MOTT MACDONALD

Cambourne to Cambridge Better Public Transport Project

Outline Business Case
Economic Case

17 January 2020

Mott MacDonald
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)1223 463500
F +44 (0)1223 461007
mottmac.com

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Contents

Glossary of terms

Analysis of Monetised Cost and Benefits (AMCB) table: Summarises the monetised impacts of a scheme that are included in the scheme's Net Present Value and Benefit-Cost Ratio.

Appraisal Summary Table (AST): Provides a complete summary of the scheme impacts, including the scheme's monetised impacts, and non-monetised impacts (both quantitative and qualitative).

Benefit Cost Ratio (BCR): Benefit Cost Ratio, is an indicator of the overall value for money of a project or proposal.

Cambridge Autonomous Metro (CAM): CAM is the proposed metro style system for Greater Cambridge.

Committed Schemes: Where a scheme has been deemed likely to proceed and is therefore included within the option appraisals.

Conservation Area: An area designated under Section 69 of the Planning (Listed Buildings and Conservation Areas) Act 1990 as being of special architectural or historic interest and with a character or appearance which is desirable to preserve or enhance.

Context: The setting of a site or area, including factors such as traffic, activities and land uses as well as landscape and built form.

Countryside: The rural environment and its associated communities.

Cumulative Impact: The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.

Early Assessment Sifting Tool (EAST): Early Assessment Sifting Tool is used by DfT, to quickly summarise and present evidence on options. INSET is an enhancement of EAST and follows the same broad principles and approach.

Effect: The consequence of the scale of any change to the baseline environment, i.e. impact, on the environmental receptor, taking account of its particular value or sensitivity.

Element: A component part of the landscape (for example, roads, hedges, woods).

Enhancement: Landscape improvement through restoration, reconstruction or creation.

Environment: Our physical surroundings including air, water and land.

Environmental Impact Assessment (EIA): A formal, structured process of evaluating the likely environmental impacts of a proposed scheme, considering inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

Full Business Case (FBC): The culmination of the final phase is the Full Business Case. An investment committee will consider the Full Business Case then make a recommendation to ministers. Ministers will decide whether a proposal should proceed to implementation.

Form: The layout (structure and urban grain), density, scale (height and massing), appearance (materials and details) and landscape of development.

Gross Domestic Product (GDP): A measure of the value of goods and services produced in the UK.

Gross Value Added (GVA): A measure of the value of goods and services produced at a sub-national or industry level. GVA is used to calculate GDP for national accounting purposes. GDP is a broad aggregate measure of economic activity and cannot be calculated at the level of the individual business, which renders it an infeasible metric for measuring economic activity at the sub-national or industry level.

High Quality Public Transport (HQPT): High Quality Public Transport, is a transport system that includes a range of features such as high levels of segregation, junction priority, high quality infrastructure (shelters, CCTV, real time, lighting, seating, help points etc), and high quality vehicles to name but a few.

Heritage Asset: A building, monument, site, place, area or landscape of historic value.

Investment Sifting and Evaluation Tool (INSET): INSET is Mott MacDonald's evaluation tool used in the optioneering process. INSET is an enhancement and expansion of EAST.

Landform: Combination of slope and elevation that produce the shape and form of the land.

Landscape: The character and appearance of land, including its shape, form, ecology, natural features, colours and elements and the way these components combine. Landscape character can be expressed through landscape appraisal, and maps or plans. In towns 'townscape' describes the same concept.

Landscape Character: The distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how this is perceived by people. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape.

Landscape Feature: A prominent eye-catching element, for example, wooded hilltop or church spire.

Landscape Quality: Based on judgements about the physical state of the landscape, and about its intactness, from visual, functional, and ecological perspectives. It also reflects the state of repair of individual features and elements which make up the character in any one place.

Landscape Sensitivity: The extent to which a landscape can accept change of a particular type and scale without unacceptable adverse effects on its character.

Land Use: The primary use of the land, including both rural and urban activities.

Land Value Uplift (LVU): The change in value from developing the land which Is the value of the land in its new use (e.g. commercial or residential) minus the value of the land in its existing use. Any increase in land value as a result of a change in its use reflects the economic benefits of conversion to a more productive use.

Local Liaison Forum (LLF): The LFF provide a link between a project team and the local community.

Multi Criteria Assessment Framework (MCAF): Multi-Criteria Assessment Frameworks are used in the optioneering assessment process and allow options to be assessed against a range of criteria linked to the scheme objectives as well as wider policy and strategy objectives.

Methodology: The specific approach and techniques used for a given study.

Mitigation: Measures, including any process, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual effects of a development project.

Modal Shift: A shift from one transport type to another e.g. road travel to rail travel.

Movement: People and vehicles going to and passing through buildings, places and spaces. The movement network can be shown on plans, by space syntax analysis, by highway designations, by figure and ground diagrams, through data on origins and destinations or pedestrian flows, by desire lines, by details of public transport services, by walk bands or by details of cycle routes.

Option Assessment Report (OAR): The Options Assessment Report sets out the process undertaken to identify and assesses options, leading to the selection of the preferred option.

Outline Business Case (OBC): Is the second phase of the process which reconfirms the conclusions of set out in the Strategic Outline Business Case (SOBC). The OBC focuses on the detailed assessment of the options to find the best solution.

Public Accounts (PA) table: Records the investment and operating costs incurred by a public sector in delivering the scheme.

Receptor: Something that makes up the environmental baseline e.g. humans or other biological species, elements of the physical environment including water, air, soil, assets that make up the cultural heritage of an area.

SATURN: Simulation and Assignment of Traffic in Urban Road Networks, is a computer program that calculates route choices between origin and destination.

Strategic Outline Business Case (SOBC): This sets out the need for intervention (the case for change) and how this will meet strategic aims and objectives (the strategic fit). It provides suggested or preferred ways forward and presents the evidence for a decision.

Strategic View: The line of sight from a particular point to an important landmark or skyline.

Supplementary Economic Modelling (SEM): Non-standard methods to estimate the economic impact of transport schemes, further outlined in TAG Unit M5.3 on Supplementary Economic Modelling.

Sustainability: The principle that the environment should be protected in such a condition and to such a degree that ensures new development meets the needs of the present without compromising the ability of future generations to meet their own needs.

Topography: A description or representation of artificial or natural features on or off the ground.

Townscape: Physical and social characteristics of the built and unbuilt urban environment and the way in which those characteristics are perceived. The physical characteristics are expressed by the development form of buildings, structures and space, whilst the social characteristics are determined by how the physical characteristics are used and managed.

Tranquillity: A state of calm or quiet.

Transport Appraisal Guidance (TAG): The DfT's Transport Appraisal Guidance (often referred to as TAG)

Transport Economic Efficiency (TEE) table: Summarises the monetised impacts against different user groups.

Transport User Benefit Appraisal (TUBA): TUBA is an economic appraisal computer programme developed for the Department for Transport (DfT) for appraising multi modal transport studies.

Value for Money (VfM): Using public resources in a way that creates and maximise public value.

Visual Impact: Change in the appearance of the landscape as a result of development. This can be positive (i.e. beneficial or an improvement) or negative (i.e. adverse or a detraction).

Wider Economic Impacts (WEI): improvements in economic benefits that are acknowledged, but which are not typically captured in traditional cost-benefit analysis.

1. Introduction

This is the Economic Case for the Camborne to Cambridge Better Public Transport project (C2C) and forms one of the 5 cases for the Outline Business Case.

The purpose of the Economic Case is to set out the assessment of the options to identify the impacts, and the resulting value for money, to fulfil Treasury's requirements for appraisal and demonstrating value for money in the use of taxpayers' money. The Economic Case identifies what economic, environmental, social and distribution impacts the scheme is expected to deliver.

1.1 Approach

The Economic Case for the C2C project has been developed to ensure that it proportionally follows the requirements of the DfT's *'The Transport Business Case: Economic Case*[1]*.* Table 1 shows where the relevant information, in accordance with DfT requirements can be found in the subsequent sections that make up the Economic Case.

Table 1: Compliance with DfT requirements for the Economic Case

Content	DfT requirements	OBC section
Introduction	Outline approach to assessing value for money.	2 – Approach to Economic Appraisal 4 – Transport Modelling Framework
Options appraised	A list of the options (set out in the Strategic Case) that have been appraised.	3 – Options Assessed
Assumptions	TAG sets out assumptions that should be used in the conduct of transport studies. List any further assumptions supporting the analysis.	5 – Transport Economic Appraisal 6 – Wider Economic Impacts Appraisal – Fixed Land Use 7 – Wider Economic Impacts Appraisal – Land Use Change 8 – Reliability Benefits 9 – Environment Impacts 10 – Social Impacts 11 – Distributional Impact Assumptions are included in narrative.
Sensitivity and risk profile	Set out how changes in different variables affect the Net Present Value/Net Present Cost. The risk profile should show how likely it is that these changes will happen.	14 – Sensitivity Tests
Appraisal Summary Table	See TAG for detailed guidance on producing the Appraisal Summary Table.	Appendix N
Value for Money Statement	See Value for Money guidance on producing the VfM statement.	13 – Value for Money

Source: DfT - The Transport Business Case: Economic Case

[1] DfT – The Transport Business Cases (January 2013) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/85930/dft-transport-business-case.pdf

1.2 Scheme overview

The Greater Cambridge Partnership (GCP) is promoting a transport scheme to improve connectivity between the town of Cambourne and Cambridge City Centre along the A428/A1303, creating a vital link to ease congestion, offer sustainable travel choices, connect communities and support growth. The scheme is known as the C2C project. This report presents the economic case for the preferred route option known as the off-road option. Full details of the preferred scheme design are presented in Section 1.4.

The Economic Case assesses options to identify all their impacts, and the resulting value for money, to fulfil Treasury's requirements for appraisal and demonstrating value for money in the use of taxpayers' money the Economic Case identifies what economic, environmental, social and distributional impacts the scheme is expected to have.

This report presents the economic case for the scheme and focuses on the monetised impacts of the scheme. The report sets out to provide:

- An assessment of the economic benefits of the C2C project capturing economic, environmental, social and distribution impacts of the scheme.
- An assessment of the scheme Value for Money (VfM) based on outputs from the Cambridge Sub-Regional Model 2 (CSRM2), as well as the monetisation of other scheme benefits where proportional to their impact, and the latest available scheme costs following current guidance on VfM.

The report describes the methodology used to produce the transport economic appraisal the calculation of accidents benefits, journey time reliability benefits and wider economic impacts. Furthermore, this report describes the methodologies used to complete the appraisals of noise, air quality and greenhouse gases.

1.3 Scheme objectives

The key objectives of the proposed scheme are to:

1

- **To achieve improved accessibility to support the economic growth of Greater Cambridge.**
- Support the delivery of new housing and job creation through the provision of HQPT that serves current and future housing sites along the A428/A1303, including Cambourne and Bourn, and employment sites within and around Cambridge city centre.
- Provide additional capacity during the peak periods to meet forecasted growth in demand along the A428/A1303.
- Does not to impede existing road traffic, resulting in a growth in delays for highway trips along the A428/A1303.
- Improve connectivity on part of the Oxford-Cambridge Arc

2

- **To deliver a sustainable transport network/system that connects areas between Cambourne and Cambridge along the A428/A1303.**
- Improve connectivity into Cambridge using sustainable modes of transport such as walking, cycling, and High Quality Public Transport (HQPT).
- HQPT that offers peak journey times that are equal to or less than the equivalent journey by car.
- HQPT frequency during the peak periods of six buses or more an hour.
- End to end journey time reliability better than the car alternative journeys.
- HQPT offering improved waiting and in-vehicle environments that are comparable to Cambridge's existing Guided Busway.

3

- **Contribute to enhanced quality of life by relieving congestion and improving air quality within the surrounding areas along the A428/A1303 and within Cambridge city centre.**
- Improve the attractiveness of sustainable modes of travel as an alternative to using cars, leading to an increase in their mode share.
- Supports Cambridge in achieving continued economic growth whilst retaining the high quality of life and place associated with the city.
- Introducing improvements which enhance levels of safety for cyclists and pedestrians and promote a healthier life style.

1.4 The preferred option

The preferred option for the C2C project is the off-road alignment for Phase 1 and Phase 2 with Scotland Farm as the preferred Park & Ride site.

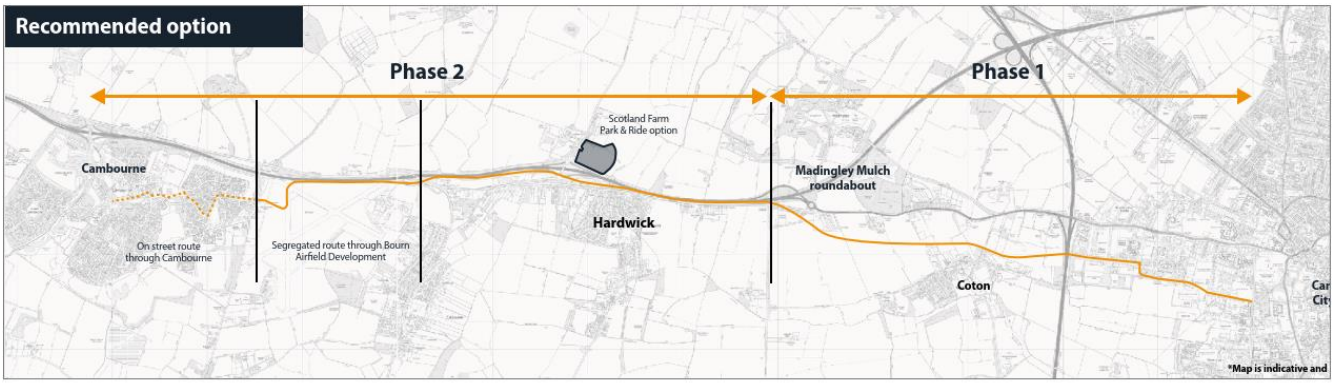
Preferred option detailed description is as follows:

- The preferred route alignment starts in Cambourne, running on the existing street network before turning off Sterling Way onto a new section of segregated public transport route which crosses Broadway and into the proposed Bourn Airfield Development.
- It then travels along the northern edge of the proposed development along a segregated corridor, crossing St Neots Road west of the roundabout on St Neots Road / Highfields Road.
- From this point it continues east on a segregated route between the A428 and St Neots Road until it re-joins general traffic at the Scotland Farm Junction.
- From here public transport vehicles will access the Park & Ride site at Scotland Farm, located to the east of Scotland Farm, just north of the A428.

- On leaving the Park & Ride, vehicles re-join a segregated route between the A428 and St Neots Road via the existing roundabouts where it travels from Hardwick to the junction with Long Road.
- Here, the route crosses to the southern side of St Neots Road and continues through existing agricultural fields to the south of the A1303, Madingley Road.
- Passing north of Coton, the route crosses Cambridge Road at a new signalised junction before continuing to cross the M11 on a new bridge.
- Entering the West Cambridge site the segregated route continues alongside Charles Babbage Road before turning south and exiting the West Cambridge site into the West Fields via the unnamed road leading to Forster Court where it immediately turns and heads east, following the line of, and to the south of, an existing cycleway / footway.
- Where it meets the junction with Adams Road and Wilberforce Road, public transport vehicles leave the segregated route and re-join general traffic along Adams Road, which will have existing parking bays removed along its length.
- Vehicles continue to the junction with Grange Road where they continue their onward journeys on the existing road network.
- A new footway cycleway follows the segregated sections of the route through Bourn Airfield up to the Scotland Farm junction.
- At this point the cycleway / footway moves to the southern side of St Neots Road up to the junction with Long Road where it re-joins the segregated route to West Cambridge.
- Existing cycle routes are utilised through the West Cambridge site and the existing cycleway / footway is maintained between West Cambridge and the Adams Road / Wilberforce Road junction.

Figure 1 illustrates the high-level summary of the emerging scheme, with detailed drawings included in Appendix R – Preferred Option Drawings.

