	4,318	4,318
Net Present Value	(598)	2,722	2,603	(430)
Benefit Cost Ratio	N/A	2.70	1.51	0.91
Pay back period from 2023 (discounted)	N/A	13 years	15 years	55 years

Table 15 - Cost Benefit Analysis Results; Accessibility Value Function

11.2 CBA Results: Community Value Function

Table 16 shows the Results of the Cost Benefit Analysis using the Community Value Function. This looks at capital and operation costs (TOTEX), as well as accessibility, health, environmental and economic benefit to the community of Stratford-upon-Avon.

In 2020 Prices (£000s)	Do Nothing	Access Ramps to LMB	Access Ramps to LMB & Aesthetic Refurb	New DDA Bridge
Economic Performance	0	54,251	54,251	54,251
Reduced Risk of Premature Death	0	3,082	3,082	3,082
Absenteeism	0	660	660	660
Accident	0	17	17	17
Congestion Benefit	0	115	115	115
Journey Quality	0	444	444	444
TOTEX COSTS (£000s)	(598)	(1,597)	(1,715)	(4,748)
TOTAL BENEFITS (£000s)	0	58,569	58,569	58,569
Net Present Value (£000s)	0	56,972	56,854	53,821
Cost Benefit Ratio	N/A	36.67	34.15	12.34
Pay back period from 2023 (discounted)	N/A	1 year	1 year	3 years

Table 16 - Cost Benefit Analysis Results; Community Value Function

11.3 Expected Numbers

If Lucy's Mill bridge is made accessible, or a similarly accessible crossing is put in place, it is forecast that over the 48 years from investment date in 2023 to 2070 owing to the bridge route becoming more attractive to users, there will be an **additional**:

- 230,270 mobility user trips
- 1,903,071 pushchair user trips
- 2,192,425 cyclist trips
- 2,006,944 pedestrian trips, which additionally considers pedestrians associated with the above users

It should be noted that the above is likely conservative as:

- The growth and demographic analysis of the mobility and cyclists within the modelling are based on the resident population only as there was no robust data to enable extension of demand forecasting to the tourist population
- Bridge survey data was taken in October and November which is likely to have lower observable bridge crossings than in summer
- Tourist growth has been conservatively assumed to be 0%
- The project has been assessed in isolation and not as part of any wider accessibility development for Stratford-upon-Avon, e.g. facilitating accommodation and transport to and from

There is much scope for the user groups analysed to add more value than calculated over the next 50 years. In particular, in the area of mobility users, the rising prominence of accessibility and disability in the media and through initiatives such as the UN sustainability goal 10: reduce inequality within and among countries; and international day of persons with disabilities day. The primetime airing of programmes such as the Paralympics promoting sport and wellness for all is also likely to accelerate the drive for inclusive societies at all levels.

11.4 CBA Results Summary

The CBA analysis shows that there is both a social and economic business case for providing accessibility to Lucy's Mill bridge. Even though the investment has been assessed as a standalone accessibility improvement and not as part of a wider accessibility or transport development strategy, it is still forecast that the investment would provide access for an additional 6.3 million user trips across the bridge over the 48 years to 2070, including a quarter of a million additional mobility user trips. This would make a significant initial step forwards toward making Stratford-upon-Avon an inclusive and accessible town for both it's community and tourists.

An accessibility investment to Lucy's Mill bridge, based on accessibility, health and environmental alone is forecast to deliver benefits **1.5 to 2.7 times** that of the costs that would be required to deliver it is based on the 50-year measurement period. The investment is expected to start paying back after **13 to 15 years**. This can be thought about as a pair of balance scales. Payback is the point in time from the initiation of the investment at which the value of the benefits outweighs the value of the costs and the scales are tipped such that in effect a profit is being realised.

When economic impact to the surrounding area is also considered, the accessibility investment is forecast to deliver benefits of between **34 and 36 times** that of the costs that would be required to deliver it, with the investment expected to payback and effective profit after **1 year**.

