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Cambourne to Cambridge Better Bus Journeys

Options Assessment

Greater Cambridge Partnership

July 2017



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This document has 60 pages.

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Document history

Job number: 5040372			Document ref: 5040372/320/002			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
A	For Information	SW/JH	MG/FQ	JW/TD	JW/CY	07/07/17

Change log

Rev	Section	Description

Hold log

Rev	Section	Description

Client sign off

Client	Greater Cambridge Partnership
Project	Cambourne to Cambridge Better Bus Journeys
Document title	Options Assessment
Job no.	5040372
Copy no.	1
Document reference	5040372/320/002

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Executive summary

Four segregated guided busway arrangement options have been assessed along the A1303 Madingley Road corridor which would all require:

- Additional land to be purchased;
- Total or partial excavation of the existing carriageway;
- Removal of the existing cycleway/footway to the south of the A1303;
- Diversion or lowering or protection of existing services
- Access to properties and provision of signalised junction at Cambridge Road junction (Coton and Madingley) to accommodate the busway;
- Increased safety risks
- Measures to reduce risks associated with vehicle exiting access, vehicles blocking the busway.

The guided busway options were presented to the Local Liaison Forum (LLF) in February 2017. The LLF presented alternative options comprising of an unsegregated tidal bus lane aligned to the centre of the A1303 Madingley Road referred to as Option 6. The do-minimum option comprising of an eastbound only unsegregated nearside bus lane, referred to as Option 1, has been further developed to make a fair comparison with Option 6. They would require;

- Additional land to be purchase, (both residential and agricultural land);
- Widening of the existing A1303 carriageway;
- Diversion or lowering or protection of existing services on both verges;
- Provision of gantries to regulate the tidal bus lane (Option 6)
- Additional signalised junctions causing delays for current road users (Option 6)
- Vehicles overtaking slow moving vehicles into the central bus lane conflicting with buses (Option 6)
- Vehicles turning left across the path of buses on the eastbound nearside bus lane (Option 1)

A Multi Criteria Assessment Framework was undertaken for the proposed Cambourne to Cambridge Better Bus Journeys option 1, option 6 and option 3a. The criteria were set out and agreed with the Local Liaison Forum (LLF) in a series of meetings with a view to broadly assessing each option against each other with respect to performance, service, cost, risk and impact. Meetings were held with the LLF Technical Group on three separate occasions, 26th May 2017, 2nd and 9th June 2017 to discuss and agree elements used to measure some of the criteria such as routes, bus stops, journey times, reliability data agreed within the MCAF assessment.

Following the series of meetings with the LLF technical group each option was scored by Skanska, Atkins and CCC with respect to the criteria being assessed, some criteria scoring was based on modelled outputs and some on professional judgement. The outcomes of the simple scoring system indicate that option 1 and option 3a are the joint best followed by option 6. It should be noted that the criteria used is considered a subset of the wider MCAF analysis that should be undertaken with respect to these options and that the simple scoring provides only an indicative result which should be treated as such.

The LLF undertook a review of the MCAF analysis and provided comments and new scores base on their views of some of the criteria assessed. The LLF comments are included in section 9 of this report and are replicated below in Table 1:

	<i>Option 1</i>	<i>Option 6</i>	<i>Option 3a</i>
<i>LLF scoring</i>	44.5	46	35

Table 1. Options Published for Consultation¹

The MCAF analysis presented within this report and scored by the joint Skanska, Atkins and CCC team based on the assessment of the options resulted in the following scores in Table 2:

	<i>Option 1</i>	<i>Option 6</i>	<i>Option 3a</i>
<i>Atkins/SKANSKA/CCC scoring</i>	51	45	51

Table 2. Options Published for Consultation²

The MCAF analysis is included in section 8 of this report and provides the rationale, commentary, metrics for each criterion and simple scores for each option considered. Notwithstanding the ongoing analysis and assessments being undertaken, the outcomes of the MCAF analysis indicate that option 3a comes out the best followed by option 1 and then option 6.

1 Purpose

Skanska and Atkins have been commissioned by the Greater Cambridge Partnership (GCP) to investigate the provision of a high quality bus link between Cambourne and Cambridge.

Catchment areas and high level route options for the Cambourne to Cambridge bus link have been identified and presented previously through public consultation.

The purpose of this report is to provide a technical review of different alternative options along the A1303 Madingley Road corridor in the Tranche 1 section between the Madingley Mulch Roundabout and west Cambridge as proposed by the LLF.

The report reviews and summarises the different options considered along the A1303 Madingley Road corridor; comparing guided and un-guided busway arrangements and highlighting the engineering potential for bus rapid transit provision.

The review considers buildability, traffic management of bus priority and safety of each option, identifying and comparing additional land requirements outside of the existing highway boundary and considers the need for further environmental assessment. A cost estimate is provided for comparison of each option considered.

An initial high level comparative assessment relating to Options 1, 6 and 3a has also been undertaken. It seeks to provide a relative assessment of the benefits and impacts of each of the options to inform the decision making and option development process in a consistent fashion. The assessment takes the form of an abridged and updated Multi-Criteria Assessment Framework (MCAF), based on that suggested by the LLF. It does not currently represent an assessment of the full costs and benefits / advantages and disadvantages of each scheme, nor does it apportion any relative importance or 'weight' in terms of the criteria used for assessment.

2 Introduction

A public consultation for the Cambourne to Cambridge Better Bus Journeys project was undertaken in the October/November of 2015. This was centred on six high-level options for bus infrastructure improvements between Cambourne to Cambridge. A general arrangement of the three different options taken to consultation for Area 1 and the three options for Area 2 are illustrated in Figure 2.

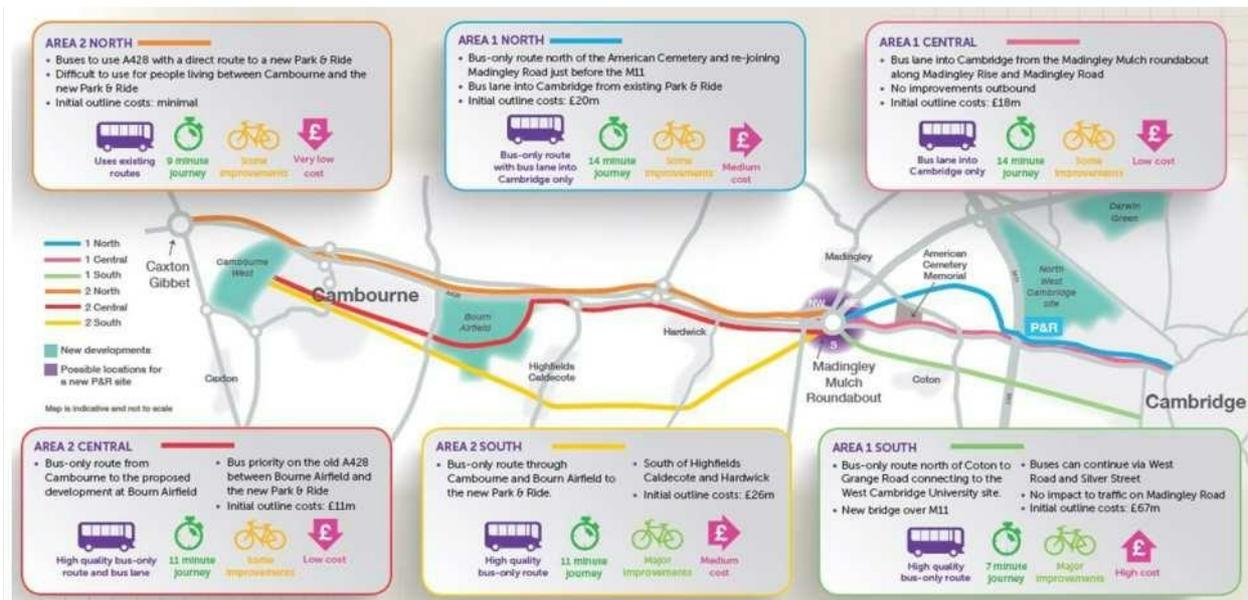


Figure 1. Options Published for Consultation³

In September 2016 at the Joint LLF for the A428 Cambourne to Cambridge Better Bus Journeys scheme, an option for an alternative bus link alignment to Option 3/3A within the Tranche 1 (area 1) section was proposed by LLF members. The alternative option proposed guided busway provision along the existing A1303 Madingley Road corridor between the Madingley Mulch Roundabout and west Cambridge, north of the Option 3/3A Catchment Area (figure 2).

In October 2016 the GCP Executive Board instructed a topographical survey be carried out of the A1303 from Madingley Mulch Roundabout to the M11, with a review of potential for two-way busway provision, a high quality footway/cycleway and the A1303 Madingley Road carriageway within the existing highway boundary to be undertaken. This information would be shared with the LLF.