Figure 1: C2C Preferred Option



Source: Mott MacDonald (© Crown Copyright. All Rights Reserved. OS License Number 100023205.2018)

Source: Mott MacDonald

1.5 Scheme benefits

The C2C project will offer the following benefits (all benefits shown for forecast year 2036):

Table 2: C2C preferred option benefits vs Do Minimum

Benefit	The scheme (DS)	The DM
Journey times (inbound)	• **32 mins** AM Peak (08:00-09:00) • **29 mins** Inter Peak (10:00-16:00) • **32 mins** PM Peak (17:00-18:00)	• **53 mins** AM Peak (08:00-09:00) • **28 mins** Inter Peak (10:00-16:00) • **38 mins** PM Peak (17:00-18:00)
Demand (peak average hourly bus passengers two-way – East of Madingley Mulch)	• **863** passengers AM Peak • **233** passengers Inter Peak • **320** passengers PM Peak	• **370** passengers AM Peak • **248** passengers Inter Peak • **231** passengers PM Peak
Service Frequency	• **6 buses per hour** (10 min interval) direct express service between Cambourne High Street and central Cambridge, via the new Park & Ride site. • Local service running in parallel **2 buses per hour** (30 min interval).	• **3 buses per hour** (20 min interval) non-express service between Cambourne High Street and central Cambridge.
Capacity (AM Peak 08:00-09:00, two way)	• **1,520** capacity	• **570** capacity
	• Demand with the scheme is forecast to increase by 233% by 2036, with capacity increasing by 267%, therefore catering for the additional demand.	
Journey time reliability	• C2C estimate at delivering £536,000 (2010 prices) in additional benefit from reliability improvements.	
Mode share (Percentage of trips undertaken by car vs bus. Two way mode share east of Scotland Farm Park & Ride across 12 hour weekday)	• 94% car • 6% bus	• 96% car • 4% bus
Wider economic impacts	• **£102.8m** direct GVA per annum • **£676.1m** in total GVA over 30 years • **£458m** (2019 prices) in Land Value Uplift	• None
Environmental	• Reduction in levels of private vehicle use will lead to: • Improved air quality in the Cambridge City Centre AQMA. • Improved setting around the SSSI and the American Cemetery.	• Higher levels of traffic compared to current levels, resulting in greater levels of congestion, resulting in: • Poorer air quality in the Cambridge City Centre AQMA. • Worsening of the setting of the SSSI and American Cemetery.

Source: Mott MacDonald

2. Approach to Economic Appraisal

2.1 Introduction

The economic appraisal has been carried out in line with Department for Transport (DfT) guidance to produce robust Value for Money (VfM) assessments for the C2C project.

The Economic Case for the C2C project concludes with a VfM assessment that incorporates both the monetised impacts and the non-monetised assessment of the project (including qualitative and non-monetised quantitative assessment where available).

The approach to the C2C project economic appraisal has been undertaken in two steps:

- **Step 1:**
  - The first step involved the assessment of the transport impacts of each shortlisted option for Phases 1 and 2 (detailed in Appendix B: OAR2 and Appendix C: OAR3).
  - When set against the project's projected expenditure, these resulted in an initial Benefit-Cost Ratio (BCR) for the short-listed options.
  - Combining the BCR results with the outputs of the multi-criteria assessment of the options against a full range of assessment criteria (detailed in Appendix B: OAR2 and Appendix C: OAR3), an overall assessment of the options' VfM was assessed, resulting in the identification and selection of the preferred option.
- **Step 2:**
  - The second step involved further assessment of the preferred option against a wider range of monetised impacts, including environmental, social and safety impacts, as well as the assessment of qualitative impacts.
  - This includes an updated assessment of the project's Wider Economic Impacts (WEIs).
  - The results of this assessment have informed the final VfM statement for the C2C project, enabling a robust VfM assessment to be presented in this Economic Case.

2.2 Transport guidance and Wider Economic Impacts

The HM Treasury (HMT) Green Book[2] provides central government guidance on how to appraise and evaluate public policies, projects and programmes (the Five Case Model), which is based on the principles of welfare economics. The Department for Transport (DfT) Transport Appraisal Guidance (TAG) is the Department's internal guidance on business case making, which the OBC for this scheme is consistent with.

The Economic Case for the scheme includes Cost-Benefit Analysis (CBA) of user and non-user impacts (from changes in travel costs and times, including decongestion), changes in the externalities associated with car use (e.g. emissions and accidents), and changes in operating costs and revenue to the public and private sector. These, under an assumption of no changes in land use, are all termed Level 1 impacts. When set against a scheme's projected capital and operating expenditure, these result in an Initial Benefit-Cost Ratio (BCR). User benefits (in the form of monetised travel time savings) are typically the principal effect of a transport improvement and form the core of an economic appraisal but there is wide agreement that they fail to capture the full impact of major projects.

[2] The Green Book: Central Government Guidance on Appraisal and Evaluation, HM Treasury, 2018

Through consumer surplus theory, user benefits are assumed to act as a proxy for conventional economic impacts, e.g. changes in Gross Domestic Product (GDP), or, at a local/regional level, Gross Value Added (GVA) and the associated jobs gains and productivity uplifts. In practice, however, because of the presence of market failures the benefits accruing to users may only partially account for the benefits of a transport improvement.

Since the mid-2000s, this analysis has been augmented within TAG [3] with recommendations for the assessment of WEIs, as set out in TAG units A.2.1-A.2.4 (& TAG unit M5.3). This guidance seeks to capture the net additional impacts (at the UK level) that can arise as the impact of the transport improvements are transmitted into the wider economy, beyond those businesses and passengers that are directly affected by the transport change.

The DfT's latest guidance on WEIs (published in May 2018) identifies three 'levels' of impact and these have been incorporated into the VfM assessment. These include:

- **Level 1 (User benefits):** These are direct effects and comprise the savings in time, vehicle operating costs and other elements of 'generalised travel cost' associated with better transport. The Level 1 BCR also includes some monetised externalities to society and the environment. These are also termed 'established' monetised economic impacts of transport investment (as they have long been the mainstay of economic appraisal).

- **Level 2 (Productivity effects):** these are productivity gains accruing to firms and workers, including those that are not themselves necessarily users of the transport improvement. These arise because of the economic benefits of scale and economic density, both of which are known to lead to higher productivity. These are also termed 'evolving' monetised economic impacts and are initially (for Level 2) considered in terms of **fixed land use** scenarios, i.e. no interaction between transport supply and land use patterns.

- **Level 3 (Investment and employment effects):** these result from the potential for transport to alter patterns of private sector investment and employment, and thereby land use. This is a complex area of debate given transport links are but one factor shaping the location decisions for firm's investment. The concepts of additionality, displacement and the social value of investment are important here. These effects are also 'indicative' monetised impacts and can involve **dynamic land use** scenarios (in response to changes in transport supply).

[3] Available at: https://www.gov.uk/guidance/transport-analysis-guidance-TAG [Accessed: 02/02/18].

Figure 2 sets out the relationship between the three levels of benefits.

Figure 2: WEIs and Levels of Analysis

Table 2 - Relationships between Wider Economic Impacts, Levels of Analysis and Land Use assumptions

	Level 1 (Initial BCR)	Level 2 (Adjusted BCR)	Level 3 (Indicative Monetised Impacts or Non-Monetised Impacts)
Fixed Land Use	User benefits →		
		Static Clustering →	
Implicit Land Use Change		Output Change in Imperfectly Competitive Markets →	
		Labour Supply Impacts →	
Explicit Land Use Change			Dependent Development
			Move to More/Less Productive Jobs
			Dynamic Clustering
			Supplementary Economic Modelling

***Note that the arrows signify the previous levels of analysis are required**

Source: TAG UNIT A2.1, Wider Economic Impacts Appraisal, December 2017

The primary rationale of the C2C project is to support the continued growth of Greater Cambridge by providing new transport infrastructure that will provide effective links to development sites, supporting housing and employment growth. It will also provide the first stage of the Cambridgeshire Autonomous Metro (CAM) which will build on this by connecting central Cambridge, its current and future rail stations, to all the major employment sites on the city's fringe, the new settlements and other key growth areas across the wider region. Fundamentally, given the overall aim of these proposals are to enable growth by ensuring sufficient transport capacity, it is critical that the business case, whilst adhering to DfT's TAG Unit A2.1 guidance, looks more widely from a local economic development perspective at how the scheme supports economic growth in Greater Cambridge and how these translate into net economic impacts at the UK level.

The accompanying Strategic Economic Narrative Report (Appendix J)[4] therefore sets out this narrative and how land uses changes supported via the C2C project support the spatial growth planned for Greater Cambridge. Using this narrative, the report then looks from a DfT TAG perspective to consider the Level 3 impacts emerging from the scheme by considering induced investment (TAG Unit A2.2) and TAG Unit M5.3 on Supplementary Economic Modelling (SEM).

Below each category of benefit is explained further and the approach for assessing each within this Economic Case.

[4] Cambourne to Cambridge Better Public Transport Project: Strategic Economic Narrative, Mott MacDonald, September 2019

2.2.1 Level 1: Transport Impacts

The Level 1 benefits for the C2C project have been calculated in line with DfT guidance to inform the initial VfM assessments and the initial BCR. The appraisal focused on the monetised transport user benefits to produce the initial BCR.

Table 3: Level 1 benefits informing core VfM statement

Benefit	Description
Transport user benefits (TAG A5-4)	• Transport economic appraisal is undertaken in accordance with published DfT guidance This has followed the marginal external costs method from TAG unit A5-4. • The use of road vehicles incurs both private costs borne by the individual traveller, such as fuel and personal travel time, and external costs borne by others. For car use, these external costs include congestion, air pollution, noise, infrastructure and accident costs. The MEC method is based on the change in these external costs arising from a change in vehicle kms as a result of the scheme.
Safety (TAG A5-4)	• As with the transport user benefits, this has followed the marginal external costs method from TAG unit A5-4.
Air Quality (TAG Unit A5-4)	• As with the transport user benefits, this has followed the marginal external costs method from TAG unit A5-4.
Noise (TAG Unit A5-4)	• As with the transport user benefits, this has followed the marginal external costs method from TAG unit A5-4.
Greenhouse gases (TAG Unit A5-4)	• As with the transport user benefits, this has followed the marginal external costs method from TAG unit A5-4.
Active Travel (TAG Unit A5-1)	• Appraisal of the active travel benefits associated with changes to walking and cycling trips using the DfT Active Mode Appraisal Toolkit (AMAT)

Source: Mott MacDonald

2.2.2 Level 2: Wider Economic Impacts (fixed land use)

Level 2 benefits have been calculated in accordance with TAG Unit A2-1 and use the transport modelling outputs as a basis for all calculations. The results of the Level 2 benefit appraisal were used to inform an adjusted BCR that takes into account the WEIs of the C2C project, assuming fixed land use.

This appraisal only captures impacts that are not already included in the conventional transport user benefit calculations, including:

- Agglomeration;
- Tax revenues arising from labour market impacts, and;
- Output change in imperfectly competitive markets.

Table 4: Level 2 - Project benefits informing adjusted VfM statement

Benefit	Description
Agglomeration (TAG Unit A2.1)	• Agglomeration refers to the concentration of economic activity over an area. Transport can increase the accessibility of an area for businesses and workers, therefore impacting on the level of agglomeration, through the reduction of generalised costs for business and commuting trips. • The level of agglomeration reflects the productivity benefits experienced by businesses as a result of improved connections to other businesses and to potential employees thus improving interaction, knowledge exchange and access to markets, including labour markets.
Tax revenues arising from labour market impacts (TAG Unit A2.1)	• Transport can have an impact on labour supply by affecting the overall costs and benefits to individual workers. An individual will weigh the cost of travel against the wages of a job travelled to. Changes in transport costs is likely to have an impact on the incentives of individuals to work and hence have an impact on the overall level of labour supplied in the economy. • This can have a positive impact on the economic at a national level with an increase in potential workers employed affecting the level of UK GDP through increases in tax revenues
Output change in imperfectly competitive markets (TAG Unit A2.1)	• Markets are generally considered not to be perfectly competitive, thus leading to lower production and higher prices than would exist in a perfectly competitive market. This is seen as being detrimental to consumers and the economy as a whole. • Reductions in transport costs allows for an increase in production in the goods and services that use transport, reducing costs so that businesses can make more profit or pass on the saving to customers so they can be more competitive.

Source: Mott MacDonald

2.2.3 Level 3: Wider Economic Impacts (land use change)

The Strategic Economic Narrative Report (Appendix J) sets out how the C2C project supports the spatial growth planned in Greater Cambridge and therefore has the potential to alter patterns of private sector investment and employment, and thereby land use.

The assessment of the Level 3 impacts has been based on a Land Value Uplift (LVU) approach which examines how the C2C project supports the planned development along the corridor. This includes the economic impacts at a:

- **Greater Cambridge level**, which focuses on how the C2C project helps to address transport and housing bottlenecks along the corridor and therefore support development. The economic impacts are measured in terms of gross jobs and the associated Gross Value Added (GVA) supported at development sites along the corridor. This primarily informs the Strategic Case.
- **UK level**, which focuses on the net benefits for the UK. A key consideration in order to set out the Level 3 WEIs is producing a best understanding of the difference between the net impacts at the sub-national level, i.e. Greater Cambridge, and national level. This depends on assessing the level of likely displacement of economic activity between Greater Cambridge and the rest of the UK which the scheme will support.

The UK impacts are primarily measured in terms of the LVU associated with dependent development (adjusted for displacement) while the sub-national impacts focus on the jobs and GVA generated.

Within this Economic Case the outputs of the assessment of Level 3 impacts within the accompanying Strategic Economic Narrative and Economic Impact Report are used to inform the Value for Money assessment using a 'Switching Value' approach following DfT Value for Money guidance. This examines the additional level of benefits required to change the

scheme's VfM category and how the additional brought about through LVU contributes to this switch.

Table 5: Level 3 economic impacts – informing this Economic Case

Benefit	Description
Dependent development	
Land Value Uplift (LVU)	• Relates to the increase in land value as a result of a change in its use reflecting the economic benefits of conversion to a more productive use. The estimate is then adjusted for any change that would occur without the proposed intervention, displacement of demand from other potential developments and the wider effects of the resulting development. • Calculated for Greater Cambridge and the net UK impacts. • Forms 'non-traditional' Level 3 impacts using dynamic land use modelling. • LVU impact at the UK level is the core Level 3 impact.
Labour supply	
Changes in total employment and GDP welfare at a net UK level	• Level 3 SEM – 'non-traditional' using dynamic land use modelling and context specific additionality. • Used as a validation test for the LVU assessment.

Source: Mott MacDonald

The full methodology and assumptions for the Level 3 WEIs are detailed in the Strategic Economic Narrative Report (Appendix J). This assessment builds on the strategic economic appraisal of the scheme in 2016[5]. The focus of the previous study was understanding which scheme option best supported Greater Cambridge's growth ambitions i.e. on-road or off-road solution, to inform the optioneering, whilst the updated report focuses on assessing the WEIs of the preferred option to inform this Economic Case.

Importantly, since 2016, TAG and other central government guidance has been updated and these changes have been incorporated into the updated study. A key aspect of this is the emphasis on assessing the LVU of dependent developments which differs from the approach used in the 2016 report which looked to capture economic impacts based on job creation and GVA impacts. Given this as further validation for the LVU, the previous analysis is updated based on assessing the degree to which the sub-national impacts can be considered net additional at a UK level (termed labour supply impacts above). The accompanying report (Appendix J) fully details the methodology adopted, these changes in full and this validation test. The results reported in this Economic Case focus on the UK LVU assessment and sub-national impacts as listed under dependent development in Table 5.

[5] Strategic Economic Appraisal of A428-A1303 Bus Scheme: Wider Economic Benefits, Cambridgeshire County Council, August 2016

3. Options Assessed

This section briefly summarises the options that were assessed as part of the options assessment process leading up to the identification of the preferred option.

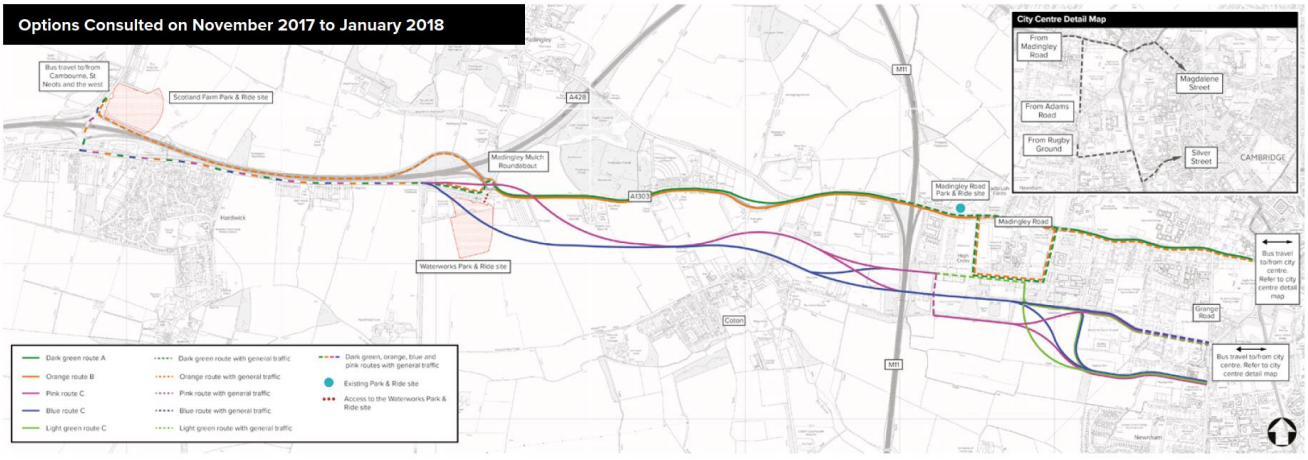
3.1 Phase 1 route options

Option development and appraisal for Phase 1 route alignment was undertaken in 2 stages.