The New DDA bridge investment alternative has a lower multiple of benefits to cost and a longer time to deliver an effective profit, as would be expected due to higher Capital costs, but nevertheless still delivers accessibility, inclusion and economic benefit.

The analysis shows that there are clear benefits for national and or regional strategies to implement an accessibility investment in respect of Lucy's Mill Bridge via traditional methods or through consideration of newer and emerging innovative funding and delivery partnerships solutions.

12. Recommendations and Summary

12.1 Recommendations for further work

Some recommendations for further work are noted below. These are recommended for consideration and should not be interpreted as requirements or be used by any party as blockers to progression towards delivery:

- Further surveying to determine baseline bridge demand, and in particular diurnal and seasonal variability to inform more robust analysis, if this is deemed necessary.
- There are a number of cycle routes, traffic free paths and greenways either side of Lucy's Mill Bridge. Cycling is not currently permitted on the route across Lucy's Mill Bridge but is nevertheless observed. It is suggested that further consideration be given to this and the support that can be provided to all users of the transport network in Stratford-upon-Avon.
- If accessibility investments to Lucy's Mill Bridge gain acceptance, it is recommended that the following are considered due to the existing bridge not meeting DDA compliance regulations in full:
 - Signage for cyclists to dismount and for bridge users to give way to those with accessibility needs whilst on the access ramps and on the bridge deck.
 - Under lighting is recommended on the access ramps and screening provided to mitigate any impact for adjoining landowners.
 - Colour luminance warning strips at the top and bottom of landing points is recommended on the existing steps, which will remain.
 - Safety gates / barriers at the top of the existing steep steps are recommended to protect mobility users using the bridge.
- It is recommended that the following stakeholders are engaged with before any investment alternative proceeds to construction:
 - The Environment Agency – regarding impact assessment and required consents
 - Adjoining Landowners – regarding enduring screening and impact during construction.
 - Warwickshire County Council, Stratford District County Council; and Potential Funders – to explore the potential funding options and future ownership relationships between these stakeholders.

Engagement with the above stakeholders in respect of the delivery (construction) phase was considered out of scope of this feasibility project as it concerns deliverability practicalities, rather than feasibility options assessment.

12.2 Summary

The analysis shows that there are clear benefits for national and or regional strategies to implement an accessibility investment in respect of Lucy's Mill Bridge via traditional methods or through consideration of newer and emerging innovative funding and delivery partnerships solutions.

Copperleaf's guidance is that the investment alternative 'Lucy's Mill Bridge with Access Ramps and Aesthetic Refurbishment' would be the preferred option. This combines good cost benefit results measured for accessibility, health; and economic benefits, coupled with the qualitative factors related to heritage, public opinion and potential flooding risk. Most importantly it would provide an accessible and attractive key link on a waterway leisure and utility route for both tourists and residents in a key area of the town of Stratford-upon-Avon.

13. Acknowledgements

This report was completed with the input and engagement of many people and organisations who participated in engagement, review and feedback.

Copperleaf would like to give particular thanks to:

- The Operational Research Society for facilitating the project;
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- Anthony Billing from Kier who provided indicative costing estimation of refurbishment of Lucy's Mill Bridge; and
- Andy Watts: Asset Management and Transformation Specialist at AWCP Ltd., for his time and expertise providing a peer review of this Feasibility Assessment Report.

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15. Appendix I

15.1 Legislation Summary

The Disability Discrimination Act (1995) required reasonable adjustments to be made to avoid discriminating against disabled people. ^[19]

The Disability Discrimination Act (2005) amended the 1995 Act and extended the principles of Part III, which prohibited discrimination in the provision of goods, facilities and services and premises, to the delivery of public authority functions.

On 5 April 2011, the Equality Act (2010) introduced a new public sector general equality duty, which requires public authorities to pay “due regard” to the need to:

- Eliminate unlawful discrimination, victimisation and harassment;
- Advance equality of opportunity;
- Foster good relations.