Four developed guided busway options along the A1303 Madingley Road were presented to the LLF at the February 2017 meeting. At the meeting the LLF members presented a 'Supplementary Option Assessment Report for Cambourne to Cambridge Better Bus Journeys.' In the document, the LLF presented an additional route option to facilitate a High Quality Public Transport (HQPT) service from Cambourne to Cambridge utilising an unsegregated tidal bus lane aligned to the centre of the A1303 Madingley Road, referred to as Option 6. This new option is additional to those options presented in the Strategic Outline Business Case (SOBC) and also with respect to those options initially taken forward for further development (Option 1 and Option 3a) following publication of the SOBC and 2015 public consultation.

Figure 2 Image has been taken from the A428/A1303 Better Bus Journeys Scheme – Public Consultation Outcomes and Next Step.

Following the February 2017 LLF, further meetings and consultation was carried out between GCP representatives and the LLF to discuss and understand the requirements of bus priority options along the A1303 Maddingley Road.

Catchment Area on Tranche 1, are illustrated below in Figure 2.

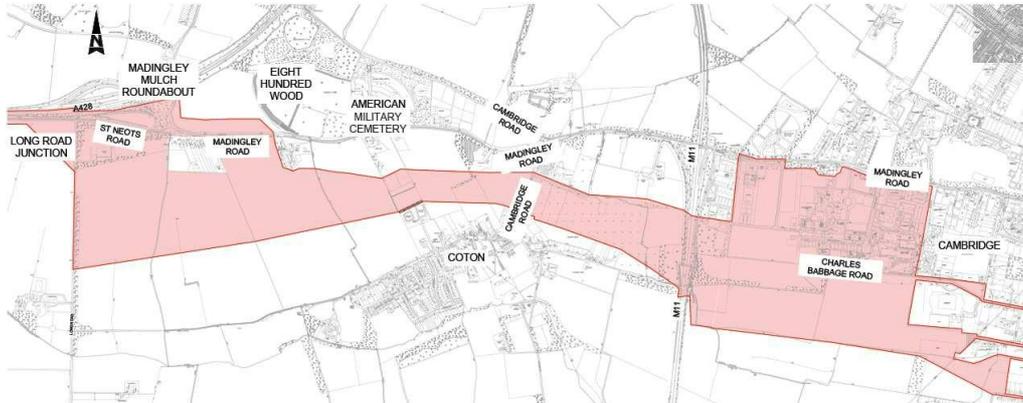


Figure 2. Busway Catchment Area Option 3a – Tranche 1 Extends Long Road to West Cambridge

The six bus link options along the A1303 Maddingley Road corridor comprising of the four segregated guided busway options (Options A-D) and the two subsequent unsegregated bus lane options (Option 1 and Option 6) are discussed in this report.

3 Existing Arrangement

3.1 A1303 Madingley Road

The section of A1303 being considered extends from Madingley Mulch Roundabout connecting with the A428 and A1303 St Neots Road, through to the junction with the A1134 and Northampton Street, Cambridge.

The section of Madingley Road subject to this review is approximately 5km in length from the Madingley Mulch Roundabout, over the M11 Junction 13 Interchange to Northampton Street, Cambridge, as indicated in Figure 3.

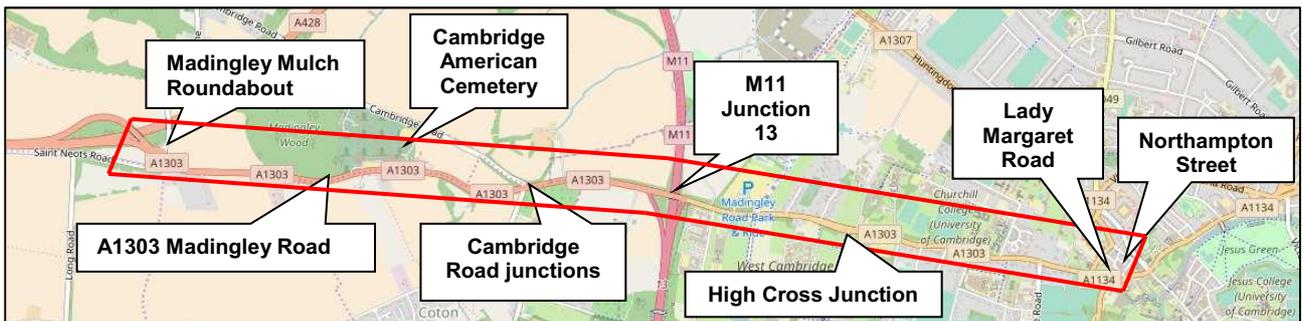


Figure 3. Location Plan

The A1303 Madingley Road west of the M11 is a two-way single carriageway road in a predominantly rural setting west of Cambridge, with a number of uncontrolled junctions, a signalised junction with the M11 Junction 13 off slip road, and private accesses along its length (as illustrated in Figure 4). Right turn lanes are provided at a number of junctions and accesses, and discrete lengths of localised widening of the carriageway are present along the length of the road.



Figure 4. A1303 Madingley Road – Uncontrolled Junction and private access

The highway is bounded to the north by farmland, the Cambridge American Cemetery and Memorial and residential properties, and to the south by farmland, Crome Lea Business Park and isolated residential properties. An existing unsegregated bus lane is present alongside the eastbound carriageway approximately 450m prior to the M11 Junction 13.

An existing combined 1.5 - 2.5m footway/cycleway runs along the south side of the A1303 from Madingley Mulch Roundabout to the Cambridge Road, Coton junction. It continues for 130m east of the Cambridge Road Coton junction where there is a crossing to the north side. The north side of this section of the footway/cycleway has been constructed significantly below the level of the adjacent carriageway due to the level difference between the A1303 and adjacent land. The combined footway/cycleway continues east across the M11 bridge into Cambridge.

East of the M11 the A1303 Madingley Road is a two way single carriageway road in an urban setting within west Cambridge. There are a number of uncontrolled junctions, signalised junctions and pedestrian crossings, and private accesses to properties fronting the road throughout the section. Right turn lanes are provided at a number of junctions and accesses. Pedestrian and cycle facilities are provided along both sides of the carriageway throughout most of the carriageway section, linking into Cambridge city centre.

The speed limit on the A1303 Madingley Road is 50mph between the Madingley Mulch Roundabout and 125m west of the Cambridge Road junction. East of the Cambridge terminal signs the speed limit is 40mph, reducing to 30mph east of the High Cross Junction through to the junction with Northampton Street.

A Clearway Order is in place to prevent stopping on the main A1303 carriageway between the Madingley Mulch Roundabout to a point approximately 130m east of the Cambridge Road junction. From thereon there are no parking restrictions through to east of High Cross junction. From east of High Cross junction to Northampton Street a double yellow lining system is provided to both sides of the carriageway. All properties within the affected length have provision for off-street parking.

The A1303 Madingley Road is lit by column mounted street lighting for 85m east of the Madingley Mulch Roundabout. From this point east up to the Cambridge terminal signs the road is unlit; this section is within the 50mph speed restriction. Column mounted street lighting is provided from the Cambridge terminal signs east through the Cambridge Road junctions continuing for the remaining affected length of Madingley Road, aligned to the 40mph and 30mph speed limits.

Realignment works were carried out in 2012 on the Madingley Hill section. The westbound carriageway previously provided two lanes for a short length up the Madingley Hill from the start of the 50mph speed limit merging prior to the Madingley Windmill site. Re-modelling of the carriageway has reduced the westbound carriageway to the current single lane arrangement with a double white line system to prevent overtaking. The eastbound right turn lane into Cambridge Road, Coton was extended at the same time to allow early access for the right turn manoeuvres past the peak time queue into Cambridge.

A right turn lane with central islands was also provided for the eastbound right turn manoeuvre into the Madingley Rise property. Realignment of the bend at the top of the Madingley Hill was carried out to provide a consistent radius.

3.2 Existing Junctions

An uncontrolled staggered junction is present at the Madingley Road junction with Cambridge Road, Coton and Cambridge Road, Madingley (as illustrated in Figure 5).



Figure 5. Uncontrolled Staggered Junction A1303 Madingley Rd-Cambridge Rd Coton/Madingley

The junction provides right-hand turning lanes on both approaches to the junctions, with a double white lining system in place to the west of the junction to eliminate overtaking for westbound traffic into the right turn lane to Cambridge Road, Coton. No such double lining system is provided for the right turn lane into Cambridge Road, Madingley, although the road alignment affords improved visibility of the junction for eastbound traffic. Refer to Figure 6.