The first stage involved consultation on three options. The definition of the three options consulted on in 2017 was as follows:

- **Option A:** An on-road option which includes the introduction of an inbound bus lane on Madingley Road between Madingley Mulch roundabout and Lady Margaret Road;
- **Option B:** An on-road tidal bus lane on Madingley Road running between Madingley Mulch roundabout and the new entrance to Eddington (High Cross); and
- **Option C:** An off-road public transport route running between Madingley Mulch roundabout and Grange Road, Cambridge.

Figure 3: Phase 1 Options



Source: Consultation leaflet, 2017-2018, (© Crown Copyright. All Rights Reserved. OS License Number 100023205.2018)

Source: November 2017 to January 2018 consultation leaflet

The options were also assessed against each other to generate an '*optimised*' on-road option that reflected Option A and some of the Option B suggested improvements to outbound traffic, and a single specific off-road route alignment from Option C in order to refine the number of variations within each option down.

Stage 2 of the options assessment process for the Phase 1 route alignment involved the assessment of these *'optimised'* options, with the incorporation of each of the proposed Park & Ride sites, against both a Do Minimum scenario and an Illustrative Comparator.

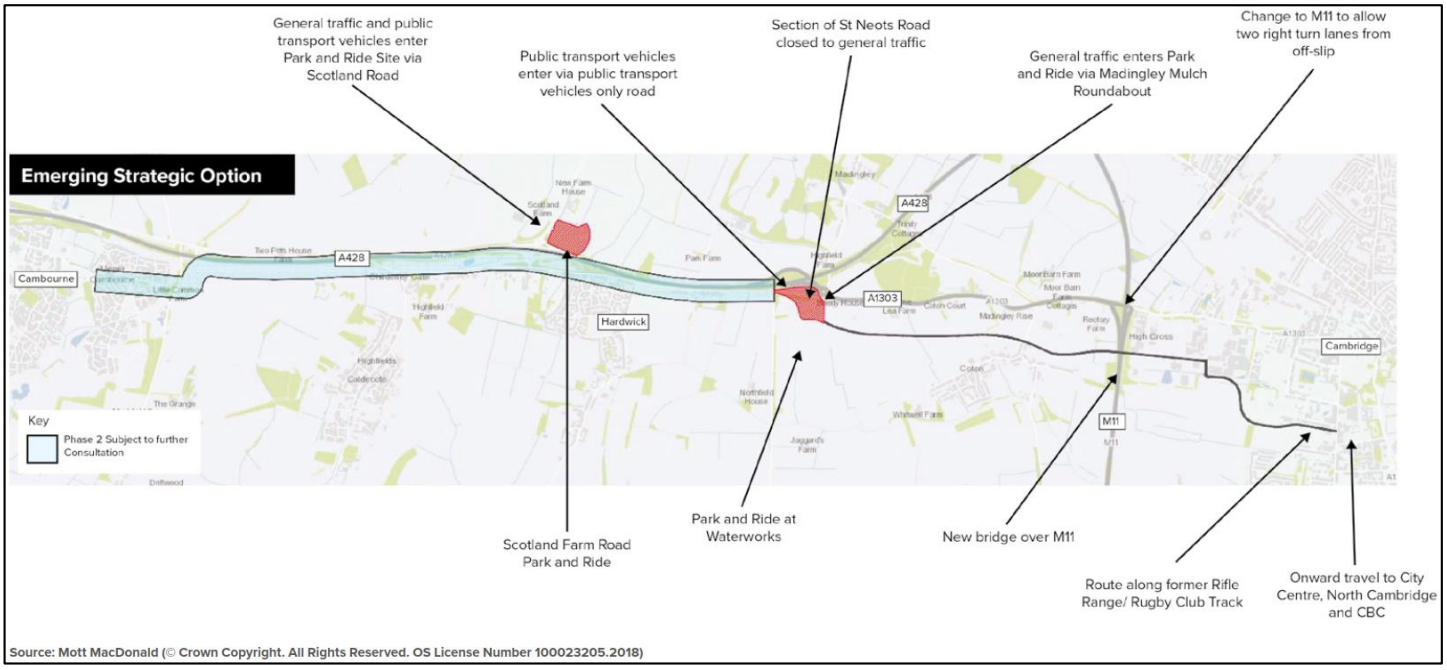
The definitions of the options as part of Stage 2 were as follows:

- **Do Minimum** – Committed Schemes
- **Low Cost a** – Recommended optimised on-road Phase 1 + Park & Ride at Waterworks
- **Low Cost b** – Recommended optimised on-road Phase 1 + Park & Ride at Scotland Farm

- **Do Something 1a** – Recommended off-road Phase 1 Madingley Mulch Roundabout to Grange Road + Park & Ride at Waterworks
- **Do Something 1b** – Recommended off-road Phase 1 Madingley Mulch Roundabout to Grange Road + Park & Ride at Scotland Farm
- ***Illustrative Comparator*** – *Recommended off-road Phase 1 and Phase 2 Cambourne to Grange Road Park & Ride at Waterworks for comparative purposes*

The results of the options assessment for Phase 1 concluded with an Emerging Strategic Option, which is illustrated in Figure 4. This was an off-road route alignment. The detailed assessment of the options, the options assessment process and results for Phase 1 are set out in OAR 1 and 2 (Appendix A and B) and in the Cambourne to Cambridge Better Public Transport Project Interim Report (November 2018)[6].

Figure 4: Emerging Strategic Option – Phase 1 route alignment



Source: Mott MacDonald

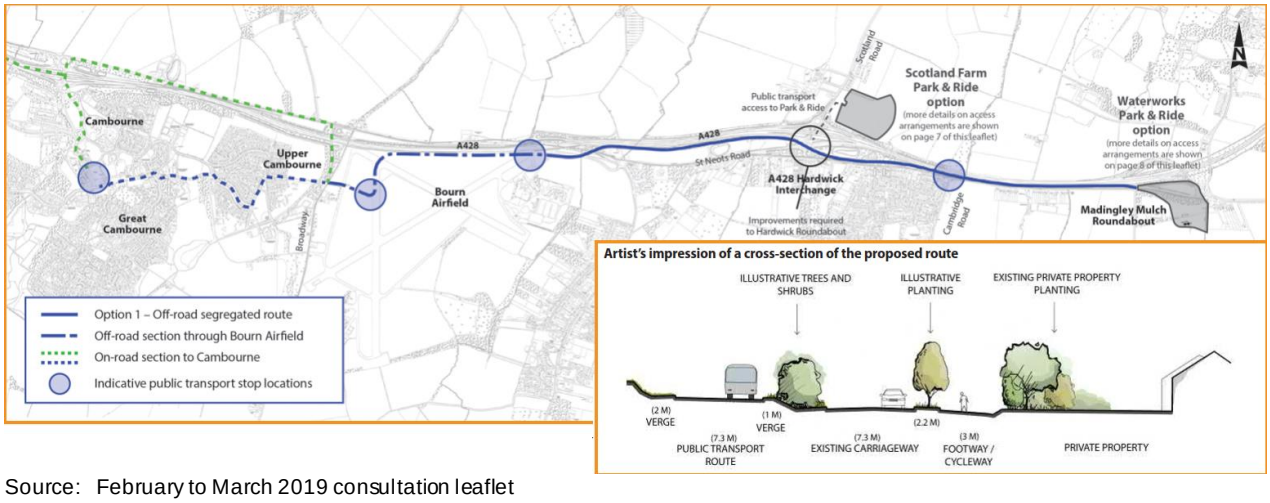
3.2 Phase 2 route options

Phase 2 route alignment options included three options, with each option including Phase 1 preferred route alignment. The definition of the three options for Phase 2 is as follows:

- **Option 1:** Off-road segregated route. A new public transport route adjacent to the A428 and St Neots Road. The route would be entirely off-road with minimal interaction with general traffic, except at junctions.
- **Option 2**: On-road with junction improvements. Public transport vehicles would run on-road along St Neots Road with general traffic east of the Bourn roundabout. There would be basic junction improvements.
- **Option 3:** On-road with public transport priority lanes. Public transport vehicles would run on-road along St Neots Road in priority lanes running in both directions.

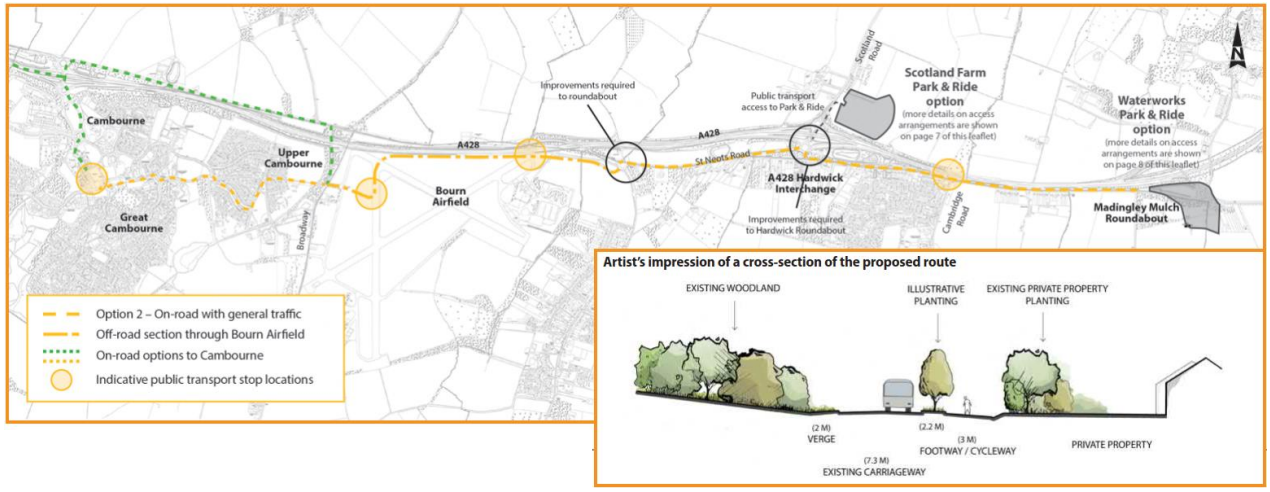
[6] https://www.greatercambridge.org.uk/transport/transport-projects/cambourne-to-cambridge/cambourne-to-cambridge-background/

Figure 5: Phase 2 – Option 1: Off-road segregated route



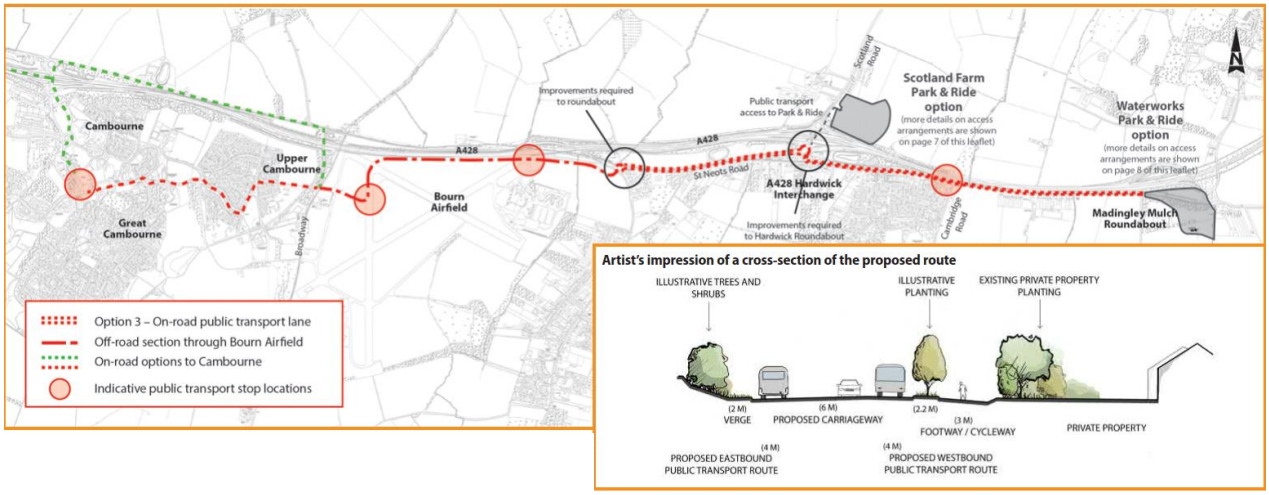
Source: February to March 2019 consultation leaflet

Figure 6: Phase 2 - Option 2: On-road junction improvements



Source: February to March 2019 consultation leaflet

Figure 7: Phase 2 – Option 3: On-road with public transport priority lanes



Source: February to March 2019 consultation leaflet

4. Transport Modelling Framework

The Cambridge Sub Regional Model D Series (CSRM2) has been used as the basis of the assessment of the different options. This has been enhanced with additional local refinements to its highway model and the creation of a new public transport model to provide a more accurate assessment of the public transport impacts of the options being considered.

The following reports explain the CSRM2 base year model, demand model set-up and forecasting approach:

- CSRM2 D-Series Highway Local Model Validation Report (v3.0, October 2018)
- CSRM2 D-Series Transport Demand and Public Transport Model Development and Validation Report (v3.0, October 2018)
- CSRM2 D-Series Model Forecasting Report

These provide details of the survey data used to build the base year traffic model and the network and planning assumptions used to produce the forecast assignments.

4.1 Base Year Modelling

4.1.1 2015 Base Year Highway Model

The base year CSRM2 SATURN highway model structure was initially reviewed along the A428/A1303 corridor, A10/A1309 and A1307 corridors. Additional local road links and new development zones were added to the network to ensure that the forecast schemes could be assessed accurately. In particular for this scheme, additional local roads were included in Cambourne close to the of the proposed off-road public transport link.

The modelled flows at various points along the A428/A1303 corridor were compared to the observed data available to ensure the model was accurately reflecting current base year (2015) flows. In addition to the observed data used as part of the CSRM2 calibration and validation, additional A428 November 2015 data taken from WebTRIS, Highway England's count data website, was used together with observed vehicles entering and exiting Madingley Park & Ride site.

In the AM peak hour (08:00-09:00), the modelled flow on the M11 J13 southbound on-slip was lower than observed and there was some inconsistency between A428 data available from WebTRIS, but at all the locations modelled flows met the TAG validation criteria from unit M3.1.

In the interpeak (10:00-16:00), the A428 westbound modelled flow just west of the A1303 junction was higher than the observed data from the CSRM2 validation but did match an equivalent WebTRIS site. At all other locations modelled flows met the TAG validation criteria.

In the PM peak hour (17:00-18:00), there is insufficient modelled flow westbound on the A1303 and A428 west of the M11 but the right levels of modelled flow east of the M11. All eastbound modelled flows and all locations east of the M11 meet the TAG validation criteria.

Detailed tables showing the comparison of observed and modelled base year flows are included as an annex to OAR3 (Appendix C).

The modelled journey times along the A1303 were also compared to observed travel times. The CSRM2 journey time route along the A1303 and then out along the A10 was subdivided to concentrate on the A1303 section between the A428 and Grange Road in more detail.

In the AM peak the observed eastbound travel times between the A428 and M11 of over 20 minutes could not be replicated by the model. Similarly, the observed travel time of 7 minutes in the westbound direction west of the M11 in the PM peak could not be replicated by the model. Contra-peak direction and interpeak travel times were all replicated well by the model.

Investigation into these large observed peak direction travel times revealed that roadworks had been in place along the A1303 during the time that the observed travel times were recorded. Comparisons of observed flow and travel time data between the model base year of 2015 and the subsequent year, 2016 when the roadworks was no longer in place were undertaken. These showed that peak direction flows were reduced with the roadworks and journey times were significantly slower.