This applies to all of the “protected characteristics” of age; disability; gender reassignment; pregnancy and maternity; race; religion and belief; sex and sexual orientation and to a limited extent to marriage and civil partnership. ^{[20] [22]}

This project is likely to have a skewed impact on a number of these characteristics, not just disability. These include:

- **Age** – The Stratford-on-Avon district has a significantly higher population than the national average (31.7% vs 22% at the 2011 census). ^[10]
- **Pregnancy/ Maternity & Sex** – Although increasing accessibility in respect of pushchair users is likely to impact both men and women (families), it is likely to have a more significant impact on women. Research has shown that men and women’s daily travel patterns are different. Whilst men more often make a single journey to work and back in the car, women tend to make more journeys (which are shorter in nature) in order to carry out daily activities. This can include taking children to school, going to work, grocery shopping, etc; and more often than men this involves the use of public transport or walking. This disparity between men and women has been observed across Europe and is more acutely pronounced in families with young children. ^{[4] [5]}
- **Race, religion and belief** - The Stratford-on-Avon district has a significantly lower proportion than the national average, with 93.6% being accounted for as ‘White British’. Increasing physical connectivity across the town may help promote and build a more diverse, networked and connected community over time. ^[10]

15.2 Highways Agency Design Manual for Roads and Bridges

15.2.1 Footbridge Deck and Ramp Width Compliance Requirements

Bridge Deck Width

Referring to Section 6.3 and Section 12.4 of the Design Manual for Roads and Bridges, based on cyclists, pedestrians and accessibility users not being segregated, the width of the bridge deck is required to be at least 3.5m if there is no segregation of users, see Table 17. ^[21]

For the investment alternatives to Lucy’s Mill Bridge, as previously discussed, due both to the fact that the bridge is a heritage asset and so as not to impact the floodplain, no structural changes will be made to the bridge deck. It will remain at 1.5m wide and be out of compliance with Equality legislation, with accessibility investments taking a reasonability approach. It is assumed that any New Bridge built will be fully compliant with Equality legislation.

	Pedestrian Path	Cycle Path	Total Width
When segregated by kerb not less than 50mm high	2.0m	2.7m	4.7m
When segregated by railings not less than 900mm high	2.0m	3.0m	5.0m
When segregated by a white line, colour contrast or surface texture	1.5m	2.5m	4.0m
Unsegregated	–	–	3.5m

Table 17 - Width requirements based on users and environment

Access Ramps Width

Referring to Section E/3.5 of CD 143, routes for cyclists and pedestrians which are unsegregated should have a minimum width of:

- 2.0 metres where there are less than 200 users per hour;
- 3.0 metres where there are less than 200 users per hour.

For this feasibility study, it has been assumed that a width of 2.0 metres will apply to the access ramps for the intervention to Lucy’s Mill Bridge. However, as is noted in the recommendations section, it is recommended that more robust bridge count surveying is considered prior to any works commencement to better understand the representative diurnal and seasonal profile of bridge demand and peak flow to determine if a ramp width of 2 meters is sufficient. ^[34]

The Government’s document Inclusive Mobility notes that “A wheelchair user and an ambulant person side-by-side need 1500mm width.” ^[23]

15.2.2 Footbridge Parapet Compliance Requirements

According to the Design Manual for Roads and Bridges, footbridges or ramps with cycle facilities, shall have a parapet height of at least 1.40m. ^[21]

The parapet height of Lucy’s Mill Bridge does not meet new building regulation standards of 1.4m. However, cyclists could be encouraged to dismount via a number of means, e.g. signage: give way signs,

demarcation of wheelchair widths, etc. Another common route for cyclists to cross is the Tramway Bridge which is pedestrianised. This can be extremely busy during weekends and times of high tourism. The Tramway Bridge is wider than Lucy's Mill Bridge and provides less encouragement for cyclists to dismount, but the bridge can be congested. The parapet height is also lower than the regulation standard height, at 1m.