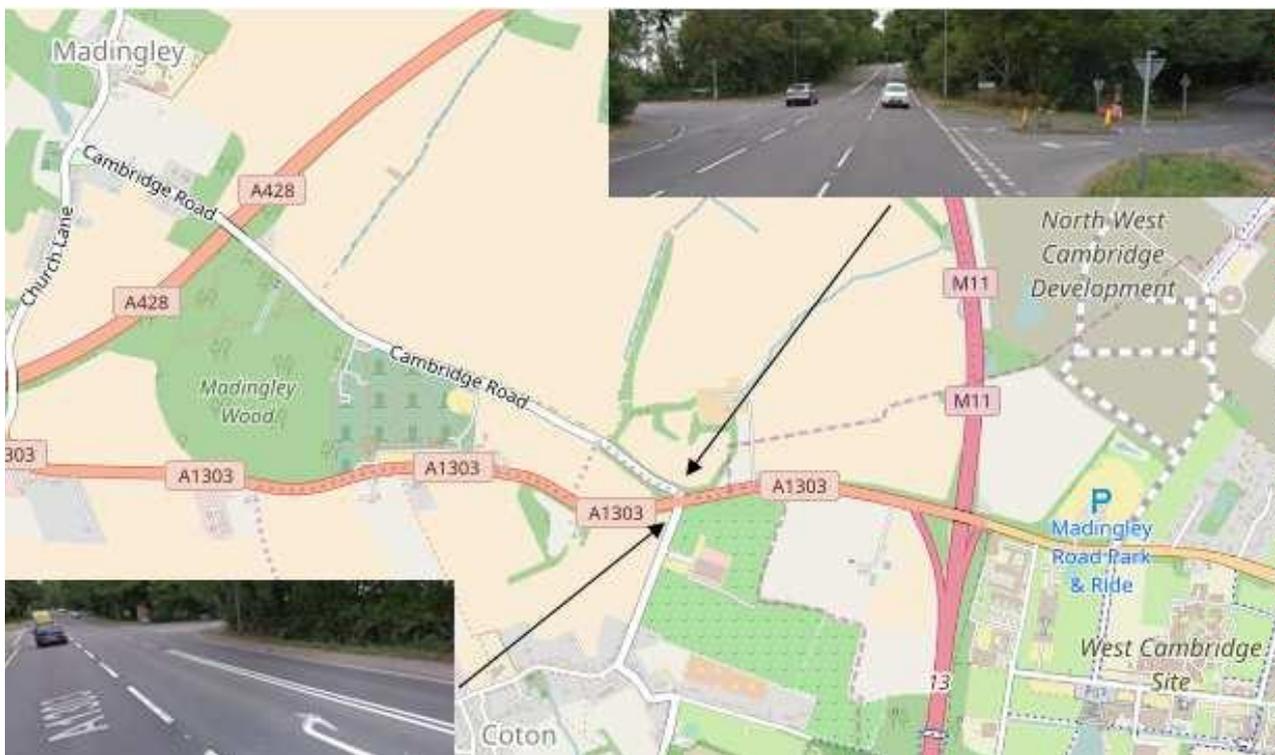


Figure 6. A1303 Madingley Rd-Cambridge Rd, Coton Junction and A1303 Madingley Rd-Cambridge Rd, Madingley Junction

The M11 Junction 13 northbound exit slip road joins with the A1303 with a signalised junction. The A1303 at this junction is a two-way single carriageway with the addition of an eastbound bus lane into Cambridge. (No segregation or prioritisation of the bus lane is provided through the signalised junction). The bus lane terminates just prior to the M11 Bridge.



Fig 7. M11 Junction13 Northbound slip/ A1303 Madingley Rd. Signalised junction

East of the M11, signalised junctions are provided at the Madingley Park and Ride site entrance, High Cross junction, Grange Road and Lady Margaret Road. All signalised junctions east of the M11 include pedestrian facilities. Separate signalised crossings of Madingley Road are also provided at JJ Thomson Avenue and to the west of the Northampton Street junction.

3.3 Existing Property Access

Widened carriageway with a half width central refuge lane is provided for the eastbound right turn manoeuvre into the Crome Lea Business Park east of Madingley Mulch Roundabout.

The American Cemetery and Memorial is located on the northern side of the A1303 to the east of the Madingley Mulch Roundabout (see Figure 3. Location Plan). Three accesses are provided to the cemetery, an entrance only for eastbound traffic, an entrance and exit for east and westbound traffic and an exit only from the main car park. There is no provision of a right turn lane for westbound traffic turning into the cemetery access, the A1303 alignment on approach to this junction is on a left hand radius for westbound traffic. A solid white centreline is provided to prevent westbound traffic turning right into the eastbound entrance.

Three private residential accesses are located south of the A1303 opposite the American Cemetery, all have gated accesses screening the properties from the A1303.

A number of other residential properties are located along this length of A1303 with accesses directly onto the A1303. The Madingley Rise property located to the south side of the A1303, to the west of the Cambridge Road junction, has right turn lane provision with traffic islands and double white centrelines to prevent overtaking due to the poor alignment of the A1303 on approach to the property access.

4 Site Constraints

4.1 General

The A1303 Madingley Road west of the M11 is predominantly bounded by agricultural land, Crome Lea Business Park, the American Cemetery and some residential properties. The main aspect to be considered if a new busway/bus lane is implemented would be to manage traffic entering/exiting residential properties, adjacent accesses and side road junctions.

The width of highway land along this length of the A1303 varies. At its narrowest, the widths between highway boundaries is 15.69m and at its widest opens up to 37.34m. The average width between the northern and southern highway boundary throughout the affected length is approximately 22.20m.

The options discussed in this report would require widening the existing highway corridor along much of this section of the A1303, and therefore additional land acquisition is required. The following site constraints have been identified along the A1303 corridor:

Property Accesses

- North of the A1303
Along the A1303 from west to east the following features can be identified; Cambridge American Cemetery and Memorial, Madingley Windmill and Moor Barn Farm Cottages.
- South of the A1303
On the south of the A1303 from west to east the following property access include; Crome Lea Business Park, Crome Lea Farm, Coton Court, Blue Gates, Madingley Rise, Bonde Mteko and Rectory Farm.

It must be noted that the number of properties affected is particularly high on the southern side of the A1303. Properties within this section of the A1303 west of the M11 are generally set back from highway boundary.

Junctions

- North of the A1303
The A1303 adjoins to the north with Cambridge Road, Madingley.
- South of the A1303
The A1303 adjoins to the south with Cambridge Road, Coton and the M11 Junction 13 northbound slip.

Lay-bys

A total of 3no lay-bys are located within the A1303 west of the M11, two in the west bound direction and one in the eastbound. The two westbound lay-bys provide bus stop provision.

4.2 Property Access Requirements

The A1303 Madingley Road east of the M11 is predominantly bounded by numerous residential and business properties fronting the carriageway. The quantity and proximity of properties that would be impacted by any significant widening of the highway corridor to accommodate a busway or bus lane make it unrealistic within this section of the A1303. Those options discussed within this report which give bus provision within the section of the A1303 east of the M11 are constrained by available land limiting the potential to widening the highway corridor.

Individual property accesses are provided directly onto the A1303 along the length of the road. The widths of accesses differs at each property, but generally fall in the range of 4 - 5.5 m. Each property access would need to be maintained through the busway/lane where affected.

4.3 Junction Requirements

The existing junction at Cambridge Road, Madingley and Cambridge Road, Coton would require full signalisation for most options discussed within this report to enable priority transit of buses utilising the busway/lane through the junction.

Both existing junctions are provided with dedicated right-turn lanes, with the Coton right-turn lane having been extended in 2012 to increase its length in order to provide additional capacity and to avoid eastbound queuing traffic on Madingley Road. Considering the available width of land at the junction it would not be possible to provide dedicated right turn lanes with the provision of a busway options unless additional land was purchased.

Other existing junctions along the A1303 Madingley Road would require some alteration and realignment to give bus priority through the junctions. The amount and junction alterations and number of junctions affected differs for each option reviewed.

4.4 Utilities

Existing utility services are present throughout the length of the A1303 Madingley Road corridor in both the eastbound and westbound verges, running parallel to the carriageway alignment.

Services comprise of:

- Virgin Media
- Cambridge Water
- BT Underground plant
- BT Overhead plant
- National Grid Gas (LP)

The depth of the utility services below the existing carriageway verge is unknown and would need to be subject to further investigation during detailed design. Based on the services being positioned with the verge area it is expected that the depth will be shallower than would be required for utility services positioned under carriageway construction. It would therefore be expected that services would need to be diverted or lowered to enable construction of the busway/lane and realigned carriageway within the verge areas, and that access requirements would need to be maintained to the utility plant where it is to be retained under the line of the proposed busway or carriageway.

5 Option Development

A segregated guided busway arrangement along the A1303 Madingley Road corridor between Madingley Mulch Roundabout and the M11 was presented by the LLF in September 2016. The proposal included a new crossing of the M11 south of the Junction 13 Interchange to link to the Option 3/3A catchment area alignment.