Detailed tables showing the comparison of observed and modelled base year and 2016 journey times are contained as an annex to OAR3 (Appendix C).

The comparison of modelled PM peak outbound journey times against the 2016 observed data shows that the model travel times compare well with the observed data. The AM peak inbound modelled travel times are still quicker than the 2016 observed data but this is to be expected as the 2015 traffic flow levels are lower than those observed in 2016.

4.1.2 2015 Base Year Public Transport Model

Public transport supply data was sourced from CSRM2 and converted from MEPLAN software to build a standalone model in CUBE software. During this conversion process, the hierarchical network of connections between modes as coded in MEPLAN was simplified such that transfers within a transit node did not require additional walk connections. The physical transit network was developed based on links describing the stopping sequences of transit lines. Thus, intermediate nodes such as junctions are not represented.

Journey times for transit services are based on the congested times modelled in the CSRM2 highway module, which are added to the timetabled running times in the MEPLAN model. Where transit lines were coded with varying headways along the route in MEPLAN, this was converted into additional variant transit lines such that link vehicle frequencies matched those in CSRM.

The zoning system was retained as per CSRM2 and additional connectors added where zones were not directly connected to constituent transit nodes served by transit lines. Direct zone connectors were added where excessively long public transport routings were being made between adjacent zones.

Rail demand matrices were sourced directly from CSRM2. New bus matrices were developed using a combination of onboard bus origin-destination surveys and ticket sales data from November 2015. Ticket sales data controlled the magnitude of the demand matrices with the Origin Destination survey data providing trip end distributions. Separate matrices were developed for conventional bus, Guided Bus and Park & Ride bus based on observed usage of each sub mode in the survey data.

For Park & Ride demand, the highway element of these trips is not modelled explicitly in the public transport model. Trips in the rail and bus Park & Ride matrices were aggregated to the zones representing either the bus Park & Ride site or the relevant rail station, using a gravity function to distribute zonal trip ends to up to three competing Pare & Ride locations. This was

based on the principle that AM Peak trips predominantly drive to the Park & Ride site and thus trip origins are aggregated to the site, and likewise trip destinations in the PM Peak. The Interpeak was aggregated to provide an overall balance of trips to and from Park & Ride sites across the day.

The aggregation process resulted in demand at most bus Park & Ride sites being up to 85% of car parking capacity, with only Madingley Road and Newmarket Road having over 100%. However, these proportions do not take account of the proportion of Park & Ride bus service usage by non-drivers (e.g. car passengers, kiss & ride, walk/PT access).

For rail, any excess in Park & Ride demand allocated to stations in excess of parking availability was not aggregated to the site but retained as full Origin Destinations and assumed to access the station by public transport. Most station car parks are effectively filled in the morning peak, and so no aggregation of interpeak rail Park & Ride demand was undertaken.

The modelled flows across the Cambridge Radial Cordon were compared to the observed data available to ensure the model was accurately reflecting current base year (2015) flows. The observed data used as part of the CSRM calibration and validation was used, with additional data cleaning to remove Monday and Friday data to be consistent with the data used to build the bus matrices, and improve matching of fare stage data to model sectors.

In all cases except Interpeak inbound, all modelled bus flows across the cordon were higher than observed; however, all flows were within TAG unit M3.2 acceptance criteria except for AM Peak outbound. Modelled guided bus flows alone were mostly lower than observed, though in most cases meeting TAG criteria. In many cases hourly flows were lower than the minimum threshold of 150 passengers per hour required to satisfy TAG criteria. Further analysis of average vehicle loadings across the cordon demonstrated no excessive loadings with average loadings in the main peak flow directions varying between 20 and 50 passengers per vehicle.

4.2 Forecast Years Modelling

Foundation Case CSRM2 demand model runs for the Do Minimum scenario and the six different scheme options were produced for the AM peak period (07:00-10:00), interpeak period (10:00-16:00) and PM peak period (16:00-19:00) for the forecast years of 2026 and 2036.

The Foundation Case represents a scenario which is consistent with the currently proposed Local Plans for the four Local Authority Districts represented in CSRM2 (Cambridge City, South Cambridgeshire, Huntingdonshire and East Cambridgeshire). This includes local assumptions on housing, employment and other developments, along with transport schemes which are either committed or expected to be required to support development.

Developments at Bourn Airfield and Cambourne West considered to be scheme dependant were excluded from the forecast demand.

The changes made to the base year highway networks were similarly applied to the forecast year highway networks. Separate networks were then created for the Do Minimum and the six Do Something options (set out in Section 3). In addition to the network changes, new public transport services were included in line with the C2C Bus Strategy (Appendix F). CSRM uses reduced waiting and travel time weightings for high quality bus services compared to ordinary bus services. These reduced waiting and travel time weightings have been applied to the new services along the proposed scheme.

The change between the CSRM2 base year output highway and public transport matrices and those output for the two forecast years were applied to the enhanced highway model and the

new public transport model to provide the final highway and public transport assignments with and without the scheme options.

For forecast year scenarios, separate park and ride matrices for each site were provided from CSRM2. These splits were used in forecasting and aggregating the bus and rail Park & Ride demand, removing the need to estimate Park & Ride site choice as undertaken for the base year.

The CSRM2 demand model had more highway trips entering than leaving both the existing Madingley Park & Ride site and the proposed new Park & Ride sites over a 12 hour period. This was due to non-home based other trips being generated by direction and therefore able to choose a different mode of travel for each direction of their journey.

A process to adjust the model outputs to balance highway trips entering and leaving the Park & Ride sites over a 12 hour day was derived. This retained the CSRM2 AM peak period results and then applied the observed profiles of arrivals and departures across the day from the existing Madingley Park & Ride site to provide interpeak and PM peak period highway trips to and from the Park & Ride sites.

It was also noted that the CSRM2 outputs did not include any trips in the pre-peak hour highway matrices to or from the new Park & Ride sites proposed. These were additionally added in based on the peak hour trips to and from the new Park & Ride sites to ensure the operation of the junctions close to the sites proposed were modelled as accurately as possible.

4.3 Key Modelling Results

4.3.1 Public Transport Journey Times

The tables below show the public transport inbound journey times from Cambourne to the city centre with and without the scheme for each modelled time period and year assessed in the traffic model.

In the AM time period, when buses are travelling in the peak direction there is a substantial journey time saving with the preferred option over the Do Minimum in 2026, journey times in the Do Minimum worsening still further by 2036. In the PM time period, the 2026 journey times are similar to the Do Minimum, but as traffic levels rise by 2036, journey times in the Do Minimum continue to increase, whilst remaining relatively static under the preferred option.

Travel times in the interpeak are roughly similar with and without the scheme for both time period, although there is a slight increase with the scheme as the buses have to route off the busway into the new Park & Ride site before re-joining the busway.

Table 6: 2026 inbound Journey Times (mins:secs)

Option	AM	IP	PM
Do Minimum	49:57	26:28	33:26
Preferred Option	31:13	27:42	31:05

Source: Mott MacDonald

Table 7: 2036 inbound Journey Times (mins:secs)

Option	AM	IP	PM
Do Minimum	52:57	27:44	38:06
Preferred Option	31:41	28:30	32:27

Source: Mott MacDonald

4.3.2 Bus passenger demand

The following tables provide bus passenger numbers across all services along the A428/A1303 corridor at four locations with and without the scheme. There is an increase in bus passengers with the preferred option in the AM and PM peak. In the interpeak passenger numbers increase with the preferred option west of Cambourne and remain roughly the same as the Do Minimum east of Cambourne.

Table 8: AM Peak hourly 2-way bus passengers

Option		West of Cambourne	East of Bourn Airport	East of Scotland Farm	East of Madingley Mulch
Do Minimum	2026	121	350	353	346
Preferred Option		152	885	903	884
Do Minimum	2036	141	373	376	370
Preferred Option		152	863	881	863

Source: Mott MacDonald

Table 9: Interpeak hourly 2-way bus passengers

Option	Year	West of Cambourne	East of Bourn Airport	East of Scotland Farm	East of Madingley Mulch
Do Minimum	2026	143	232	233	241
Preferred Option		197	216	228	228
Do Minimum	2036	153	240	241	248
Preferred Option		204	221	232	233

Source: Mott MacDonald

Table 10: PM Peak hourly 2-way bus passengers

Option	Year	West of Cambourne	East of Bourn Airport	East of Scotland Farm	East of Madingley Mulch
Do Minimum	2026	99	199	206	211
Preferred Option		250	278	297	298
Do Minimum	2036	110	219	226	231
Preferred Option		273	302	320	320

Source: Mott MacDonald

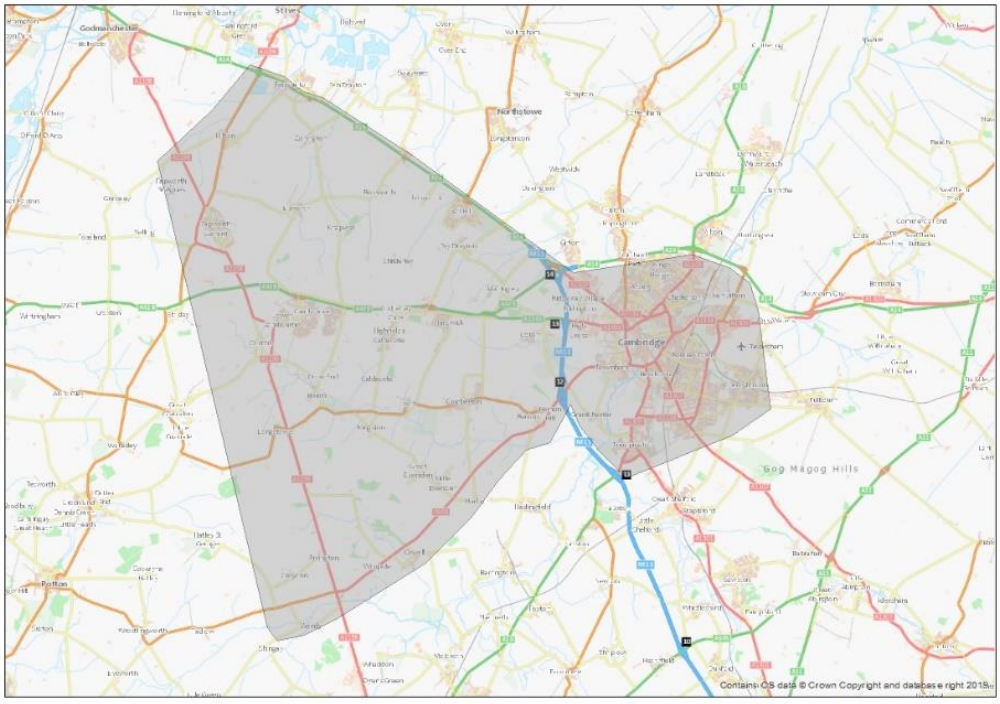
5. Transport Economic Appraisal

5.1 Approach

To ensure consistent and comparable benefit results across the options, the marginal external cost (MEC) has been applied. TAG unit 5.4 suggests that this can be applied in the absence of a suitable multi-modal model. This external cost calculation includes congestion, air pollution, noise, infrastructure and accident costs. The benefits calculated are based on the reduction of vehicle kilometres on the network due to the scheme, while also considering different road types, areas types and congestion levels.

In order to avoid model noise affecting the results from the wider model area, the MEC process has been based on the model area immediately affected by the scheme. The figure below shows the area included from the SATURN model to compare Do Minimum and Do Something vehicle kilometres. This includes the A428 corridor as well as an alternative route to the north, the A14, and an alternative route to the south, the A603.

Figure 8: MEC area



Source: Mott MacDonald

The following steps were carried out to calculate the benefits.

- *Calculating the vehicle kilometres for the scheme area for the Do Minimum and the Do Something.* The actual flow values by user class and time period were extracted from the model assignments excluding scheme dependant development and multiplied by the distance of each link.

- *Identifying the characteristics of each vehicle journey by identifying link capacities.* These were calculated based on suggested average capacities described in TAG unit 5.4 tables A5 and A6 multiplied by the number of lanes. The Cambridge area falls into area type 8 for urban medium. However, as this area type does not provide capacities for motorways the motorway capacities were taken from the rural roads section.
- *Calculating the marginal external costs.* TAG Databook May 2019 marginal external costs and indirect tax values from table A.5.4.2 are available for 2025 and 2030 as well as 2035. Thus, interpolated factors assuming linear growth were calculated for the forecast years. The databook factors are provided for cars, LGV's, artic and rigid HGV's and buses for all costs described above for AM, IP and PM peak. The SATURN model provides forecast traffic flows for cars, LGVs, HGVs and bus. The split between artic and rigid HGV's was based on a selection of DfT counts along the A428, A10 and A1307 to ensure consistent split factors across all current Cambridge schemes assessed by Mott MacDonald. The marginal cost application achieved daily values for an average 2026 and 2036 weekday. These were annualised based on WebTRIS local count data covering all Mott MacDonald project areas.
- *Converting to Present Value Benefits.* Standard TAG databook discount factors were applied over a 60 year appraisal period with benefits assumed to remain consistent from the last forecast year onwards prior to discounting.

During the review of the method it was noticeable that some comparability issues between the options remained. Analysis showed that this was due to the high impact of the congestion band 5 costs on a differing number of links between options. Section 2.4.5 of TAG unit 5.4 warns about the impact of using congestion band 5 and thus, for conservatism, links with type 5 values were changed to a link type 4 in each options including the Do Minimum. The following table list the number of link type 5's in each option converted to link type 4's.

Table 11: Adjusted links

Option	No of links adjusted to link type 4
Do Minimum	411
Option 1a	406
Option 1b	387
Option 2a	386
Option 2b	393
Option 3a	409
Option 3b	401

Source: Mott MacDonald

5.2 Safety impacts

The MEC method has been used for consistency to provide quantitative safety benefits for the preferred option.

5.3 Air quality

The MEC method has been used for consistency to provide quantitative air quality benefits for the preferred option.

5.4 Greenhouse gases

The MEC method has been used for consistency to provide quantitative greenhouse gas benefits for the preferred option.

5.6 Noise

The MEC method has been used for consistency to provide quantitative noise benefits for the preferred option.

5.7 Cycling and walking

Given that the guided busway will also provide facilities for cyclists and pedestrians away from other road traffic, the DfT's Active Mode Appraisal Toolkit (AMAT) and guidance in TAG Unit A5.1 was used to quantify the benefits of the scheme associated with walking and cycling.

AMAT enables the following benefits to be quantified:

- User benefits - estimated journey time savings and journey ambience uplift;
- Business benefits - reduction in absenteeism;
- Health benefits - economic benefits of preventing early mortality through cycle exercise; and,
- Marginal external cost savings – reduction in the number of car trips of 5km due to mode switch to cycling.

5.7.1 Baseline demand

To calculate the current *'without scheme'* walking and cycling demand, road traffic count data available from Cambridgeshire County Council for a site on A1303 Madingley Road (site 2015-56: parallel to the guided busway) was used[7]. The data provides 12 hour, two way count figures for pedestrians and cyclists so is likely to be conservative as demand outside of 7am-7pm is not accounted for.

For the appraisal, it was assumed that not all cyclists will divert from Madingley Road to the guided busway as it is likely that some cyclists will choose to remain on-road and cycle with other traffic. Therefore, it was assumed 15% of current cyclists would remain on their current route.

To growth the demand data (2017) to the scheme opening year (2024), values from the National Trip End Model (NTEM) for walking and cycling in Cambridge and South Cambridgeshire were used to apply a growth factor to the 2017 demand figures.

5.7.2 Demand uplift

To estimate future levels of cycling and walking brought about by the scheme, a comparative study approach as outlined in TAG Unit A5.1 was used. The comparative scheme is the St Ives Guided Busway, Cambridgeshire, which is felt to provide a useful indicator of potential demand uplift given the geographical similarity of each scheme.

The St Ives Guided Busway was opened in 2011, but as the busway provided a 'new' route, there is no pre-scheme demand data. Therefore, traffic count data from Cambridgeshire County Council for 2013 (earliest year data is available) and 2017 at the St Ives Park & Ride was used to understand the demand uplift potential for the C2C project.

The data showed a 153% uplift in cycling and a 73% uplift in walking with these factors being applied to understand the number of *'with scheme'* journeys.