16. APPENDIX II

16.1 Baseline Bridge Demand

16.1.1 Baseline Bridge Demand Pedestrians

Baseline Bridge Demand for Pedestrians based on data in Table 11 & Table 12 in Section 9.2.1:

Pedestrians	Count (uses/day[10hr])
Weekday	962
Weekend	2,052
Average day	1,273

Table 18 - Baseline Bridge Demand Pedestrians 2017

16.1.2 Baseline Bridge Projected Demand Cyclists

Baseline Bridge Demand for Cyclists based on data in Table 11 & Table 12 in Section 9.2.1:

Cyclists	Count (uses/day[10hr])
Weekday	34
Weekend	65
Average day	43

Table 19 - Baseline Bridge Demand Cyclists 2017

19% of people in the Stratford-on-Avon District cycle to work, which is higher than the national average. 23% of journeys to work are less than 5km, of which 13% are less than 2km. Currently only 2.1% of adults living in Stratford-on-Avon District cycle for utility at least once per week. Compare this with Cambridgeshire at 15.6% and the city of Cambridge at 47.4%. This shows there is much scope for growth in cycling within Stratford-on-Avon and Stratford-upon-Avon, if cycle paths and greenways are successfully promoted in order to maximise utility and wellbeing. ^[34]

Assumptions applied for Cyclists	Assumption	Comments
Percentage of Residents who cycle to work	19%	Assume same for Stratford-upon-Avon as for Stratford-on-Avon. Apply to weekdays
Percentage of Residents who cycle for utility once a week	2.1%	
Percentage of Cyclist Population using LMB	5%	Assumption

Table 20 - Assumptions for Cyclists' Forecasting

16.1.3 Baseline Bridge Projected Demand for Users with Mobility Issues

Baseline Bridge Demand for users with mobility issues based on data in Table 11 & Table 12 in Section 9.2.1:

Users with accessibility issues	Count (people/day[10hr])
Weekday	1
Weekend	1
Average day	1

Table 21 - Baseline Bridge Demand for Users with Accessibility Issues 2017

Key information on population and accessibility data can be found in Section 4.6 and 4.8, but salient assumptions taken into account in the forecasting analysis are summarised in Table 22.

Issue that may cause accessibility issue	Proportion of population (%)
% in Stratford-upon-Avon assumed to have a disability, of which:	19
% of disabled population using a wheelchair	6
% of disabled population with visual impairment	10
% of disabled population with other mobility issues	25
% of disabled population assumed to use LMB	5

Table 22 - Accessibility assumptions

Analysis of the increase in users with mobility issues using Lucy's Mill Bridge has only been applied to the residential population of Stratford-upon-Avon, as no mobility demographic data was available for the tourist population. Therefore, the benefits of providing accessibility in this area are likely conservative.

16.1.4 Baseline Bridge Projected Demand Pushchair Users

Baseline Bridge Demand for pushchair users based on data in Table 11 & Table 12 in Section 9.2.1:

Users with Pushchairs	Count (people/day[10hr])
Weekday	6
Weekend	14
Average day	8

Table 23 - Baseline Bridge Demand for Pushchair Users 2017

Key information on population and pushchair users can be found in Section 4.6, but salient assumptions taken into account within the forecasting analysis are summarised in Table 24.

Description	Number / %
Population of Stratford-upon-Avon aged 0-4 years old (2017)	1,519 (5.2%)
Growth rate of population <i>Assumed to apply to all categories of population</i>	1.66%pa to 2031; 0%pa after 2031
Percentage of Pushchair Users within resident population assumed to be using LMB	5%
Multiplier effect for families using Pushchairs	*3

*weighted average allowing multiplier of 2 during week and 4 during weekend, also taking weightings of base week and weekend demand into account

Table 24 - Pushchair Users Data and Assumptions

16.2 Outcome Bridge Demand

The Department for Transport's WebTAG methodology has been used to monetise benefits. Underpinning this is the assessment of the change in 'active modes' of movements in each of the user categories, i.e. demand over time. This has been assessed before and after accessibility investments. The forecasting methodology of Wardman, Tight and Page (2007) has been used to determine the increase in attractiveness of cycling after investment; and approximate the increase in demand for other users after investment. [29]

$$P_y^f = \frac{P_y^b e^{\Delta U_y}}{P_y^b e^{\Delta U_y} + (1 - P_y^b)}$$

Where:

ΔU_y is the change in utility of the cycling mode, in year y

P_y^b is the proportion of those choosing to cycle out of the maximum of those where it is a viable option, without any intervention, in year y

P_y^f is the proportion of those choosing to cycle out of the maximum of those where it is a viable option, with intervention, in year y .