The options considered within this report assessed the provision of a segregated busway between Madingley Mulch Roundabout and the M11 Junction 13 along the existing A1303 Madingley Road Highway corridor. Four different guided busway options were considered; these are listed below:

- **Option A** – Busway segregated from the existing A1303 (single lane busway eastbound direction to the north of the A1303 and single lane busway in westbound direction to the south of the A 1303); Refer to Appendix B, Option A.
- **Option B** – Busway segregated from the existing A1303 (paired two-way busway arrangement to the south of the A1303); Refer to Appendix B, Option B.
- **Option C** – Busway segregated from the existing A1303 (paired two-way busway arrangement to the north of the A1303); Refer to Appendix B, Option C.
- **Option D** – Busway centralised to the A1303, providing paired two-way flow with A1303 traffic segregated either side of the busway. Refer to Appendix B, Option D.

5.1 Guided Busway

5.1.1 Design Approach

The design approach adopted for each route alignment considers the following criteria:

- For the purpose of this assessment the proposed design and layout of the proposed bus route should be similar to the existing Cambridgeshire Guided Busway, providing a consistent approach and providing continuity for existing bus operators and passengers;
- The design of the busway arrangement has been based on design guidance provided in the 'Guided Busway Design Handbook' published by Britpave;
- The proposed alignment shall remain within the existing A1303 highway corridor where practicable to minimise any unnecessary land take, including loss of amenity and wildlife habitat. Where land is required the proposed alignment would look to utilise agricultural land where possible in favour of residential property;
- The proposed alignment shall where possible minimise severance of access, public footpaths, rights of way, wildlife corridors, etc.;
- The proposed alignment shall consider new connections and improvements to existing connectivity for access, public footpaths, rights of way, wildlife corridors, etc.;
- The proposed alignment shall consider potential access and egress requirements along the route corridor;
- The Design Manual for Roads and Bridges (DMRB) shall be adhered to when constructing new sections of carriageway;
- The proposed alignment shall consider the existing constraints and any mitigating measures required to accommodate the works and
- A high quality 4m wide footway/cycleway will follow the alignment of the busway in common with proposed dual function footway/cycleway/maintenance track provision along the Cambourne to Cambridge busway.

The A1303 Madingley Road guided busway link could continue to the west of Madingley Mulch Roundabout linking to a busway along the A1303 St Neots Road corridor towards Bourn Roundabout, not covered within this report. At the east end of the busway it could link with the identified Option 3/3A catchment area corridor, running parallel to the M11 Junction 13 northbound exit slip road. The busway then would cross the M11 via a new curved structure and continue to west Cambridge.

The proposed M11 curved bridge crossing could consist of a single span or two span structure. A two span bridge structure would require support piers to be constructed in the central reserve of the M11, as shown in the example in Figure 8. Additional construction activities would be required to provide the central piers with associated traffic management restrictions on the M11. Individual closures of the M11 northbound and southbound carriageways would be required to install the two sections of bridge deck.

A single span bridge structure would require only supports within the M11 verges, reducing traffic management requirements on the M11, but the option would be more technically challenging to construct, with a full closure of the M11 required in both directions during installation of the single span bridge deck. Further considerations would be required at detailed design stage, hence the feasibility of the structure is not intended to be covered in this report. Figure 8 shows a typical example of an existing curved crossing over the M11.



Figure 8. Example of an existing curved crossing over the M11 – A120 Stansted Duck End Bridge

5.1.2 Design Options

5.1.2.1 Option A – Single Lane Busway Eastbound to the North of the A1303 and Single Lane Busway Westbound to the South of the A1303.

Option A would provide segregated single-lane guided busways either side of the A1303 carriageway providing bus links directional with the flow of traffic (eastbound and westbound). A new footway/cycleway would be provided on the north side of the A1303, the existing footway/cycleway to the south of the A1303 would be removed. The typical configuration of the proposed busway section for Option A is shown in Figure 9.

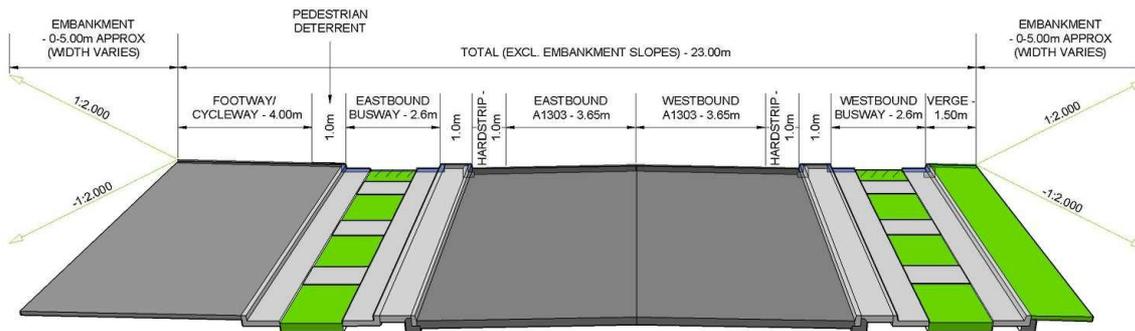


Figure 9. Option A Typical Cross Section (Off network Busways: Single lanes)

The arrangement would move the position of the A1303 carriageway to the south, requiring realignment of the carriageway by constructing into the existing westbound verge. The eastbound carriageway of the existing A1303 would fall within the extent of the proposed eastbound busway over a significant length, and would be required to be excavated to allow the eastbound busway to be constructed. The proposed carriageway widths shown are in accordance with the Design Manual for Road and Bridges (DMRB) Single (S2) carriageway with 3.65m carriageway lanes and 1.0m hard strips. The busway shown has two kerbed guideway systems as utilised throughout the Cambridgeshire Guided Busway network, with 2.6m busway widths.

To maintain connection to the south catchment area at the east end of the section, the eastbound busway lane could cross the A1303 carriageway to continue alongside the M11 Junction 13 northbound exit slip to cross the M11 via a new structure and continue into west Cambridge. This manoeuvre would require a new signalised junction arrangement at the existing A1303 and M11 northbound exit slip road signalised junction. An alternative arrangement could be for the busway to end at the existing A1303 Rectory Farm (M11 Junction 13) overbridge and continue over an altered structure via bus lanes into west Cambridge.

The westbound busway would not impact on traffic flow along the A1303 at the M11 Junction 13, joining the A1303 busway from the southern link from the proposed bridge and continuing alongside the south side of the A1303.

At the western end of the A1303 Madingley Road the busways could connect with the Madingley Mulch Roundabout via a signalised junction arrangement, enabling buses to continue to the west.

Refer to the following drawings in Appendix B for layout arrangements for Option A:

- DWG 5040372/HW/FS/010 Rev A
- DWG 5040372/HW/FS/011 Rev A

- DWG 5040372/HW/FS/012 Rev A
- DWG 5040372/HW/FS/013 Rev A

The proposed footway/cycleway is 4.0m in width to align with the Cambridgeshire Guided Busway footway/cycleway provision. Providing the footway/cycleway to the northern side of the A1303 gives connectivity with the existing footway/cycleway at the M11 crossing, where the existing footway/cycleway continues alongside the A1303 Madingley Road into west Cambridge. A crossing facility would be provided at the signalised M11 junction to enable pedestrians and cyclists to cross the A1303. An offline footway/cycleway would be provided alongside the busway link at this point, connecting with the Coton Path cycle route via the proposed M11 crossing.

At the western end of the site a crossing facility could be provided at the Madingley Mulch Roundabout to link with proposed footway/cycleway provision alongside the St Neots Road west towards Cambourne.

Option A presents the following advantages and disadvantages, these are summarised below in Table 3.

ADVANTAGES	DISADVANTAGES
Broadly maintains the position of the A1303 carriageway, utilising the existing carriageway construction where possible.	Busway will cross every junction and property access along the affected length of Madingley Road.
Busway direction flows in line with A1303 traffic flow, providing high quality guided busway provision in both directions.	Buses required to reduce speed at the numerous entry and exits and 'Burst throughs' increasing journey times.
Easier provision of and access to potential bus stops along the route for patrons.	Risk associated with (left) turning vehicles crossing the busway resulting in potential conflict with buses.
Enables buses to enter and exit the busway at points along its lengths (i.e. entering and exiting the eastbound busway at the American Cemetery and Cambridge Rd Junctions to take alternative routes).	Vehicles exiting unsignalised accesses will have to wait across the busway increasing the potential for conflict.
Safer crossing of the busway for pedestrians as directional flow is aligned with approaching traffic.	Loss of existing lay-by provision on A1303.
Lowest required additional land requirements outside of the highway boundary (17,171m ²) of busway Options A-D	Revised signalised arrangement required at the A1303/M11 Junction 13 slip road.

Table 3. Advantages and disadvantages Option A

5.1.2.2 Option B – Two Busway Arrangement to the South of the A1303

Option B would provide a segregated two-lane guided busway positioned on the south side of the A1303 carriageway providing bus links separated from the A1303 highway. A new footway/cycleway would be provided on the north side of the A1303, the existing footway/cycleway to the south of the A1303 would be removed. The typical configuration of the proposed busway section for Option B is shown in Figure 10 below.