[7] https://www.cambridgeshire.gov.uk/residents/travel-roads-and-parking/roads-and-pathways/road-traffic-data/

5.8.3 Appraisal assumptions

The majority of the assumptions in the AMAT template were kept the same as those prepopulated by the DfT. However, a few were altered, namely:

- Cycle storage facilities are to be provided at the Park & Ride site – therefore the benefit of additional secure storage facilities in AMAT was included.
- With the guided busway providing new footpaths, the walking infrastructure benefits of kerb level and pavement evenness was assumed along with directional signage as it was assumed wayfinding would be provided to show how the new route can be accessed.
- A 30-year appraisal period was used rather than the standard 20 years in the AMAT template. It was assumed that as the walking and cycling infrastructure is segregated from road traffic, the infrastructure would have a longer asset life.
- The number of days the scheme data is applicable was altered to 253 to align with the other appraisal elements. Therefore, weekend demand for the scheme is not accounted for further making this a conservative appraisal of the scheme's benefits.

5.8.4 Benefits not accounted for

Whilst AMAT quantifies several benefits of new walking and cycling infrastructure, there are other likely benefits of the scheme which were not calculated, therefore meaning the overall active travel appraisal was conservative. Additional benefits that were not calculated include:

- New housing development from 2017 to scheme opening year within close proximity to the scheme which would be likely to generate additional demand for the scheme;
- Journey time savings brought about by the more direct and low traffic volume route the scheme will deliver; and,
- Safety benefit due to the improved cycling infrastructure and segregation from a large proportion of road traffic using TAG Unit A4.1 values for the prevention of casualties.

The results of AMAT have been incorporated into the AST and the overall AMCB and TEE tables, informing the BCR calculations and final Value for Money assessment.

5.9 Present Value of Benefits – Established Monetised Impacts

The results of the assessment of the Level 1 benefits and established monetised impacts for Do Something preferred option for the C2C project is presented in Table 12. This excludes the impact of scheme dependant development and indicates that the C2C project results in a PVB £82m (2010 prices, discounted to 2010).

Table 12: Level 1 benefits
(£'000s, 2010 prices discounted to 2010, over a 60 year appraisal period)

Impact	PVB
Congestion	63,014
Infrastructure	2,407
Accidents	7,803
Air Quality	164
Greenhouse Gases	1,159
Noise	887
Indirect Taxes	-3,407
Active Travel	11,726
Level 1 Total PVB	**83,753**

Source: Mott MacDonald

5.9.1 Transport Economic Efficiency

Table 14 below provides the Level 1 congestion benefits split across consumer user benefits and business user benefits as they would be shown in a transport economic efficiency (TEE) table.

Table 14: Benefits by purpose (£'000s, 2010 prices discounted to 2010, over a 60 year appraisal period)

Purpose	Benefits
Consumer – Commuting user benefits	16,061
Consumer - Other user benefits	39,354
Business	7,599
TOTAL	**63,014**

Source: Mott MacDonald

6. Wider Economic Impacts – Fixed Land Use

6.1 Wider economic impacts assessment – Fixed land use

This section examines the wider economic impacts for the C2C project that are additional to the transport user benefits. These benefits are calculated following the DfT's TAG guidance which defines wider impacts as the impacts of transport interventions on welfare at a national level that are not captured by a conventional appraisal of transport user benefits. These impacts are omitted because the conventional appraisal assumes theoretical 'perfectly competitive' transport-using markets, whereas in reality markets are imperfect, leading to the potential for additional benefits (or dis-benefits). The fixed land use wider economic impacts assessed for the C2C project, and their definitions, are set out in Table 15.

Table 15: TAG Wider economic impacts definitions

Wider impact	Definition
Agglomeration	Agglomeration refers to the concentration of economic activity over an area. Transport can increase the accessibility of an area for businesses and workers, therefore impacting on the level of agglomeration, through the reduction of generalised costs for business and commuting trips. The level of agglomeration reflects the productivity benefits experienced by businesses as a result of improved connections to other businesses and to potential employees thus improving interaction, knowledge exchange and access to markets, including labour markets.
Tax revenues arising from labour market impacts	Transport can have an impact on labour supply by affecting the overall costs and benefits to individual workers. An individual will weigh the cost of travel against the wages of a job travelled to. Changes in transport costs is likely to have an impact on the incentives of individuals to work and hence have an impact on the overall level of labour supplied in the economy. This can have a positive impact on the economic at a national level with an increase in potential workers employed affecting the level of UK GDP through increases in tax revenues.
Output change in imperfectly competitive markets	Markets are generally considered not to be perfectly competitive, thus leading to lower production and higher prices than would exist in a perfectly competitive market. This is seen as being detrimental to consumers and the economy as a whole. Reductions in transport costs allows for an increase in production in the goods and services that use transport, reducing costs so that businesses can make more profit or pass on the saving to customers so they can be more competitive.

Source: TAG Unit A2.1

The issues with model noise away from the scheme corridor described earlier means that DfT's WITA software[8] will not necessarily provide robust results for the above impacts. A simplified approach to the estimation of these impacts has therefore been used:

- 'Output change in imperfectly competitive markets' has been estimated as 10% of business user benefits, as per TAG.
- An uplift has been applied to user benefits to account for agglomeration and labour market impacts. The uplifts implied by the estimates in the SOBC range from -12% to 14%. We have used the 14% figure, which is more in line with our experience from other projects.

[8] WITA is a software package often used to translate transport model outputs into estimates of the wider impacts set out in Table 10.

6.2 Present Value of Benefits – Evolving Monetised Impacts

The table below provides a summary of the value of the level 2 benefits described above.

Table 16: Level 2 benefits (£'000s, 2010 prices discounted to 2010, over a 60 year appraisal period)

Impact	PVB
Agglomeration	8,822
Tax revenues arising from labour market impacts	
Output change in imperfectly competitive markets	760
Level 2 Total PVB	**9,582**

Source: Mott MacDonald

7. Wider Economic Impacts – Land Use Change

7.1 Introduction

This section summarises the Level 3 WEIs that have been assessed for the C2C project, which are fully detailed in the accompanying Strategic Economic Narrative Report (Appendix J), which assesses the potential economic impacts of the scheme by understanding the levels of development along the Cambourne to Cambridge corridor that could be supported by the scheme (for the preferred option only). The Strategic Economic Narrative and Economic Impact Report also sets out the logic of how the scheme supports economic growth and how this has been measured, both at the Greater Cambridge and UK levels, to inform this Economic Case and the VfM assessments.

The accompanying report, particularly Section 4, should be read in conjunction with this Section which summarises the methodology adopted and the main findings.

7.2 Methodology

Fundamentally, the C2C project will support economic growth by providing faster and more reliable journey times that will improve connectivity and accessibility and thereby link housing and employment growth areas more closely. Providing the 'first phase' of CAM, the scheme will become part of a wider network that seamlessly connects the planned growth areas to the West with central Cambridge and other key growth locations. The specific developments and their dependency with the scheme are fully outlined in the Strategic Economic Narrative Report (Appendix J).

The appraisal of the Level 3 benefits focuses on a land use approach which examines how the C2C project supports the planned development along the Cambourne to Cambridge corridor. Given the C2C project is about supporting growth, it is critical that the assessment approach, whilst adhering to standard transport guidance, considers how the scheme supports economic growth in Greater Cambridge from the local perspective while also maintaining an understanding of how this translates this into impacts at the UK level. These have been the governing principles of the approach adopted within the accompanying report.

In summary the following tasks have been carried out based on the evidence base gathered on the strategic growth context and developments planned along the corridor:

- **Sub-national economic impacts (jobs and gross value added (GVA)**). For Greater Cambridge, based on the assessment of the linkages between the C2C project and planned development, the gross direct employment and GVA impacts have been calculated. These relate to the workplace jobs and associated GVA in Greater Cambridge that the C2C project is assessed to support. Specifically, these are the planned developments at Cambourne West, Bourn Airfield and West Cambridge.
- **Land value uplift (LVU) assessment – net UK impacts**. At a UK level, and in order to adhere to the latest government guidance across all departments (see the Strategic Economic Narrative report for further details), the economic impacts of the dependent development along the corridor have been assessed based on their LVU impacts.
  - The LVU impacts relate to the increase in land values along the corridor due to the land's conversion into more productive uses.

  - The LVU analysis includes only the two housing developments, Cambourne West and Bourn Airfield, which are deemed 100% dependent upon the C2C project given the policy position set out in the adopted Local Plans.
  - The LVU impacts are assessed in line with the DCLG Appraisal Guide[9] and TAG Unit A.2.2 and all key assumptions are outlined in the Strategic Economic Narrative report.
  - The LVU impacts are then adjusted for displacement to derive a net UK impact.
  - A number of sensitivity tests are also run examining various levels of dependency and displacement.
- **Labour supply impacts – net additionality to the UK (validation test).** Although not reported here, the accompanying report also includes an updated of the previous 2016 labour supply impacts and examines, based on context specific factors, the degree to which the sub-national impacts can be considered net additional at a UK level.
  - This is based on assuming that 44% of the jobs supported by the C2C project can be considered net additional at a UK level. In addition to the core analysis the benefits emerging from the move to more productive jobs was also assessed, which examines the changes in GVA from the displaced employment within the UK.
  - The 2016 study, as part of the labour supply impacts, also considered socio-economic welfare impacts from providing opportunities in areas of high deprivation or high unemployment. These impacts were relatively small previously given the low deprivation levels in Greater Cambridge. At this stage it has not been possible to update these but they are considered likely to be relatively small (especially in comparison to the impacts discussed previously).

    Although the results of this validation test are not reported here (but are fully outlined in the accompanying report) the impact was larger than the LVU assessment and implies a conservative approach has been adopted.
- **Transport external costs.** Transport external costs (TEC) associated with scheme dependent development refers to the change in costs (including time, vehicle operating costs and charges) caused to all other transport users on the network by the traffic generated by the additional development. To account for this within the final VfM assessment, the application of LVU benefits has been undertaken using different percentage levels to reflect possible TEC impacts i.e. rather than applying 100%, the application of values of 50% and 75% has been examined to provide some sensitivity analysis.

7.3 Present Value of Benefits – Indicative Monetised Benefits

The following presents the overall results of the core analysis relating to Level 3 WEIs of the preferred option from the C2C project. The results are presented in 2010 values and prices, and discounted to 2010 over a 60 year appraisal period.

Table 17: Level 3 benefits (£'000s, 2010 prices discounted to 2010. 60 year appraisal period[10])

Impact	PVB
Net LVU impacts	£287,800
Level 3 Total PVB	**£287,800**

Source: Strategic Economic Narrative and Economic Impact Report, Mott MacDonald, September 2019

[9] The DCLG Appraisal Guide, Department for Communities and Local Government, December 2016. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/576427/161129_Appraisal_Guidance.pdf [Accessed: 18/06/2019]

In addition to the Level 3 benefits for LVU impacts, impacts at a regional Greater Cambridge level show that the preferred option offers the following benefits:

- 975 direct jobs
- £102.8m direct GVA per annum
- £676.1m in total GVA over 30 years

8. Reliability Benefits

8.1 Reliability Benefits

The reliability assessment was undertaken in line with the methodology in TAG unit A1.3 section 6.5. Public transport schemes consider reliability in terms of the standard deviation of lateness.

Bus journey data for routes along the scheme corridor were supplied by Cambridgeshire County Council. Of the existing bus routes along the corridor at least as far as Cambourne, a suitable dataset was available for the Citi 4 route. There will be a stopping service on the busway with similar stop locations along the route.

In line with TAG A1.3 Appendix C, the raw bus data was processed to calculate the lateness and lateness squared between each stop. The stops were considered individually to account for delay/lateness at each stop rather than including any previous delay from other stops on the route as this is how passengers perceive lateness. Buses which arrived early were treated as on time with a lateness of zero.

The Standard Deviation (SD) of lateness was then calculated at each stop before calculating the value of the standard deviation of lateness. TAG uses evidence from the PDFH to give the value of average lateness for public transport as 2.5 times the value of in-vehicle time. The value of time was taken from the May 2019 TAG data book (table A1.3.2) using market prices for PSV passengers split into working, non-working commuters and non-working other. This was applied with the recommended reliability ratio of 1.4 to fix the value of SD of lateness which was applied to the SD of lateness at each bus stop.

Passenger numbers were output for matched bus stops from the public transport model for the Citi4 route in the Do Minimum and the equivalent route in the preferred option. These passenger numbers were then applied to the value of SD of lateness for the stops applying the web tag data book proportion of split by purpose to give the cost of lateness at each stop. The total cost of lateness was then summed across matching bus stops for the Do Minimum and Do Something. For those bus stops on the new busway a value of 0 for lateness was assumed as they are the only vehicles using the scheme.

Benefits over a 60 year appraisal period were calculated by interpolating between 2026 and 2036, extrapolating back to 2024, scheme opening year, and assuming a flat profile beyond 2036. Standard TAG databook discount factors were applied to calculate PVB. Results of £536,000 in 2010 prices discounted to 2010 were calculated for the 60 year appraisal period.

8.2 Reliability impacts qualitative assessment

In addition to the economic appraisal of the reliability benefits of the C2C preferred option, a qualitative assessment of the benefits of delivering a fully segregated public transport route were appraised by examining the reliability ratios for the existing Cambridgeshire Guided Busway and non-busway services within Cambridge.

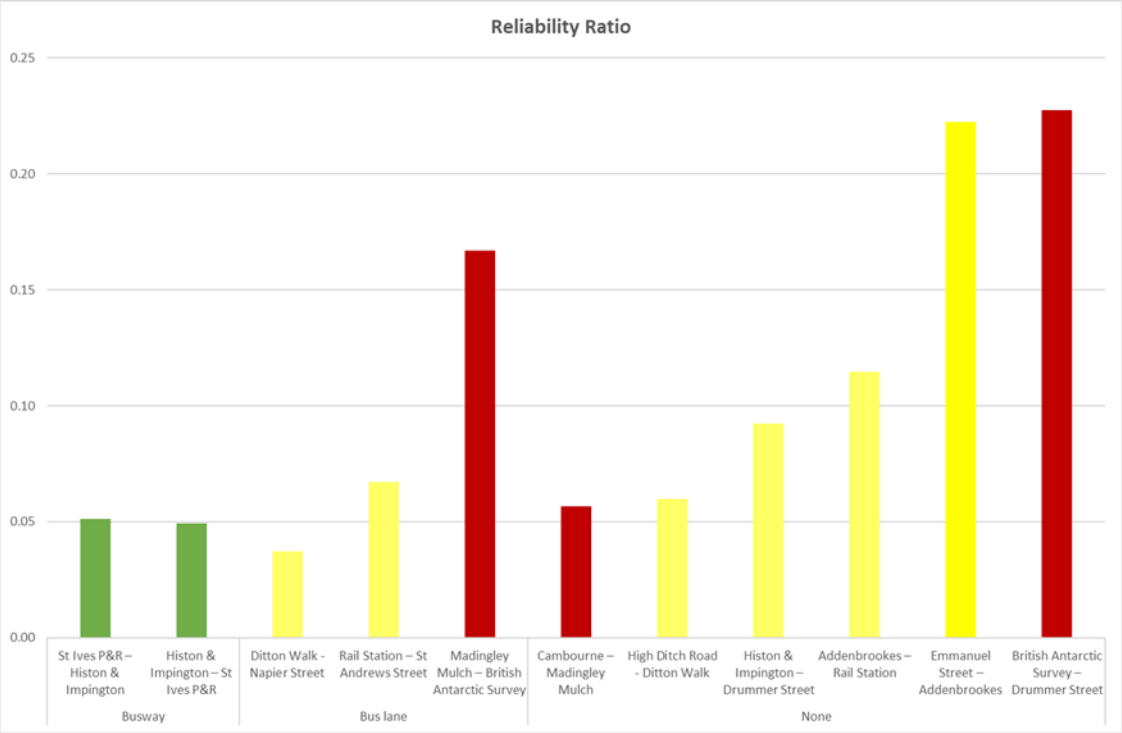
Following DfT TAG Unit A1.3 guidance two measures of lateness were considered: average lateness; and the variability of lateness, measured by the standard deviation of lateness.

Using Real Time Public Information (RTPI) data for Monday to Friday journeys in November 2018 on services 1, 4, 12 and Busway B, the Standard Deviation for certain sections along the routes service by these services were derived (for each hour from 07:00 to 18:00).

For each section, the maximum journey times, the average lateness (taking the lateness of on time and early journeys as zero) and the Standard Deviation of lateness were derived for each hour from 0700 to 1800. This allowed for a Reliability Ratio to be calculated.