Figure 14 - Wardman, Tight and Page (2007) model [29]

16.2.1 Outcome Bridge Demand Pedestrians

The calculations applying the data to the Wardman, Tight and Page (2007) model to determine the increase in Pedestrians expected after the intervention alternatives are set-out in Table 25. This includes any assumptions applied. This results in an improvement factor of 1.09 for Pedestrians.

i.e. For Pedestrians Outcome Bridge Demand is equal to Baseline Bridge Demand until 2023, at which point it becomes 1.09 x Baseline Bridge Demand until 2070.

This applies for all investment alternatives, except the 'Do Nothing' alternative, where Outcome and Baseline Bridge Demand are equal until 2070.

T =	travel time, minutes	30
cw =	Coefficient – Change in time on off-road cycle track	-0.033
cn =	Coefficient – Change in time on no facilities	-0.036
delta U =		0.09 calculated

Without Intervention

1270	Total equivalent Number Pedestrian Users per day at 2023 (Baseline Bridge Demand / 365.25)
32039	Total equivalent population (residential) per day Residential population of 29025 at 2017 with 6 years of 1.66% yearly growth.
5744	Total equivalent population (tourism) per day
20101	Resident population (pedestrian) available to use per day
4848	Tourism population (pedestrian) available to use per day
5.092%	Pb: Those cycling as Proportion of those available (calculated)

With Accessibility Intervention

5.545%	Pf: Those cycling as Proportion of those available (calculated)
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Improvement factor =	1.09
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Table 25 - Pedestrian Improvement Factor Calculation

16.2.2 Outcome Bridge Projected Demand Cyclists

The calculations applying the data to the Wardman, Tight and Page (2007) model to determine the increase in Cyclists expected after the intervention alternatives are set-out in Table 26. This includes any assumptions applied. This results in an improvement factor of 3.34 for Cyclists.

i.e. For Cyclists, Outcome Bridge Demand is equal to Baseline Bridge Demand until 2023, at which point it becomes 3.34 x Baseline Bridge Demand until 2070.

This applies for all investment alternatives, except the 'Do Nothing' alternative, where Outcome and Baseline Bridge Demand are equal until 2070.

t =	travel time, minutes	15
cw =	Coefficient - Change in time on off-road cycle track	-0.033
cn =	Coefficient - Change in time on no facilities	-0.115
delta U =		1.23 calculated

19.0%	Proportion cycling per day for work (apply to residential population)
2.1%	Proportion cycling per day for utility (apply to residential population)

Stratford-upon-Avon Area Transport Strategy (WCC), May 2018 ^[35]

Without Intervention

47	Total equivalent Number Cycling per day in 2023 (Baseline Bridge Demand / 365.25)
32039	Total equivalent population (residential) per day Residential population of 29025 at 2017 with 6 years of 1.66% yearly growth.
4348.1	Resident population Available to Cycle daily (work) - assume 19% weekdays
96.1	Resident population Available to Cycle daily (work) - assume 2.1% once per week utility
1.1%	Pb: Those cycling as Proportion of those available (calculated)

With Accessibility Intervention

3.5%	Pf: Those cycling as Proportion of those available (calculated)
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Improvement factor =	3.34
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Table 26 - Cyclists Improvement Factor Calculation

16.2.3 Outcome Bridge Projected Demand for Users with Mobility Issues

The calculations applying the data to the Wardman, Tight and Page (2007) model to determine the increase in Users with Mobility Issues expected after the intervention alternatives are set-out in Table 27. This includes any assumptions applied. This results in an improvement factor of 11.65 for Users with Mobility Issues.

i.e. For Users with Mobility Issues, Outcome Bridge Demand is equal to Baseline Bridge Demand until 2023, at which point it becomes 11.65 x Baseline Bridge Demand until 2070.