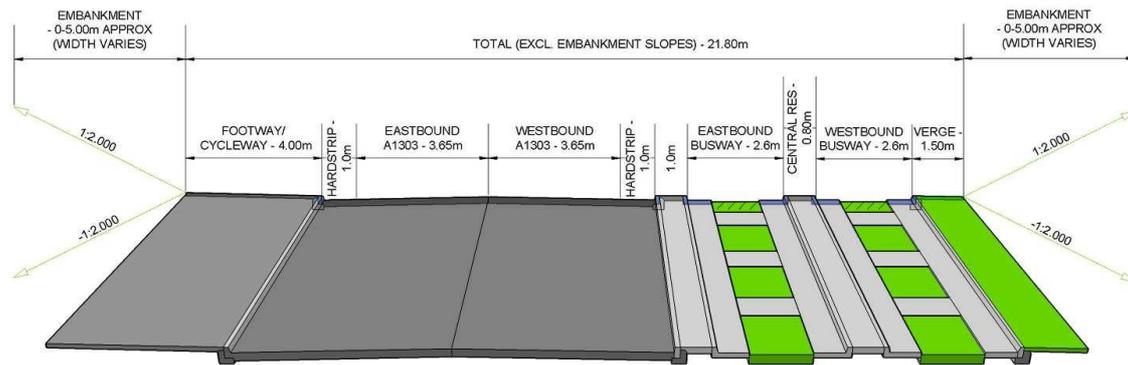


Figure 10. Option B Typical Cross Section (Off network Busways: Two-way). South of A1303

The arrangement would move the position of the A1303 carriageway to the north, requiring realignment of the carriageway by constructing into the existing eastbound verge. The westbound carriageway of the existing A1303 would fall within the extent of the proposed busways over a significant length of the site. A Britpave concrete busway system would be used this would require the existing carriageway to be partially or fully removed to allow the busway to be constructed.

The proposed carriageway width shown is in accordance with the Design Manual for Road and Bridges (DMRB) Single (S2) carriageway with 3.65m carriageway lanes and 1.0m hard strips. The busway shown indicates a two-way kerbed guideway system as utilised throughout the Cambridge busway network, with 2.6m guideway widths.

At the east end of the section the busway lane could link into the continuation of the route south alongside the M11 Junction 13 northbound exit slip to cross the M11 via a new structure into west Cambridge. With the positioning of the busway to the south side of the A1303 the manoeuvre would have little or no impact on the flow of traffic on the A1303. An alternative arrangement could be for the busway to end at the existing A1303 Rectory Farm (M11 Junction 13) overbridge and continue over an altered structure via bus lanes into west Cambridge.

At the west end of the A1303 Madingley Road busway continuation could potentially remain unimpeded south of Madingley Mulch Roundabout. The busway could continue into the proposed St Neots Road busway link following the alignment of the old road that was abandoned when Madingley Mulch Roundabout and the A428 were constructed. A signalised crossing of the carriageway for eastbound buses could alternatively be provided to allow buses to enter the busway from the eastbound carriageway at Madingley Mulch Roundabout. Consideration would be needed at further design stage on the interaction between the busway and the residential and business properties at the Madingley Mulch Roundabout.

Antidazzle fencing would be required between the busway and the A1303 due to opposing vehicle flows. To mitigate risks associated with vehicles crossing the two-way busway to access the A1303 from un-signalised accesses, and the restriction on sightlines resulting the antidazzle fencing, a 5.0m waiting area between the busway and the carriageway edge would be required.

The proposed footway/cycleway is 4.0m width to align with Cambridge busway footway/cycleways provision. Providing the footway/cycleway to the northern side of the A1303 gives connectivity with the existing footway/cycleway at the east end of the site, where the existing footway/cycleway continues alongside the A1303 Madingley road into west Cambridge.

Crossing facilities would additionally be provided at the east and west end of the site as with Option A to provide continuation of the footway/cycleway alongside the bus way alignment.

Option B presents the following advantages and disadvantages, these are summarised below in Table 4.

ADVANTAGES	DISADVANTAGES
Reduced impact on accesses and junctions by aligning the route to one side of the A1303.	Two way bus travel in south verge adjacent to the A1303 is an unfamiliar arrangement to road users.
Busway will cross accesses and junctions on the south side of the A1303 only.	Anti-dazzle screening required between busway and A1303 due to opposing traffic flows, requiring greater verge width to accommodate the fencing.
Combined bus stop provision for both busways to the south side of the A1303, patrons do not have to cross the A1303 to access the opposing busway.	Buses required to reduce speed at the numerous entries and exits and 'Burst through' increasing journey times.
High quality guided busway provision in both directions.	Increased risk associated with left turning vehicles (westbound direction) crossing the two-way busway resulting in potential for conflict with buses.
Simple busway layout at the A1303/M11 Junction 13 slip road with no requirement for buses to cross the A1303.	Vehicles exiting un-signalised accesses will have to cross the two way busway then wait to enter the A1303, 5m waiting areas required to mitigate risk of conflict from waiting on the busways increasing the construction width and requiring additional land outside of the highway boundary (20,302m ²)
	Loss of existing lay-by provision on A1303.

Table 4. Advantages and disadvantages Option B

5.1.2.3 Option C – Two Way Busway Arrangement to the North of the A1303

Option C gives provision of a segregated two-lane guided busway positioned on the north side of the A1303 carriageway providing bus links separated from the A1303 highway. A new footway/cycleway would be provided on the south side of the A1303, upgrading the existing footway/cycleway to the south of the A1303. The typical configuration of the proposed busway section for Option C is shown in Figure 11 below.

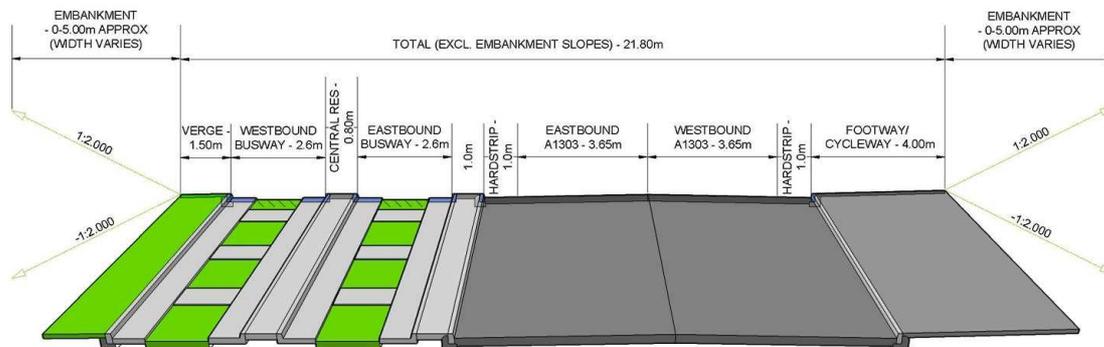


Figure 11. Option C Typical Cross Section (Off network Busways: Two-way). North of A1303

This option would move the position of the A1303 carriageway to the south, requiring realignment of the carriageway by constructing into the existing westbound verge. The eastbound carriageway of the existing A1303 would fall within the extent of the proposed busway over a significant length of site. A Britpave concrete busway system would be used this would require the existing carriageway to be partially or fully removed to allow the busway to be constructed.

The proposed carriageway width shown is in accordance with the Design Manual for Road and Bridges (DMRB) Single (S2) carriageway with 3.65m carriageway lanes and 1.0m hard strips. The busway shown indicates a two-way kerbed guideway system as utilised throughout the Cambridge busway network, with 2.6m guideway widths.

At the east end of the section the bus way lane could link into the continuation of the route south alongside the M11 Junction 13 northbound exit slip to cross the M11 via a new structure into west Cambridge. The positioning of the bus way to the north of the A1303 would require all manoeuvres to and from the A1303 busway to cross the A1303 carriageway, this would require a new signalised junction arrangement at the existing A1303 and M11 Junction 13 northbound exit slip road signalised junction. The impact on A1303 traffic flow of both east and westbound busway manoeuvres crossing the A1303 has not been modelled as part of this report, but is expected to have a negative impact on traffic flow on the A1303. An alternative arrangement could be for the busway to end at the existing A1303 Rectory Farm (M11 Junction 13) overbridge and continue over an altered structure via bus lanes into west Cambridge.

At the west end of the A1303 Madingley Road the interface with the Madingley Mulch Roundabout would require signalisation of the junction, this could provide connectivity with a St Neots Road busway link continuation. The positioning of the bus way north of the A1303 would reduce the impact on residential and business property accesses on the southern side of Madingley Mulch Roundabout in comparison with Option A and B.

Antidazzle fencing would be required between the busway and the A1303 due to opposing vehicle flows. To mitigate risks associated with vehicles crossing the two-way busway to access the A1303 from un-signalised accesses, and the restriction on sightlines resulting the antidazzle fencing, a 5.0m waiting area between the busway and the carriageway edge would be required.