The results for the 0700 – 1800 period for each section, ranked by the reliability ratio are summarised in the chart below.

Figure 9: Reliability comparison of non-segregated routes vs segregated routes



Source: Mott MacDonald

The Reliability Ratios show that the existing Cambridgeshire Guided Busway sections perform better than the non-busway sections, meaning that the infrastructure is delivering journey times that are more consistent.

The urban sections of services 1, 4 and B have higher reliability ratios, so journey times are more variable. Two sections of the C2C route, from Madingley Mulch to Drummer Street, are among the three worst performing sections.

9. Environmental Impacts

9.1 Introduction

A series of environmental impacts have been assessed as part of the INSET options assessment (summarised in the Strategic Case, Section 8 and OAR 1, OAR 2 and OAR 3 – Appendix A, B and C respectively). A full description of the environmental assessment works and the detailed worksheets completed are included in the Environmental Appraisal Report (see Appendix I)

The appraisal of options was undertaken in accordance with the DfT's TAG Unit 3A guidance by specialists in the following topics:

- Landscape and townscape
- Air quality
- Noise
- Carbon/greenhouse gases
- Biodiversity
- Heritage

In addition, a review of the potential effect by the options on the Green Belt was undertaken by an independent organisation for GCP (this can be found in Appendix U).

Those environmental impacts that are able to be monetised as part of the economic appraisal for the preferred option include air quality, greenhouse gases and noise. The results of these assessments are included in Section 5 of this Economic Case. The other environmental impacts feed into the VfM statement have been assessed in a qualitative and non-monetised manner using TAG appraisal worksheets.

TAG Unit A3 stipulates as part of the standard assessment methodology that the first activity is to scope out the potential significant effects on the environmental attributes. In doing this scoping exercise water resources were identified as not being significantly affected by any of the options, as no main rivers or minor watercourses are crossed, and there are no groundwater receptors likely to be affected by a scheme.

9.2 Air quality

The proposed infrastructure will have an impact on air quality with the potential to:

- Improve air quality where there is a mode shift from private car to public transport or active modes;
- Improve air quality where traffic flows more freely with less stop and start movements;
- Worsen air quality where there are increased emissions from buses; and,
- Worsen air quality where there is increased congestion to general traffic.

The proposed project and associated air quality study area lie within the boundaries of CaCC and SCDC areas. There is one AQMA within the air quality study area, covering Cambridge city centre, declared for exceedances of the annual mean NO_2 UK AQS objective. Defra PCM mapping of roadside NO_2 concentrations in 2014 indicates no roadside exceedances of the annual mean NO_2 EU limit value and UK AQS objective within the air quality study area.

Monitoring data from surveys undertaken by CCC in 2014, SCDC in 2013 and Highways England in 2013 (undertaken to inform the A14 Cambridge to Huntington Improvement Scheme environmental impact assessment), indicates that there are no exceedances of the annual mean NO_2 UK AQS objective at roadside locations adjacent to the proposed project.

There were exceedances of the annual mean NO_2 UK AQS objective at two diffusion tubes adjacent to the affected road network (ARN) in Cambridge city centre in 2014 (local authority site number S18 and S22), however, the exceedances are at kerbside (S18) and within a confined street canyon (S22) and therefore not representative of sensitive receptors in the wider study area.

There is one statutory designated ecological site within 200 metres of the ARN. The Madingley Wood Site of Special Scientific Interest (SSSI), located adjacent the A1303, contains broad-leaved, mixed and yew woodland habitat, which is sensitive to nitrogen deposition. The impact of the proposed project on the SSSI is not required within the TAG assessment, however consideration of the impact of the options on the SSSI is recommended.

Three areas were subject to a qualitative assessment to see if current air quality was at risk of being significantly affected by the recommended option, these assessments were for Adams Road, the Coton area and Hardwick area. All areas have good air quality at present and the conclusions were that the scheme was not likely to cause any significant change in air quality.

The assessment was undertaken considering the following key aspects:

- Existing baseline conditions – risk of exceedances of air quality objectives and EU limit values;
- Number of properties affected;
- Potential changes in traffic data, and;
- Potential effects on the Cambridge City Air Quality Management Area (AQMA).

PM levels are a growing concern because in heavily congested areas such as city centres, NO_2 levels are predicted to reduce as the number of hybrid and electric vehicles grow whereas such vehicles still emit particulates albeit in very small quantities. Where there is no current traffic related NO_2 exceedances of ambient air quality objectives, it is unlikely that there would ever be a traffic related PM10 or PM2.5 exceedances of ambient air quality objectives unless the traffic levels increased very dramatically.

The air quality along the route is generally well within government defined limits for good air quality. There are no long term air quality monitoring locations in the route west of Cambridge city limits as the good air quality does not justify such monitoring by SCDC. Defra have modelled the air quality across the UK and this modelling confirms that air quality is good quality. Within Cambridge the City Council have a defined Air Quality Management Area around the city centre. The western limit of the AQMA is along Grange Road. Poor air quality in the city is largely due to vehicle traffic, so any scheme that seeks to reduce the number of vehicles entering the city centre should bring benefits to air quality. Air quality from exhaust emissions tends to drop rapidly away from the source of emissions, so alongside roads the air quality impact from traffic is negligible beyond 200m.

Overall, the changes in air quality from any of the scheme options was judged to be small at affected receptors. It was considered that increases in public transport numbers along the route would be offset by a reduction in car numbers on the A428 and other local roads due to the expected modal shift towards public transport.

It was concluded that air quality would have **neutral effect** for the preferred option.

During the EIA the air quality implications of the scheme will be modelled to consider the changes in traffic more widely and along the route itself. The modelling will identify if there are sensitive receptors (including residential buildings and schools) that could experience poor air quality as a result of the scheme. Where possible mitigation measures will be included to manage such impacts (eg. Moving the route further away from a sensitive receptor, or putting traffic calming measures into an area to reduce traffic flow through that area).

9.3 Greenhouse gases

Government has commitments to see reductions in carbon (and other greenhouse gases) which require a step change in transport using vehicles. The scheme is a key part of the strategy to achieve such modal shift by providing high quality public transport. In creating this option for travel there will be some embedded carbon implications of any construction works. Therefore one element of the design decision will be to minimise the carbon footprint of the construction works.

During operation the carbon footprint of the scheme will be minimised by requiring operators to use vehicles that achieve minimum standards in CO_2 emissions. The scheme also has aspirations to consider alternative, hybrid, powered vehicles to reduce the green house gas emissions from the scheme even further. This is likely to become a mandatory requirement of government during the lifetime of the scheme.

The initial qualitative assessment (carried out as part of the optioneering process) concluded that the proposed route alignments would not be expected to cause substantial changes to traffic flows on the surrounding road network. Overall, the changes in traffic from any of the scheme options was judged to be small and therefore differences in greenhouse gases between schemes would not be significant.

It was considered that increases in public transport numbers along the route options would be offset by a reduction in car numbers on the A428 and other local roads due to the expected modal shift towards public transport.

As such it was concluded that greenhouse gases would effectively be **neutral to minor adverse** for the preferred option**.**

9.4 Noise

The assessment of noise has been carried out qualitatively at this stage by considering the proximity of receptors (residential and commercial properties and educational facilities) in the appraisal.

Noise from road vehicles is generated from tyre noise on the road surface itself and the noise of the engine and other mechanical parts. Modern buses of the type that will use the route will generate very low noise levels, and the majority of the noise is likely to be from the tyres on the road. The number of vehicles using the route will be relatively low so noise will be intermittent and short duration at any point along the route.

The Scotland Farm Park & Ride site is near to the A428 and the area is already subject to traffic noise impacts. With proper design to minimise noise effects (through provision of appropriate acoustic barriers near residential properties) the noise impacts are considered negligible site although it is recognised that ad-hoc noise will still occur (e.g. car alarms and doors open and closing loudly).

However, along the route the public transport vehicles will present be a new noise source in many places, and so there will be some impact from noise on nearby receptors. Along the majority of the route there are no sensitive receptors as the route is across agricultural land. However, around Coton there will be some noise from the scheme near to existing properties. In this area noise abatement measures will be included in the design such as low earth bunding or acoustic fencing. The precise nature of the mitigation will be agreed with stakeholders during design development.

In other areas there are existing noise sources but the route will also be near residences or commercial properties. This is the case along St Neots Road in Hardwick and along Adams Road in west Cambridge and along the new section of route in Cambourne between Sterling Way and Broadway.

Along St Neots Road the A428 dual carriageway is a major source of road noise which will dominate the noise environment in the area. The preferred route alignment will remove trees along the A428 boundary which residents are concerned will increase noise levels, but GCP is committed to providing an improved acoustic barrier along this section of route to ensure that residences along St Neots Road do not experience any deterioration in noise from the A428. In the short section of new route in Cambourne (about 400m long) between Sterling Way and Broadway there will be appropriate acoustic barriers installed on either side to minimise noise impacts on residential properties that back onto the route.

Along Adams Road and in Cambourne the route will be on existing roads where the level of bus traffic will not create any significant change in the noise levels experienced in these areas.

The EIA will carry out noise modelling along the route and the wider network that experiences changes in traffic that could affect noise at sensitive receptors. Where required noise mitigation will be included in the design including acoustic barriers or means to reduce noises at source (eg. reducing speed limits).

The overall impact of the preferred option is **minor adverse** on noise.

9.6 Biodiversity

Biodiversity was assessed using the information collected from the field surveys between 2017 and 2019. Additional survey information was available in the Bourn Airfield Environmental Statement submitted as part of the planning application for that site in late 2018. The knowledge gained on the habitats in different areas was also considered where habitat exists that is not provided any formal protective designation.

The route avoids all sites protected for ecological purposes except where it crosses the City Wildlife Site on the eastern side of the M11. This narrow protected site has relatively poor value scrub which would be impacted by the loss of about 110m of scrub where the route crosses it. There are known protected species near the impacted area but they are resident to the south of the proposed crossing and measures will be put in place to prevent their harm during construction or operation of the route. The remainder of the route does impact on habitat of value as it crosses Coton Orchard and around the Waterworks site at Madingley.

There are also a number of trees that will be lost along the St Neots Road section east of Hardwick village, although the majority of the trees are relatively young (<30years) and the habitat has limited value in that area. The belt of Tree Preservation Order (TPO) trees around the Waterworks site will have some loss where the route cuts through the TPO belt. The precise location of the route will be aligned, where possible, to minimise the loss of any trees of value (as defined by the arboricultural survey undertaken in 2018). Surveys are ongoing for a range of

protected species but too date no protected species roosts or hibernation sites are likely to be lost from the route. The most protected species identified too date along the route are barbastelle bats which are the species designated as part of the Wimpole Hall Special Area of Conservation by Natural England.

A biodiversity net gain assessment has been carried out on the initial design of the scheme, which showed that with the mitigation opportunities that exist along the route there is potential for significant net gain to be derived from the project. The final net gain assessment will be completed during the EIA to take into account the final proposed mitigation and habitat creation along the route, the results will be reported in the environmental statement. Opportunities to improve biodiversity include:

- Increasing species rich hedgerows in the area by planting new hedgerows as part of the Non motorised User (NMU) route.
- Improving existing hedgerows which may be species poor by additional planting along the hedgerows.
- Increasing chalk grassland or other semi-improved grassland habitat along the route through planting adjacent to the route and in fields severed by the route that are no longer viable for agriculture
- Providing habitats suitable for invertebrates and reptiles where existing populations are of local or regional value.
- Providing nesting boxes for barn owls in appropriate locations.
- Increasing woodland/scrub by planting in areas where this provides visual barriers to the scheme (eg around the edge of Coton, around the Scotland Farm Travel Hub site and in field corners along the route).

Without the mitigation opportunities described above the overall assessment of the impact on biodiversity is **moderate adverse** for the preferred option due to the loss in habitat and potential disturbance impacts on protected and important flora and fauna species.

9.7 Landscape

Landscape impacts were assessed against impacts on landscape pattern, landscape tranquillity, cultural receptors and landcover features.

Landscape and townscape issues Phase 2 - Option 1 The route alignment between Cambourne and Madingley lies in the Western Claylands Landscape Character Area (LCA). The landscape is mainly rural and open, with a series of residential settlements to the south of the St Neots Road and A428. The field pattern tends to be large-scale and field boundaries are generally formed by hedgerows with hedgerow trees. The A428 dual carriageway runs east/west through the centre of the study area, severing the landscape north and south of the road. Woodland belts lining the A428 and associated slip roads and roundabouts reinforce the strong linear character of the road.

Within Cambourne the route will be on existing roads and along a short section of new road between Sterling Way and Broadway. In Cambourne the impact on townscape is negligible as the route will be using existing highways. The new road section to Broadway will be along the existing cycleway, it will be shielded from view by the boundary fences of private residences and there are not likely to be any long distance views of the scheme. The route would be landscaped where practical to soften the impact of the infrastructure on local views. Where the scheme crosses Bourn Airfield it will become a part of the new proposed development, landscaping plans for that development include bunding to minimise views from the south, and

the route would be largely parallel to the A428 along the northern boundary of the airfield. The impact on the new landscape of the housing development would be negligible as it would fit into the new townscape as part of the new infrastructure required for that development.

From Bourn Airfield to Scotland Farm the route would be close to and parallel to the existing A428. The design will need to ensure it is not visible from nearby residences through use of low bunds and appropriate planting. Vehicles using the route would be visible but the road itself would not. The impact on the landscape would be neutral largely – especially as planting became established.

From Scotland Road the route will be between St Neots Road at Hardwick and the A428. This will result in the loss of vegetation shielding the A428 from residences between Cambridge Road and Long Road (this is a section about 1km long, of which 500m have residences facing the road). There will be opportunities to include new planting between the residences facing St Neots Road and the route which, over time, will reduce the visual impact of the system.

Improved acoustic barriers along this section would also reduce the amount of visible traffic on the A428, but the overall impact on the local landscape will be moderate adverse. As this area is within a highways corridor the impact on the wider landscape is neutral to minor adverse. Madingley Road that are subject to covenants held by the National Trust to protect the landscape in the area but the landscape is not designated in any other manner. As the route crosses the open landscape from the Waterworks site at Madingley down to Coton it would have an impact on the pattern and tranquillity of this rural landscape. There will be long views of the route from the south (Red Meadow Hill) and there will be views of parts of the route from the local public footpaths and from the A1303. The route will need to be designed to be as level as possible across the hill so it will be in a shallow cutting for much of these area.

The excavated materials will provide for the creation of small bunds adjacent to the route as well. The final alignment is still be defined in this area, and consultation with key stakeholders in the area continues to identify an optimum route that minimises the landscape impacts between Madingley and Coton. With appropriate design features and planting it is considered the impact will be moderate adverse initially, improving over time to be minor adverse. The final assessment will be confirmed in the EIA process.

Around the Scotland Farm Park & Ride the scheme would reduce tranquillity and would alter the pattern of the landscape at Scotland Road Farm where a car park would replace part of an arable field. The scheme would increase light levels in the open landscape north of the Scotland Farm site. Landscape mitigation planting would reduce the landscape and visual impacts of the proposed scheme.

The overall impact on landscape for the preferred option is **moderate adverse**.

9.8 Historic Environment

The heritage appraisal considered the following features along each option:

- Built Heritage covering
  - Listed buildings (Grade I, Grade II and Grade II*)
  - Registered Park and Gardens (Grade I and Grade II)
  - Conservation Areas (Coton Village Conservation Area and West Cambridge Conservation Area)
- Buried Archaeological Remains

Information on HER assets were obtained from CCC. Policy information for the appraisal were the SCDC Development Control Policies (2007), City of Cambridge Local Plan (2006) and the emerging SCDC and City of Cambridge Local Plans.[11] A geophysical survey was carried out on accessible land that was suitable for such surveys and preliminary results have been used in this appraisal. The scope of the surveys was agreed with the County Archaeologist.

There are no direct impacts on any listed buildings or other protected sites from the route. However, there are a number of listed buildings which could have their setting affected by the route of which the most significant are:

- St Peters Church in Coton.
- The American Cemetery on Madingley Hill.

There are a number of other listed buildings in Coton Village reflecting the value of the village setting defining it's conservation area status. Along Grange Road there are a few other listed buildings which are important in defining the setting of this part of the West Cambridge Conservation Area.

There are only two listed structures west of Madingley, (one in Hardwick and one on the eastern edge of Cambourne) neither of which is particularly close to the proposed route and whose setting is not likely to be impacted by the route in that area.