This applies for all investment alternatives, except the 'Do Nothing' alternative, where Outcome and Baseline Bridge Demand are equal until 2070.

t =	travel time, minutes	30
cw =	Coefficient - Change in time on off-road cycle track	-0.033
cn =	Coefficient - Change in time on no facilities	-0.115
delta U =		2.46 calculated

7.8%	Proportion of population with mobility issues (apply to residential)
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Sport England, mapping disability report

Without Intervention

1.1	Total equivalent Number Mobility Users per day in 2023 (Baseline Bridge Demand / 365.25)
32039	Total equivalent population (residential) per day Residential population of 29025 at 2017 with 6 years of 1.66% yearly growth.
2496	Resident population (mobility) available to use
0.043%	Pb: Those cycling as Proportion of those available (calculated)

With Accessibility Intervention

0.506%	Pf: Those cycling as Proportion of those available (calculated)
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Improvement factor =	11.65
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Table 27 - Users with Mobility Issues Improvement Factor Calculation

16.2.4 Outcome Bridge Projected Demand Pushchair Users

The calculations applying the data to the Wardman, Tight and Page (2007) model to determine the increase in Pushchair Users expected after the intervention alternatives are set-out in Table 28. This includes any assumptions applied. This results in an improvement factor of 11.52 for Pushchair Users.

i.e. For Pushchair Users, Outcome Bridge Demand is equal to Baseline Bridge Demand until 2023, at which point it becomes 11.52 x Baseline Bridge Demand until 2070.

This applies for all investment alternatives, except the 'Do Nothing' alternative, where Outcome and Baseline Bridge Demand are equal until 2070.

t =	travel time, minutes	30
cw =	Coefficient - Change in time on off-road cycle track	-0.033
cn =	Coefficient - Change in time on no facilities	-0.115
delta U =		2.46 calculated

5.2%	Proportion of population with pushchairs available to use (apply to residential and tourism)
3	Assumed multiplication factor for additional users (family units) due to pushchairs

Census data

Without Intervention

9.1	Total equivalent Number Pushchair Users per day at 2023 (Baseline Bridge Demand / 365.25)
32039	Total equivalent population (residential) per day Residential population of 29025 at 2017 with 6 years of 1.66% yearly growth.
5744	Total equivalent population (tourism) per day
4998	Resident population (pushchair users) available to use per day
896	Tourism population (pushchair users) available to use per day
0.154%	Pb: Those cycling as Proportion of those available (calculated)

With Accessibility Intervention

1.771%	Pf: Those cycling as Proportion of those available (calculated)
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Improvement factor =	11.52
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Table 28 - Pushchair Users' Improvement Factor Calculation

17. APPENDIX III

17.1 Bridge Capacity

Based on Lucy's Mill Bridge, bridge deck width of 1.5 metres and a flow rate of 300mm of width per 20 persons per minute on the flat to meet peak pedestrian flow ^[21], 100 persons per minute can be accommodated (pedestrians) according to PART 8 BD 29/17 DESIGN CRITERIA FOR FOOTBRIDGES.

Based on CD 143 England National Application Annex to CD 143 Designing for walking, cycling and horse-riding, a maximum of flow rate of 200 persons per hours can be accommodated.^[34]Table 29 compares the bridge demand in 2070 against maximum capacity for each user category as indicated by the above regulations. The above flow rates up have been converted into maximum capacity per year, by assuming 10 hours usage 365.25 days per year; and apportioning this to each user category according to the proportional demand immediately after investment.