The proposed footway/cycleway is 4.0m width to align with Cambridge busway footway/cycleway provision. Providing the footway/cycleway to the southern side of the A1303 could give connectivity with the proposed continuation of the footway/cycleway to the west end into St Neots Road. At the eastern extent of the site the footway/cycleway could directly continue along the south link away from the A1303 to cross the M11 Bridge and connect to Coton Path cycleway. A crossing facility could additionally be provided at the east end of the site to provide a link within the existing footway cycleway to the north side of the A1303 into west Cambridge.

Option C presents the following advantages and disadvantages, these are summarised below in Table 5.

ADVANTAGES	DISADVANTAGES
Reduced impact on accesses and junctions by aligning the route to one side of the A1303	Two way bus travel in north verge adjacent to the A1303 is an unfamiliar arrangement to road users and pedestrians.
Combined bus stop provision for both busways to the north side of the A1303, patrons do not have to cross the A1303 to access the opposing busway.	Anti-dazzle screening required between busway and A1303 due to opposing traffic flows, requiring greater verge width to accommodate the fencing.
Combines bus stop provision for both busways to the north side of the A1303, patrons do not have to cross the opposing busway.	Buses required to reduce speed at the numerous entries and exits and 'Burst through' increasing journey times.
High quality guided busway provision in both directions.	Increased risk associated with left turning vehicles (eastbound direction) crossing the two-way busway resulting in potential for conflict with buses.
	Vehicles exiting un-signalised accesses will have to cross the two way busway then wait to enter the A1303, 5m waiting areas required to mitigate risk of conflict from waiting on the busways increasing the construction width and requiring additional land outside of the highway boundary (19,379m ²)
	New signalised junction at the A1303/M11 Junction 13 slip road requires both east and westbound buses to cross the A1303, potentially having a negative impact on traffic flows.
	Loss of existing lay-by provision on A1303.

Table 5. Advantages and disadvantages Option C

5.1.2.4 Option D – Paired Two Way Flow with A1303 Traffic Segregated either side of the Busway

Option D gives provision of a segregated two-lane guided busway positioned centrally to the A1303 carriageway providing a two way bus link separated from the A1303 highway. The option separates the east and westbound carriageway on the A1303 Madingley road within the site extents. A new footway/cycleway would be provided on the north side of the A1303, the existing

footway/cycleway to the south of the A1303 would be removed. The typical configuration of the proposed busway section for Option D is shown in Figure 12 below.

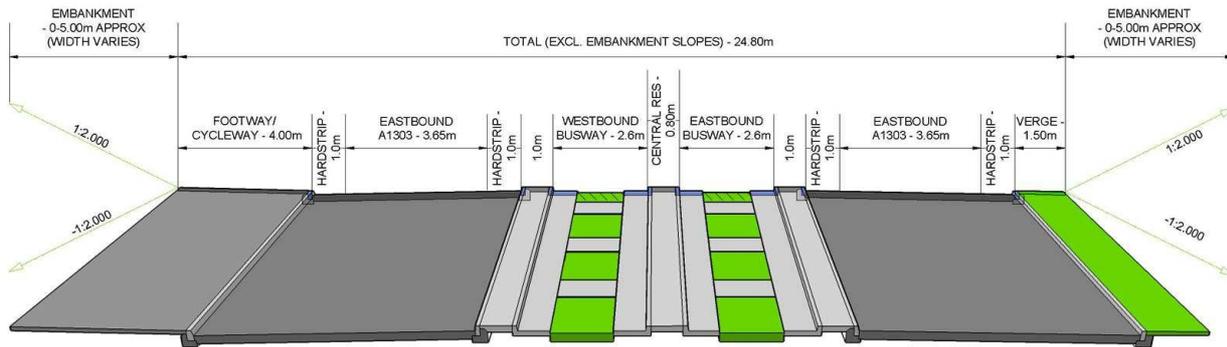


Figure 12. Option D Typical Cross Section (Off network Busways: Two-way) A1303 Traffic Segregated either Side of the Busway

The arrangement provides a central two way guided busway within the A1303 corridor separating the east and westbound carriageways. The busway alignment closely follows the alignment of the existing A1303 carriageway. A Britpave concrete busway system could be used, this would require the existing carriageway to be removed to allow the bus way to be constructed. The separated A1303 carriageway lanes would be aligned to fall within the existing east and westbound verges requiring significant construction of new carriageway.

The arrangement would be unfamiliar to road users, particularly in a rural environment. The proposed non-standard cross section is shown with carriageway lane widths in accordance with the Design Manual for Road and Bridges (DMRB) with 3.65m carriageway lanes. Offside and nearside 1.0m hard strips are included to give capacity for wide vehicles and assist with preventing the carriageways from being blocked in the event of a vehicle breakdown. The busway shown indicates a two-way kerbed guideway system as utilised throughout the Cambridge busway network, with 2.6m guideway widths.

The centralised position of the busway does not provide well aligned links with the bus route at either end of the A1303 corridor. At the east and west extents of the A1303 section of bus way all manoeuvres to and from the busway would be required to cross the A1303 westbound carriageway, this would require new signalised junction arrangements at the existing A1303 and M11 northbound exit slip road signalised junction, and at the Madingley Mulch Roundabout.

The proposed footway/cycleway is 4.0m width to align with Cambridge busway footway/cycleway provision. Providing the footway/cycleway to the northern side of the A1303 gives connectivity with the existing footway/cycleway at the east end of the site, where the existing footway/cycleway continues alongside the A1303 Madingley road into west Cambridge. Crossing facilities would additionally be provided at the east and west end of the site to provide continuation of the footway/cycleway alongside the bus way alignment.

Option D presents the following advantages and disadvantages, these are summarised below in Table 6.

ADVANTAGES	DISSADVANTAGES
The busway does not conflict directly with any property accesses and turning vehicles.	Bus stop arrangement is more complex and require patrons to cross one lane of Madingley Road to reach bus stops.
Reduced junction crossing and 'Burst-Through' allowing buses to maintain higher speeds.	Reduced potential for buses to enter and exit the busway along its lengths, other than at Cambridge Road junctions.
Improved journey times with few breaks in the busway due to fewer junctions and accesses needing to be crossed.	Unfamiliar arrangement on rural/semi-rural areas with higher traffic speeds, particularly for pedestrians trying to cross Madingley Road.
	Vehicles entering/exiting the A1303 from accesses and junctions, other than at the Cambridge Road junctions, are only able to make left turns in and out only.
	Carriageway section would be wider than the standard to enable vehicles to pass broken down vehicles due to the central kerbed guideway. increasing the construction width and requiring additional land outside of the highway boundary (20,519m ²)
	Option requires removal of the majority of the existing A1303 carriageway to construct the busway, providing poor value and potentially increasing costs.
	Loss of existing lay-by provision on A1303.

Table 6. Advantages and disadvantages Option D

5.1.3 Environmental Impacts. Guided Busway

Busway alignments Option A – D would each require the existing vegetated areas of trees and hedge either side of the existing Madingley Road corridor to be removed to varying extents, as indicated on busway alignments plans provided in Appendix B – Options A-D. Environmental Impact Assessments would be required to determine the effect of each option.



Figure 13. A1303 Vegetation lining on either side of the highway

- Between Madingley Mulch and the M11, there is a significant amount of vegetation lining the highway on either side, both within and directly adjacent to the highway boundary;
- The widening the existing highway corridor would result in a significant loss of vegetation along the route;

Mitigation works due to vegetation loss as a result of these options are to be assessed outside of this report.

5.1.4 Land Availability and adjacent land requirements. Guided Busway

The land-take required for each option has been assessed, modelling the option alignments against the existing topography of the area and the existing highway boundary. The land-take required for each of the options considered is summarised below in Table 7. A further 5.0m temporary working area would be required beyond extent of the proposed edge of construction.

OPTION	A	B	C	D
Highway Width (m)	23	21.8 – 25.8	21.8 – 25.8	24.8
Corridor Width Required (m)	33	31.8 – 35.8	31.8 – 35.8	34.8
Length (m)	3320	3320	3320	3320
Land Take Required (m ²)	17,171	20,302	19,379	20,519

Table 7. Land-taken required

5.1.5 Safety Considerations. Guided Busway

The addition of a busway would increase the total carriageway width, this increases the risk associated with actions such as entering/exiting accesses or pedestrians crossing from one side of the road to the other, with road users being required to assess the traffic flow of both the busway and the A1303 carriageway. Particular attention must be considered at junctions (Madingley Road-Cambridge Road, Coton and Madingley Road- Cambridge Road, Madingley).

Provision of vehicular access through a segregated busway, other than at signalised road junctions, is uncommon. Signalisation of individual property accesses is not feasible due to the number of accesses and their relatively infrequent use. The alternative is for accesses to remain un-signalised, however this results in significant risk of a vehicle crossing the path of a potentially unsighted bus.