The setting of the Coton listed buildings and conservation area is likely to be impacted by the introduction of the new infrastructure through the rural edge of the village. This indirect impact will reduce over time with the introduction of new planting to soften the visibility of the new route. By refining the precise alignment of the route and the design the impact could be further minimised and this refinement will take place during the EIA phase of the project. The route has little impact on the setting of the American Cemetery as this is on the opposite side of the A1303 and the route is not visible from the cemetery. There is little physical change to the highways network when the route enters the Cambridge suburbs and so is not going to affect the conservation area setting or the listed buildings in the area of Grange Road.

There are no scheduled monuments along the route, or close to the route. A number of geophysical surveys have been undertaken along the route where it is has been possible to access land, and in locations suited for such surveys (as agreed with the county archaeologist). Desk based research and the surveys have identified the potential for buried archaeology along the route, although nothing has been identified to date that is considered to be of sufficient value to require changes in the proposed design. Potential impacts on buried archaeology could be major (due to the loss of the in-situ archaeology).

Further works prior to construction (trial trenching) will be undertaken to confirm the presence of archaeology along the route and the design will include a full archaeological scheme of investigation agreed with the county archaeologist as part of the EIA process. The final design of the scheme shall seek to preserve the historic setting of the landscape as much as possible, this may include recreating some hedgerows along boundaries which have been lost where agreement with landowners and stakeholders determines this is appropriate to do.

The assessment has identified the preferred option would have an overall potential **moderate adverse** effect on heritage.

[11] Note that since this assessment was carried out the Local Plans for CaCC and SCDC have both been adopted.

10. Social Impacts

10.1 Introduction

Social impact (SI) appraisal covers the human experience of the transport project and its impact on social factors. Guidance is included in TAG Unit 4.1.

A full Social Impacts and Distributional Impacts appraisal summary report can found in Appendix K. The appraisal has sought to best represent the anticipated positive and negative changes for users of the junction, relating to the human experience of the scheme.

10.2 Results

The initial qualitative appraisal has found that the scheme will deliver a broadly positive benefit within relevant impacts, with only severance anticipated to result in adverse impacts. The anticipated assessment scores for the social appraisal can be seen in Table 18 below.

Table 18: Social impacts – scoping summary scores

Impact area	Score	Assessment Comments
Accidents	Slight beneficial	As a result of changes to the road alignment, changes in the number of vehicles on the network and other contributing factors, there may be an impact on the number of accidents in future years.
Physical activity	Moderate beneficial	The Active Modes Appraisal Tool (AMAT, TAG Unit A5-1) assessment shows monetised benefits of almost £7m over 30 years for the reduced risk of premature death and almost £1m of benefits from reduction in absenteeism.
Security	Neutral	Negative impacts in terms of encouraging users to leave vehicles are offset by security features provided by the park and ride facility. Overlaps with Journey Quality are assessed within Journey Quality section.
Severance	Slight beneficial	The scheme will provide improvements to pedestrian movement through segregated paths alongside the bus route. The proposed route will cut across some footways introducing additional complexity through signals and crossings as result of the busway, which may result in some minor hindrance to movement, however the benefits to pedestrian flow are on balance likely to be greater.
Journey quality	Slight beneficial	Traveller care impacts are expected to be beneficial due to the new facilities and services. Frustration due to congestion and parking is likely to be improved with the scheme. A conservative slight beneficial assessment has been made in the absence of demand data.
Option values and non-use values	Large beneficial	The number of households benefitting from the existence of the service is higher than the threshold of 1000 required for a large beneficial impact assessment.
Accessibility	Slight beneficial	Residents along the route will benefit from wider public transport provision with better private car and public transport access to Cambridge where many services and activities are based. Difficulties would still exist for more remote residents not close to the route who do not have access to a private car. Those from the wider area with access to a private car will be most likely to realise the benefits of the scheme.
Personal affordability	Neutral	There may be slight beneficial impacts that arise from the free parking compared to costly parking in the city centre, and the reduction of miles travelled therefore a reduction in fuel consumption, though this may be offset by the cost of the bus service however this is expected to be in line with costs across the Cambridge network.

Source: Appendix K – Social Impact and Distributional Impact Appraisal Report

11. Distributional impacts

11.1 Introduction

Distributional impact (DI) appraisals build on the SI appraisal and transport modelling outputs to assess the variance of a project's impact across different social groups. Guidance is included in TAG Unit 4.2. Both beneficial and/or adverse impacts of the proposed interventions are considered, along with the identification of social groups likely to be affected.

Table 19: Scope of socio-economic analysis

Social group (tick indicates analysis required for each impact)	Distributional impacts							
	User benefits	Noise	Air quality	Accidents	Security	Severance	Accessibility	Affordability
Income distribution	✓	✓	✓				✓	✓
Children: proportion of population aged under 16		✓	✓	✓	✓	✓	✓	
Young adults: proportion of population aged between 16 and 25				✓			✓	
Older people: proportion of population aged 70 and over		✓		✓	✓	✓	✓	
Proportion of population with a disability					✓	✓	✓	
Proportion of population of Black, Asian and Minority Ethnic (BAME) origin					✓		✓	
Proportion of households without access to a car						✓	✓	
Carers: proportion of households with dependent children							✓	

From the initial screening in terms of whether there is potential impact across the impacts listed above, and therefore further assessment is required, it was established that all areas warranted further assessment and appraisal.

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The following sections summarise the findings for each impact across the identified social groups.

11.2 User benefits

User benefits impacts are assessed against income groups to determine proportionality across social groups, specifically across the income distribution as per Scope of socio-economic analysis. A proxy study area has been used for user benefits of the Cambridge and South Cambridgeshire local authority areas.

In terms of distributional impact, Table 20 below shows there will be beneficial impacts felt in larger proportion by the least deprived quintiles due to the proportionately larger presence of lower deprivation groups across the study area.

Table 20: Summary assessment scores – user benefits

Index of Multiple Deprivation Quintile	Impacts
Most deprived quintile	Slight beneficial
Second most deprived quintile	Moderate beneficial
Third most deprived quintile	Moderate beneficial
Second least deprived quintile	Moderate beneficial
Least deprived quintile	Large beneficial

Source: Appendix K – Social Impact and Distributional Impact Appraisal Report

11.3 Noise

Based on initial assessments from the Mott MacDonald environment team returning a neutral impact, the distributional impacts have been deemed to be neutral and therefore this impact has been scoped out.

11.4 Air

Based on initial assessments from the Mott MacDonald environment team returning a judgement showing no significant changes to air quality, the distributional impacts have been deemed to be neutral and this impact has been scoped out.

11.5 Accidents

A qualitative accident assessment approach, building on the SI appraisal, has been used in assessing the distributional impacts of accidents. At present, there is a concentration of accidents along the current A1303. The risk of accidents for the wider road network are likely to be reduced because of fewer cars on the road and the segregated off-road route is likely to reduce the likelihood of accidents due to reduced interaction.

Table 21 sets out the summary appraisal score for each option and each social group. Based on an indicative 1km study area surrounding the site and route, there will be moderate beneficial distributional impacts experienced by children and older people, and a large beneficial impact on young people given their proportionate presence within the study area.

Table 21: Summary assessment scores - accidents

Expected overall impact (derived from SI appraisal)	Social group	Distributional impact (seven-point scale)
Beneficial	Children	Moderate beneficial
	Young People	Large beneficial
	Older People	Moderate beneficial

Source: Appendix K – Social Impact and Distributional Impact Appraisal Report

11.6 Security

The social appraisal found a neutral impact on balance therefore has been scoped out of the distributional appraisal.

11.7 Severance

It is expected that the proposed new busway will provide unhindered pedestrian pathways however changes to road alignment could cause minor changes to the pedestrian crossing provision along the route.

For children, the proportion of residents within the study area is broadly in line with that of the national average and therefore these groups would experience the slight beneficial severance impacts in line with the general population. However, the proportion of households with older people, LTHD and those with no access to a car is less than that of the national average and therefore a disproportionately low number of these resident groups would experience these impacts.

There are a number of amenities that could act as trip attractors for one or more of the vulnerable social groups mentioned, therefore increasing journeys including nurseries and schools, universities, sporting facilities such as playing fields and tennis courts, health centres and play areas. The University of Cambridge has a significant presence to the east of the study area.

Table 22: Summary assessment scores

Expected overall impact (derived from SI appraisal)	Social group	Distributional impact (seven-point scale)
Slight beneficial	Children	Moderate beneficial
	Older people	Slight beneficial
	Those with a LTHD	Slight beneficial
	Households with no car access	Slight beneficial

Source: Appendix K – Social Impact and Distributional Impact Appraisal Report

11.8 Accessibility

As this scheme will provide new public transport route and service it is appropriate to appraise

the distributional impact of the potential changes to accessibility. The approach focuses on availability, physical accessibility, cost, accessible places, safety and security and travel horizons.

The scheme was assessed as providing beneficial impacts within the Social Impact appraisal due to wider public transport provision with better private car and public transport access to amenities. Barriers would still exist for more remote residents not close to the route who do not have access to a private car.

Young adults and BAME groups have a larger proportionate representation, and a large number of amenities catering to young adult requirements are located within the area, therefore these groups will experience a large beneficial impact. The groups with LTHD, older people and those without access to a car are underrepresented within this area therefore this group will experience proportionately slighter fewer benefits.

Table 23: Summary assessment scores - accessibility

Expected overall impact (derived from SI appraisal)	Social group	Distributional impact (seven-point scale)
Moderate beneficial	Most deprived quintile	Neutral
	Second most deprived quintile	Moderate beneficial
	Third most deprived quintile	Moderate beneficial
	Second least deprived quintile	Moderate beneficial
	Least deprived quintile	Large beneficial
	Children	Moderate beneficial
	Young adults	Large beneficial
	Older people	Moderate beneficial
	Those with a LTHD	Moderate beneficial
	BAME residents	Large beneficial
	Households with no car access	Moderate beneficial
	Households with dependent children	Moderate beneficial

Source: Appendix K – Social Impact and Distributional Impact Appraisal Report

11.9 Personal Affordability

The qualitative Social Impact assessment found a neutral impact due to reduced parking charges and potential reduced car fuel costs being off-set by bus fare charges. This impact is therefore scoped out of the distributional impact appraisal.

12. Impact on Public Accounts

This chapter sets out the costs of the options that are captured in the appraisal and explains the costs included and how they are manipulated following TAG guidance to provide Present Value of Costs (PVC). First the capital cost is presented for all options and then the whole life costs (maintenance and renewals) associated with the proposed projects. The risk allowance for each option is presented and then the inflation and optimism bias assumptions are explained. The costs are brought together, adjusted and discounted for inclusion in the cost benefit analysis.

12.1 Baseline capital costs

Cost estimates have been prepared by quantity surveyors from Mott MacDonald. The detailed breakdown of construction cost estimation is presented in the Financial Case and Appendix O: Project Breakdown Costs. Key assumptions are outlined below:

- **Construction costs**: Costs have been calculated based on the current level of design for all the constructions works and activities.
- **Preparation costs:** This consists of all project management, consultant support and agent authority fees to cover the elements of survey requirements, preliminary design, public consultation, public inquiry, and the costs of obtaining statutory orders.
- **Statutory Undertakings**: Estimated costs to divert or protect existing equipment. This estimate will be updated prior to final OBC to be based on estimates provided by the affected Statutory Undertakers.
- **Land Costs:** Costs have been calculated for the purchase of areas of permanent land take. Costs have also been considered for temporary land required for construction as working areas or compounds. Allowance has been made for General Disturbance, Injurious Affection, Severance and Loss Payments.

The base cost estimates are presented in Table 24. These detail the capital costs associated with each option divided into construction, design, testing and commissioning, management, land and statutory undertakers costs. The costs include a P80 risk allowance.

Table 24: Preferred Option capital base costs (£000's, Q4 2018 prices)

Item	Cost (£,000)
Construction	103,101
Design	16,496
Management	12,134
Environmental Mitigation	1,743
Land	11,114
Statutory Undertakers	1,100
TOTAL	**145,688**

Source: Mott MacDonald

12.2 Whole life cost estimates

Table 25 below summarises the operation and maintenance costs associated with each option over a 60-year period. This includes annual maintenance and renewals of new infrastructure as well as bus purchase and operating costs. For the basis of calculating the Present Value Costs,

it has been assumed that these costs are borne by the public sector and not by private sector operators.

Table 25: Operational and maintenance costs (£000's)

Item	Price Basis	Cost (£,000)
Infrastructure maintenance	2018 prices	66,042
Bus purchase costs	2019 prices	17,361
Bus operating costs	2019 prices	205,292

Source: Mott MacDonald

12.3 Inflation and optimism bias

A 15% optimism bias has been applied, in line with TAG A1-2 (Table 8 - appropriate level of optimism bias for a guided system at Stage 2 (OBC)), to the capital costs to reflect the current level of design detail for the emerging preferred option. No optimism bias has been applied to the operational and maintenance costs, also in line with guidance.

12.4 Present Value of Costs

The costs outlined above have been converted to Present Value Costs (PVC), using default discount factors from the May 2019 TAG databook. The overall PVC for the preferred option is shown in Table 26.

Table 26: Project present value costs (£000s, 2010 market prices, discounted to 2010)

	PVC (£,000s)
Investment PVC	114,298
Operating PVC	80,844
Overall PVC	**195,141**

Source: Mott MacDonald

12.4.1 Public Accounts

The total impact on public accounts is estimated to be £195.1m (2010 prices) of which all is a cost to local government. Note for the economic appraisal all funding costs and maintenance costs for the scheme were allocated to local government. No funding costs have been allocated to central government.

13. Value for Money

The Value for Money (VfM) statement for the C2C project takes into consideration all appraisal and assessment work undertaken to date to arrive at the emerging scheme that is shown to present the best VfM. This takes into account the monetised impacts vs the project costs presented as a Benefit to Cost Ratio (BCR), as well as the findings from any qualitative and non-monetised assessments.

The approach to the assessment of VfM of City Deal schemes, as set out in the City Deal Assurance Framework, reflects this by stating that projects scoring a BCR less than 2:1 may still be considered for funding if they can demonstrate a compelling case for investment based on meeting the objectives of the City Deal. These include, for example, unlocking barriers to growth, delivering wider economic benefits, environmental and social benefits. As long as the project provides a robust evidence base with a proportionate level of quantitative and qualitative analysis to demonstrate that the project represents good VfM and can meet the policy objectives of the City Deal, these do not need to be included in the central benefit-cost analysis.[12]

The role the C2C project plays in unlocking and supporting future housing and economic growth is a key element of the strategic rationale for the scheme. Therefore, in establishing the final VfM position of the C2C project, the role of Wider Economic Impacts (which are not part of a standard BCR) should be considered central to examining the case for investing in the scheme.

13.1 Analysis of Monetised Costs and Benefits

The Benefit to Cost Ratio (BCR) is an indication of the return on public sector investment in a project. The BCR is the ratio of the Present Value of Benefits (PVB)[13] over the Present Value of Costs (PVC)[14], and indicates how much benefit is obtained for each unit of cost. Based on an assessment of the benefits and costs of each option an initial assessment of the C2C project's VfM has been calculated and is presented, that includes an initial BCR (established monetised impacts) and an adjusted BCR (evolving monetised impacts).

Whilst the Wider Economic Impacts (relating to land use changes) for the project are central to demonstrating the benefits of the project and to assessing its VfM, these cannot be included in the initial or adjusted BCRs when following TAG guidance as they are considered to be indicative monetised impacts with a greater level of uncertainty. However, they have been considered by being presented in the VfM assessment using the switching values approach as set out in DfT Value for Money guidance.

13.2 Initial Benefit Cost Ratio

Table 27 presents an Analysis of Monetised Costs and Benefits (AMCB) for the C2C preferred option informing the initial BCR. This is based on the monetised Level 1 transport user benefits (established monetised impacts) presented in Section 5.

[12] City Deal Assurance Framework

[13] PVB is the present value of the future stream of estimated benefits of an option over 60 years discounted to the DfT's base year of 2010

[14] PVC is the present value of the future stream of estimated costs of an option over 60 years discounted to the DfT's base year of 2010

Table 27: AMCB – Level 1 benefits established monetised impacts (£'000s, 2010 prices discounted to 2010)

Impact	Value
Bus passenger PVB	63,014
Decongestion PVB	2,407
Safety PVB	7,803
Air quality PVB	164
Greenhouse gases PVB	1,159
Noise PVB	887
Indirect Taxes	-3,407
Active travel PVB	11,726
Total PVB	**83,753**
PVC	**195,141**
Initial BCR	**0.43**

Source: Mott MacDonald

13.3 Adjusted Benefit Cost Ratio

Additional Level 2 benefits of the project related to the Wider Economic Impacts (evolving monetised impacts) are included in an adjusted economic assessment as the realisation of these benefits is less certain. These Wider Economic Impacts include agglomeration, output change in imperfectly competitive markets and tax revenues arising from labour market impacts. These impacts have been assessed as described in Section 6. Table 28 presents an AMCB for the C2C preferred option informing the Adjusted BCR.