Bridge User Category	Proportion of Users at 2070	Limits of maximum annual capacity based on regulations		2070 Projected User Demand
		Lower bound Maximum Annual Capacity (LMB Bridge Deck) ^[43]	Upper bound Maximum Annual Capacity (CD143 Regs) ^[21]	
Pedestrians	81.44%	594,911	17,847,329	506,455
Cyclists	10.63%	77,638	2,329,128	66,094
Users with Accessibility Issues	0.86%	6,249	187,478	5,320
Users with Pushchairs	7.08%	51,702	1,551,064	44,015

Table 29 - 2070 Projected Demand against Maximum Capacity

When considering the size of existing population and compound growth rate, the predominant user class is projected to be pedestrians in 2070, accounting for over 99% of demand. The project demand of the mixed user group of pedestrians, cyclists, mobility and pushchairs users at 2070 is projected to be under the maximum capacity of the bridge based on both the CD 143 design guidance based on mixed users and the Design Criteria of Roads and Bridges (footbridges) based on pedestrians. This does not preclude that there may be seasonal or peak times in the future when flow per minute may peak above that assumed in the basis of this calculation and flow across the bridge would be slower than normal at this time. ^[43] ^[21]

18. APPENDIX IV

18.1 Residential Growth

Section 6.1.2 of the Stratford-on-Avon District Core Strategy details Stratford-upon-Avon as having c.26,000 residents within c. 11,500 dwellings in 2011. This would infer an average rate of 2.26 residents per dwelling.^[12]

Section 6.1.30 of the Stratford-on-Avon District Core Strategy details c.3,600 homes to be built over the Strategy period (2011 to 2031). Based on the assertion in the Strategy document that this should be seen as minimum provision, an additional 25% provision has been assumed. Therefore, the assumed population of Stratford-upon-Avon is:

$$26,000 + (1.25 \times 3,600 \times 2.26) = 36,174$$

Moving from a population of c.26,000 in 2011 to a population of 36,174 in 2031, **assuming a steady rate of growth**, indicates an annual growth of 1.66%.

19. About C55

Copperleaf C55 is a unique decision analytics solution that helps asset-intensive organizations decide where and when to invest in their businesses to optimize performance and manage risk. C55 can empower your organization to achieve optimal asset performance and business outcomes including:



Higher value decisions

- Create an investment strategy that delivers greater value to your organization more effectively
- Align investment decisions to your strategic objectives, including risk and service level targets

Staff efficiency improvements

- Improve the efficiency and effectiveness of your planning processes
- Reduce the time and effort needed for justifications and approvals

Integrated strategic & budgetary plans

- Proactively manage risk in your aging infrastructure
- Compare investment scenarios for both short- and long-term planning to optimize the use of scarce resources

Superior business performance

- Track progress and update assumptions to continuously improve

C55 can be used collaboratively across your entire enterprise as the system of record for asset investment planning. It integrates seamlessly into your IT environment, to connect disjointed systems and data, and bring rigor, discipline and transparency to the decision-making process.

20. About the Authors



Keri Bunnell is a Senior Consultant and Project Manager with Copperleaf. She is a Chartered Engineer and a Member of the Institute of Asset Management. She has over 11 years of consulting and asset management experience, with academic background in civil engineering, renewable energy and aerospace dynamics.

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21. Contact Copperleaf

Copperleaf provides decision analytics to companies facing the challenges of managing critical infrastructure. Our enterprise software solutions leverage operational, financial and asset data to empower our clients to make investment decisions that deliver the highest business value. Copperleaf C55 has been adopted by some of the largest, most well-respected utilities in the world—including Northern Gas Networks, Anglian Water, BC Hydro, Hydro-Québec, ONE Gas, Manitoba Hydro, Hydro One, Tennessee Valley Authority, Powerlink, and many other thought leaders in asset management.

Copperleaf is a member of The Institute of Asset Management (IAM) and actively participates in shaping the future of asset management standards, including ISO 55000. Headquartered in Vancouver, our solutions are distributed and supported by regional staff and partners worldwide. We are committed to building a better world, one decision at a time.

If you would like to learn more about why a Copperleaf Value Framework should be a central part of your Asset Management System and the potential benefits for your organisation, please contact us at our head office below or in the UK:

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