Where segregated busway options are proposed each of the options would impact on property accesses either to the north, to the south or both verges throughout the affected length of the A1303 Madingley Road. Provision will need to be included within the busway layout to enable access across the busway to maintain accesses to the properties and the American Cemetery and Memorial.

Signalisation of the A1303 at each access should be provided where vehicles are required to cross the busway preventing the risk of vehicles pulling across the path of a bus on the busway. The low level of use of property, accesses and the frequency of them along the A1303 corridor makes this an unsuitable option. Grouping of junctions and accesses into larger signalised arrangements is feasible where properties are in close proximity to one another and where land is available to provide link roads with single access points onto the A1303, but is expected that the increase in signalised junctions would increase driver delays on the A1303.

Some of the risk identified are summarised below:

- Vehicles exiting/entering the different accesses along the A1303 Madingley Road (additional visibility requirements and signalised access), Refer to Figure 14, 15 and 16;
- Potential conflict with vehicles blocking the busway (vehicle waiting areas required);
- Potential conflict between vehicle and cyclist blocking the cycleway;
- Potential conflict between vehicle-bus speeds, i.e. vehicles entering into properties or business accesses (busway traffic speed would have to be reduced to 25mph on approach to an access/junction crossing).
- Public traffic accidentally entering the busway by confusion;
- Additional refuge/crossing Islands could be introduced to mitigate risk associated with pedestrians crossing the carriageway;
- Signal controlled junction would be required at Cambridge Road, Coton, at the American Cemetery and at Crome Lea Business Park junction (Option C), to allow the junctions to operate safely with the busway arrangements.

The following images illustrate some of these situations:

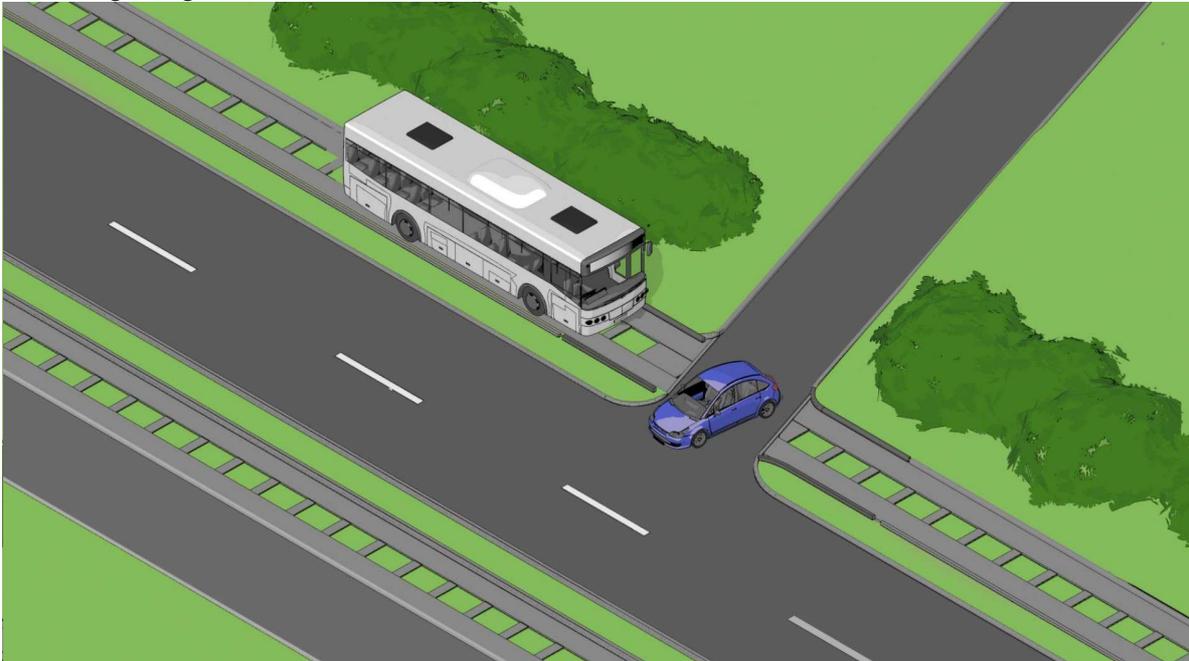


Figure 14. Potential Risk of Vehicle Blocking the Busway (Design Option A)

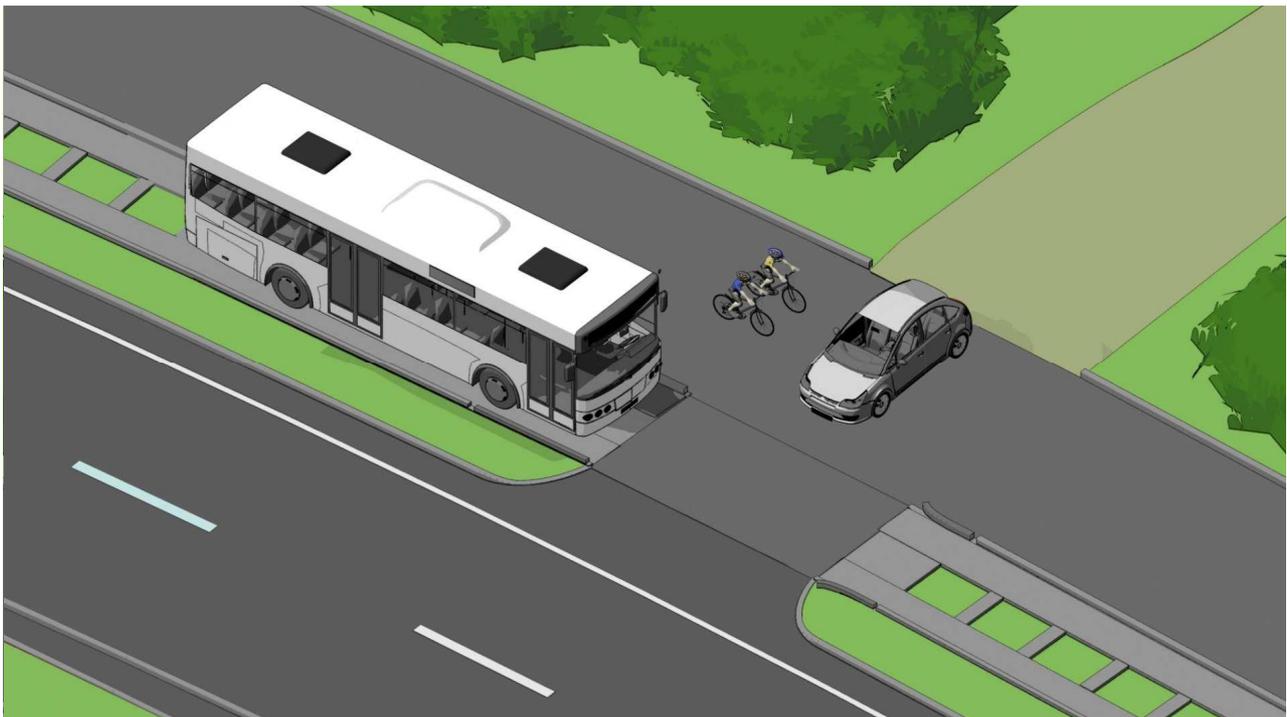


Figure 15. Potential Risk of Vehicle Blocking the Cycleway (Design Option A)

An anti-dazzle fence would be required due to opposing flows of traffic, between the busway and carriageway for Options B & C, making it difficult for vehicles to see traffic on the A1303 carriageway from the access, combined with vehicles crossing a two-way busway to enter the A1303. A 5.0m waiting area is necessary to allow vehicles to cross the busway and then stop safely to assess A1303 traffic flows before entering the carriageway. This arrangement would accommodate smaller vehicles, the use of the accesses by longer vehicles could not be accommodated without providing larger waiting areas which would require excessive land requirements beyond the existing highway boundary.