Table 28: Analysis of Monetised Costs and Benefits – Level 1 and 2 benefits (£'000s)

Impact	PVB
Level 1 PVB	83,753
Agglomeration	8,822
Tax revenues arising from labour market impacts	
Output change in imperfectly competitive markets	760
PVB	**93,334**
PVC	**195,141**
Adjusted BCR	**0.48**

Source: Mott MacDonald

13.4 Value for Money Statement

The VfM categories defined by the DfT and used by GCP are set out in Table 29.

Table 29: Department for Transport VfM Categories

VfM Category	Implied by…*
Very High	BCR greater than or equal to 4
High	BCR between 2 and 4
Medium	BCR between 1.5 and 2
Low	BCR between 1 and 1.5
Poor	BCR between 0 and 1
Very Poor	BCR less than or equal to 0

Source: Department for Transport Value for Money Framework

The monetised Level 1 economic benefits (based on transport modelling outcomes) show that the scheme produces an **initial Benefit to Cost Ratio** (BCR) of 0.43 from a PVB of £93.334m (2010 prices, discounted to 2010) and a cost to public accounts of £195.141m (2010 prices, discounted to 2010). According to DfT guidance and criteria the BCR of 0.43 yields poor VfM.

Taking into account the monetised Level 1 benefits and Level 2 additional benefits of the scheme, relating to Wider Economic Impacts based on fixed land use, the scheme produces an **adjusted BCR** of 0.48 from PVB of £93.334m (2010 prices, discounted to 2010). According to DfT guidance and criteria the BCR of 0.48 reflects poor VfM.

13.5 Indicative Monetised Impacts - Value for Money

In evaluating the overall VfM of the C2C project it is crucial to incorporate the impact the scheme has on supporting new housing and employment developments, and in particular assessing how much of this is dependent on the C2C investment.

The DfT guidance on dependent development states that:

"Dependent development impacts are classed as indicative monetised impacts and are not included in the initial or adjusted benefit cost ratio (BCR) for the scheme. However, they inform the final VfM category of the scheme."[15]

Following DfT VfM guidance, it is recommended that in order to assess the impact of dependent development on the VfM of a scheme, the assessment should look at applying a switching value:

"The Value for Money Framework proposes that an assessment is made as to whether the benefits of the housing are equal to or greater than a 'switching value', defined as the additional benefit required to move the scheme to a more favourable VfM category. VfM guidance also suggests that the sensitivity of key assumptions is assessed, such as the extent to which new housing is additional (how much of the benefit is attributable to the transport scheme), and occupancy rates for new housing."[16]

"Switching values represent the extent to which the Present Value Benefits or Present Value Costs would need to increase or decrease for the VfM Category of the proposal to change."[17]

The core scheme has an adjusted BCR of 0.48 (PVB £93.334m and PVC £195.141m) suggesting a poor VfM. The PVB would therefore have to rise by at least £101.806m for the BCR to increase and the scheme fall into a higher VfM category.

A key question is how much dependency can be attributed to the scheme and therefore how much likely additional benefit can be attributed to the scheme that would change its VfM category. Due to the high level of dependency of future housing along the route as set out in the Strategic Economic Narrative Report (Appendix J) and summarised in Section 6 of this Economic Case, the delivery of the housing sites is highly dependent on delivery of the scheme and therefore the final VfM should reflect this relationship.

Key in demonstrating this dependency is the current status of new development sites in the Local Plans which state that planning permission for sites such as Cambourne West, Bourn Airfield, and West Cambridge are conditional on transport improvements and introduction of a HQPT system, such as C2C, that will link them up to Cambridge.

[15] DfT Guidance - Capturing housing impacts in transport appraisal: Case Studies - Moving Britain Ahead (2018)
[16] DfT Guidance - Capturing housing impacts in transport appraisal: Case Studies - Moving Britain Ahead (2018)
[17] DfT Guidance – Value for Money: Supplementary Guidance on Categories - Moving Britain Ahead (2016)

As well as the planning dependency, current transport constraints along the corridor, in the form of congestion, are only set to worsen if the planned new developments were constructed, without additional transport capacity provided. In other words, there isn't enough capacity on the current highway network to accommodate additional traffic.

For example, the A428 has shown the highest growth on trunk roads within the County in recent years with an increase of 25% since 2002. Congestion and delay along the A428 are currently showing signs of a fully capacitated network with:

- Traffic moving at over 75% slower travelling in to Cambridge in the AM Peak compared to night time average speeds between Madingley Mulch Roundabout and the M11 Junction;
- Traffic exiting the M1 motorway moving at between 50% and 75% slower compared to night time average in both the AM and PM Peak; and,
- Delays occurring in both the AM and PM Peak with traffic moving at over 75% slower than the night time average speed at the Madingley Road Park and Ride site.

Future traffic forecasts in the Cambridge area indicate a significant increase in demand for travel, which will exacerbate existing problems – particularly east of Madingley Mulch roundabout along the A1303.

Between 2015 and 2036 and without the developments at Bourn Airfield and Cambourne West, car trips along the A428/A1303 route eastbound are forecast to increase by:

- 14% in the AM Peak hour;
- 82% in the Inter-peak period, and
- 37% in the PM Peak period.

Even without new development sites such as Bourne Airfield and Cambourne West, annual average daily traffic flows are predicted to increase by 70% (an increase from 38,250 to 65,200 AADT) along the A428 east of Cambourne and by 52% (an increase from 15,300 to 23,200 AADT) east of Madingley Mulch without C2C between 2015 and 2036. Journey times are also forecast to almost double inbound between Cambourne and the A1303/A1134 junction in the AM peak between 2015 and 2036 from 20mins 21secs to 40mins 7secs.

Applying Switching Values

Table 30 sets out the additional PVB required to switch the VfM category.

Table 30: PVB switching values required to change VfM category (2010 prices,

Switching value to reach:	Low	Medium	High	Very High
PVB	£101,806	£199,377	£296,947	£696,986

Source: Mott MacDonald

Table 31 below shows how the changes in LVU impacts on the VfM category. The different percentage values reflect the impact that not all houses being built and occupied would have on the value of LVU achieved. In addition, the alternative percentage values of the LVU seek to reflect the potential transport external costs impact (currently not accounted for in the LVU value due to issues including the uncertainty of the current status of other proposed initiatives such as City Access,).

Table 31: Switching value impact on VfM category

% of LVU	LVU value (2010 prices, £,000)	VfM Category
100%	£287,800	Medium
75%	£215,850	Medium
50%	£143,900	Low

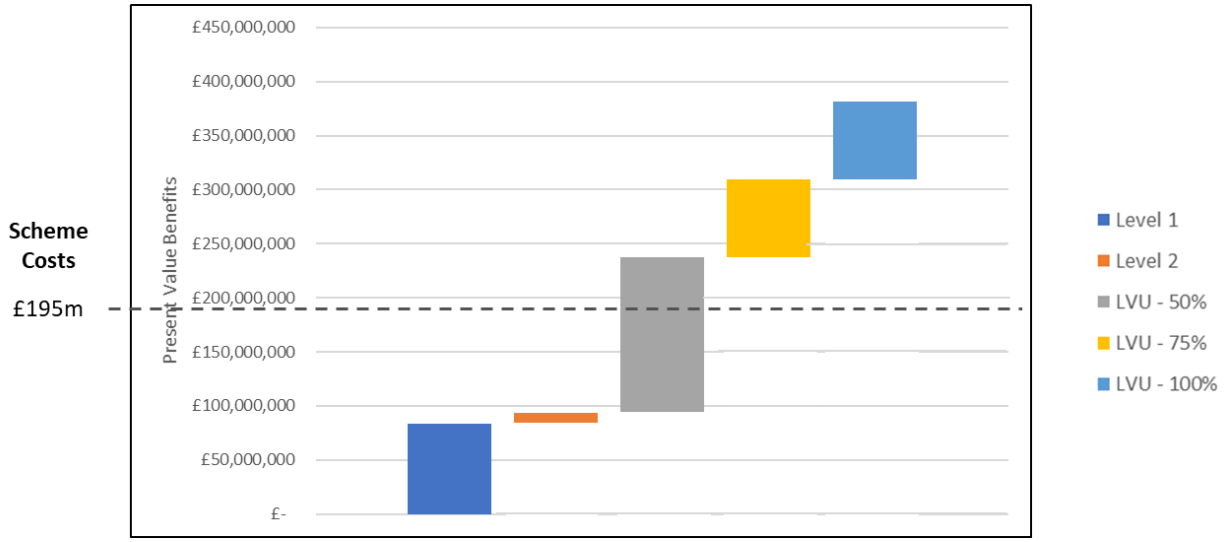
Source: Mott MacDonald

As the strategic case that underpins the need for investment is based on the scheme supporting future economic growth by unlocking dependent housing sites, the scheme's Wider Economic Impacts in relation to land use change must be taken into consideration. Taking into account estimated Land Value Uplift (LVU) impacts, the scheme has the potential to deliver additional PVBs valued up to £287.8m (2010 prices). Applied these as a switching value moves the scheme into a **Medium VfM category**.

If the value LVU drops by 25%, either because not all houses are built and occupied, or to reflect the transport external costs impact (not accounted for in the initial LVU value), then the VfM category still remains **Medium**. This would drop to low if only 50% of the LVU value is realised and linked to the scheme. In all cases, this is still greater than the poor VfM category based on the core PVB used to calculate the initial BCR.

Figure 10 illustrates the impact LVU has on the scheme's overall VfM.

Figure 10: C2C VfM assessment



Source: Mott MacDonald

Based on evidence of the significant economic growth in Greater Cambridge, and the linkages between this growth and the C2C project (as set out in the Strategic Economic Narrative and Economic Impacts Assessment Report), it is considered appropriate, reasonable, and realistic, to assess the scheme as providing Medium VfM.

Further to the LVU impact on justifying the VfM category to Medium, other non-monetised benefits associated with the scheme further strengthen this justification.

For example, the scheme will significantly reduce journey times for those using it in comparison to the Do Minimum scenario where the scheme is not constructed. The preferred option for C2C

will offer journey times of 32mins in the AM Peak (08:00-09:00) compared to 53mins along the A428/A1303, with significant reliability benefits (see Section 8), with an estimated £536,000 (2010 prices) in additional benefits.

The scheme will offer slight beneficial impacts in relation to accidents, severance, journey quality and accessibility, as well as moderate beneficial impacts on physical activity , and will bring about improved user benefits by areas of deprivation so that those in the most deprived quintile see a slight benefit, whilst those in the second and third most deprived quintile seeing a moderate benefit.

13.6 Appraisal Summary Table

The Appraisal Summary Table (AST) presented is included in Appendix N and provides details of the overall impacts of the scheme. These include both qualitative and quantitative benefits.

14. Sensitivity Tests

A number of sensitivity tests have been carried out around the preferred option. The purpose of the sensitivity tests is to understand if the intervention being proposed is still value for money given alterative cost assumptions and demand levels driven by higher growth scenarios. The sensitivity tests can be grouped into the following categories:

- Sensitivity around scheme costs for the preferred scheme – investigating the impact of different levels of optimism bias and risk allowance, and investigating the impact of electric vehicles in place of diesel vehicles
- Sensitivity around alternative growth scenarios – looking at the impact higher demand growth, in line with that reported in the Cambridgeshire & Peterborough Independent Economic Review (CPIER)

14.1 Sensitivity to scheme costs

Three sensitivity tests have been carried out to assess the sensitivity of the scheme to different assumptions surrounding scheme costs. These relate to:

- The level of optimism bias
- The treatment of risk
- Use of electric vehicles

14.1.1 Optimism bias

TAG A1-2 presents guidance on determine the appropriate level of optimism bias to apply to scheme costs. This is dependent on the nature of the scheme and its status in the scheme development process. The preferred scheme has been assessed based on the guidance included in TAG A1-2, which results in optimism bias of 15% being applied, commensurate with a local authority scheme at OBC stage.

It is important to examine the impact of a range of other possible levels of optimism bias on the cost estimates reported in the TEE and PA tables. To address this a sensitivity has been carried out assuming an optimism bias level of 44%, which is the appropriate level for a local authority scheme at SOBC stage. The scheme costs with an optimism bias of 44% are shown in Table 31, with corresponding impact on the BCR.

14.1.2 Treatment of risk

Risk in this context refers to identifiable factors that may impact on scheme costs, leading to over- or under-spends. The risk adjusted costs used in the economic appraisal for the preferred option. For the core base costs a risk value based on P80 was applied. For the purpose of this sensitivity test the P90 costs have been used. The P90 cost estimate represents an 90% likelihood that the project will be delivered within budget. The scheme costs based on a P90 estimate are shown in Table 31, with corresponding impact on the BCR.

14.1.3 Electric Vehicles

As the C2C project is aspiring to use the most up to date technology, it is considering the use of electric vehicles on the new system. These vehicles would have an impact on costs due to their higher purchase value, however they are less costly to operate and maintain. The impact of using electric vehicle on the scheme's VfM are shown in Table 31.

14.2 Alternative growth sensitivity test

One sensitivity test has been carried out to assess the sensitivity of the scheme to different assumptions surrounding future growth. This is based on the CPIER findings that Cambridge is expected to achieve growth greater than that set out I the adopted Local Plans.

CSRM2 (D-series) was developed with three future year scenarios, known as the Foundation Case (2026 FC, 2031 FC and 2036 FC), of which 2026 and 2036 have been used in testing the various options for C2C. The Foundation Case represents a scenario which is consistent with the Local Plans for the four Local Authority Districts covered by CSRM2 (Cambridge City, South Cambridgeshire, Huntingdonshire and East Cambridgeshire). As such it is constrained to the levels of growth and locations contained in published and proposed plans.

However, since the Local Plans were published, actual growth has differed in terms of the rate and locations in which it is occurring. In addition, there is the potential for overall employment growth to be greater in the period to 2031 than projected in the Local Plans, particularly in the Cambridge area, as noted in the CPIER interim report.

An alternative future growth scenario was therefore developed (nominally called 'High Growth' (HG)) to represent a revised pattern and rate of growth across the modelled area. In addition to revised employment and dwelling forecasts, the High Growth forecasts also included academies and other private schools.

As such the impact of this High Growth alternative scenario on the scheme's VfM has been tested, with a greater level of demand and therefore associated benefit evaluated. The results are shown in Table 32.

14.3 Sensitivity test results

Table 32: C2C Preferred Option – Economic appraisal sensitivity tests

	Core	Sensitivity Test 1	Sensitivity Test 2	Sensitivity Test 3	Sensitivity Test 4	Sensitivity Test 4+1	Sensitivity Test 4+2	Sensitivity Test 4+3
		Optimism Bias 44%	**Risk P90**	**Electric vehicles**	**High Growth**	**High Growth+ Optimism Bias 44%**	**High Growth+ Risk P90**	**High Growth+ Electric vehicles**
Level 1 PVB	**83,753**	83,753	83,753	83,753	89,015	89,015	89,015	89,015
Level 2 PVB	**9,582**	9,582	9,582	9,582	10,144	10,144	10,144	10,144
PVC	**195,141**	223,964	198,480	190,470	195,141	223,964	198,480	190,470
Initial BCR	**0.43**	0.37	0.42	0.44	0.46	0.40	0.45	0.47
Adjusted BCR	**0.48**	0.42	0.47	0.49	0.51	0.44	0.50	0.52
VFM Category	**Poor**	Poor	Poor	Poor	Poor	Poor	Poor	Poor

Source: Mott MacDonald

There is an increase in the initial and adjusted BCRs under the High Growth Scenario and with the use of Electric Vehicles, whilst there is a decrease with costs increase due to the application of a higher risk value and application of greater uncertainty i.e. Optimism Bias. However, under each sensitivity test the VfM category does not change (not factoring in the final VfM assessment of the scheme with the application of LVU values as switching values). This supports the economic case for the scheme in that where costs may increase the VfM of the scheme remain unchanged, and that if a greater level of growth does materialise then the VfM scheme will increase.