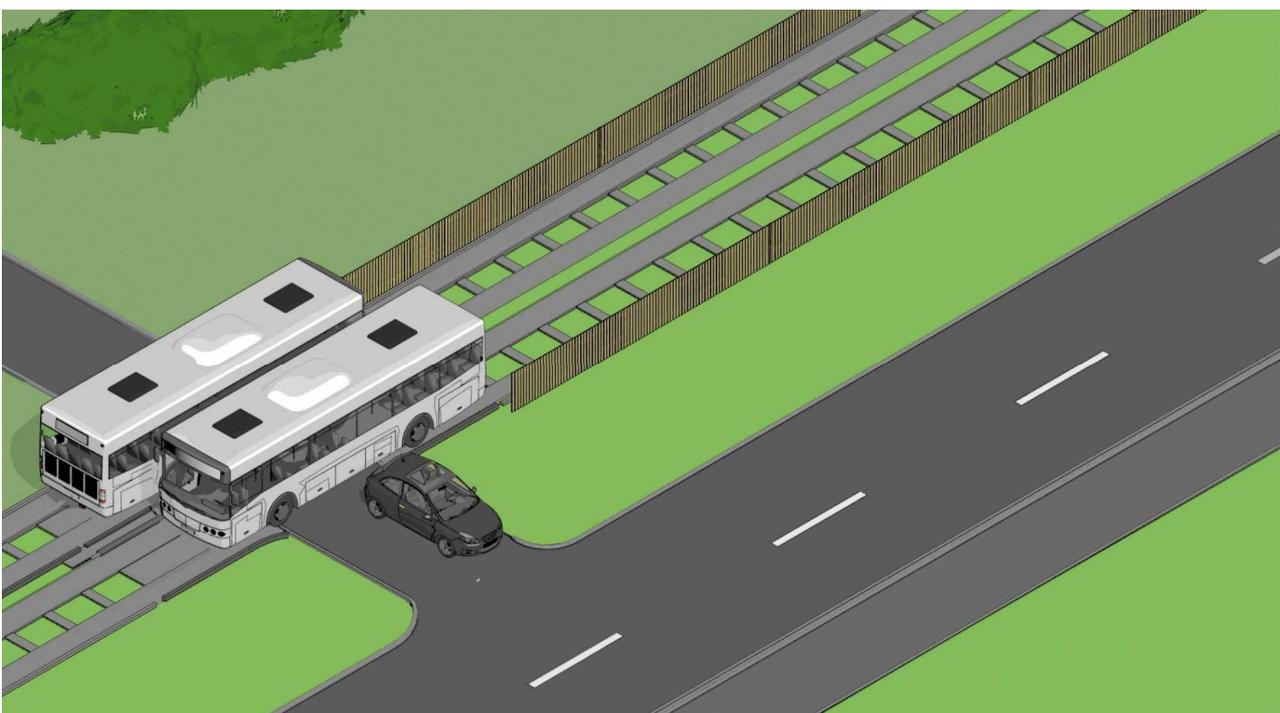


Figure 16. Anti-dazzle fencing required (Design Option B&C)

5.1.6 Buildability and Traffic Management. Guided Busway

Option A - Single Lane Busway Eastbound to the North of the A1303 and Single Lane Busway Westbound to the South of the A1303.

The A1303 carriageway would be aligned south of the existing carriageway. The arrangement would require widening into both the eastbound and westbound verges. Existing lay-by/bus-stop provision in each direction would be lost. The existing right turn lane provision at Madingley Rise property would be removed, also the dedicated right turn lane into Cambridge Road, Madingley on the A1303 westbound direction. The existing open ditch (westbound verge) within the proposed corridor would be affected during site works.

The alignment would require existing utility services in both verges to be diverted or lowered. Existing carriageway drainage would need to be amended to accommodate the revised carriageway position.

This option could require extensive site earthworks to accommodate the southern connecting alignment running parallel to the existing M11 Junction 13 northbound slip road; additional land would be required to accommodate the off line busway. A new curved bridge structure over the M11 would be required for this connecting alignment.

Potential construction risks:

Encountering unknown utility services;

Existing drainage found to be unsuitable to connect the required drainage into;

Unsuitable ground conditions found within areas of required carriageway widening.

For further details refer to the following drawings in Appendix B:

- DWG 5040372/HW/FS/010 Rev A
- DWG 5040372/HW/FS/011 Rev A
- DWG 5040372/HW/FS/012 Rev A
- DWG 5040372/HW/FS/013 Rev A

Traffic management required to deliver Option A could comprise of a phased approach utilising temporary two way traffic signals and lane restrictions along the A1303. Maximum permitted length of two-way signalised lane closures is 300m (Traffic Signs Manual Chapter 8 guidance) requiring consecutive closures along the A1303 to deliver the works required.

Initial phases would comprise of lane restrictions with temporary two way traffic signals to enable works to be carried out in the eastbound and westbound verges to undertake utility diversions. Two way signals would then be utilised for the carriageway realignment into the westbound verge and the westbound busway to be constructed. During this phase once the carriageway realignment into the westbound verge is complete the additional carriageway width would enable the westbound busway to be constructed without the need for carriageway lane restrictions.

The following phase would switch traffic onto the realigned carriageway section to enable the eastbound carriageway to be excavated as required to construct the eastbound busway and the footway/cycleway in the eastbound verge, with further lane restrictions and temporary two-way traffic signals required once the carriageway width is reduced by the carriageway excavation works.

A final carriageway resurfacing phase would be required utilising full carriageway closures with traffic diversions in place. Throughout the construction period temporary diversions of the existing footway/cycleway would be required.

Construction of the curved bridge crossing over the M11 will require M11 traffic management lane restrictions and full carriageway closures during the placement of the bridge deck.

Option B - Two Busway Arrangement to the South of the A1303

The A1303 carriageway would be aligned north of the existing carriageway. The arrangement would require widening into both the eastbound and westbound verges. Existing lay-by/bus-stop provision in each direction would be lost. At the Mill Farm access location the A1303 carriageway would be aligned with the existing carriageway requiring the busway alignment to be constructed within the westbound verge, the existing right turn lane provision at Madingley Rise property would be removed, also the dedicated right turn lane into Cambridge Road, Madingley and Cambridge Road, Coton on the A1303. The existing open ditch (westbound verge) within the proposed corridor would be affected during site works.

The alignment would require existing utility services in both verges to be diverted or lowered. Existing carriageway drainage would need to be amended to accommodate the revised carriageway position.

This option could require extensive site earthworks to accommodate the southern connecting alignment running parallel to the existing M11 Junction 13 northbound slip road; additional land would be required to accommodate the off line busway. A new curved bridge structure over the M11 would be required for this connecting alignment.

Potential construction risks:

Encountering unknown utility services;

Existing drainage found to be unsuitable to connect the required drainage into;

Unsuitable ground conditions found within areas of required carriageway widening.

For further details refer to the following drawings in Appendix B:

DWG 5040372/HW/FS/014 Rev A

DWG 5040372/HW/FS/015 Rev A

DWG 5040372/HW/FS/016 Rev A

DWG 5040372/HW/FS/017 Rev A

Traffic management required to deliver Option B could comprise of a phased approach utilising temporary two way traffic signals and lane restrictions, and utilising temporary carriageway widening along the A1303. Maximum permitted length of two-way signalised lane closures is 300m (Traffic Signs Manual Chapter 8 guidance) requiring consecutive closures along the A1303 to deliver the works required.

Initial phases would comprise of lane restrictions with temporary two way traffic signals to enable works to be carried out in the eastbound and westbound verges to undertake utility diversions. Two way signals would then be utilised for the carriageway realignment into the eastbound verge. The adjacent proposed footway/cycleway temporarily surfaced to carriageway level to allow vehicles to run on it would allow traffic to be moved towards the eastbound side of the carriageway and maintain two-way traffic when works move to the westbound verge to construct the busways.

A further phase would again utilise carriageway restrictions and temporary two-way traffic signals to install the footway/cycleway kerb line and raise levels of the footway/cycleway up to finished level.

A final carriageway resurfacing phase would be required utilising full carriageway closures with traffic diversions in place. Throughout the construction period temporary diversions of the existing footway/cycleway would be required.

Construction of the curved bridge crossing over the M11 will require M11 traffic management lane restrictions and full carriageway closures during the placement of the bridge deck.

Option C - Two Way Busway Arrangement to the North of the A1303

The A1303 carriageway would be aligned south of the existing carriageway. The arrangement would require widening into both the eastbound and westbound verges. Existing lay-by/bus-stop provision in each direction would be lost. At the Mill Farm access location the A1303 carriageway would be aligned with the existing carriageway requiring the busway alignment to be constructed within the westbound verge, the existing right turn lane provision at Madingley Rise property would be removed, also the dedicated right turn lane into Cambridge Road, Madingley and Cambridge Road, Coton on the A1303. The existing open ditch (westbound verge) within the proposed corridor would be affected during site works.

The alignment would require existing utility services in both verges to be diverted or lowered. Existing carriageway drainage would need to be amended to accommodate the revised carriageway position.

This option could require extensive site earthworks to accommodate the southern connecting alignment running parallel to the existing M11 Junction 13 northbound slip road; additional land would be required to accommodate the off line busway. A new curved bridge structure over the M11 would be required for this connecting alignment.

Potential construction risks:

Encountering unknown utility services;

Existing drainage found to be unsuitable to connect the required drainage into;

Unsuitable ground conditions found within areas of required carriageway widening.

For further details refer to the following drawings in Appendix B:

- DWG 5040372/HW/FS/018 Rev A
- DWG 5040372/HW/FS/019 Rev A
- DWG 5040372/HW/FS/020 Rev A
- DWG 5040372/HW/FS/021 Rev A

Traffic management required to deliver Option C could comprise of a phased approach utilising temporary two way traffic signals and lane restrictions, and utilising temporary carriageway widening along the A1303. Maximum permitted length of two-way signalised lane closures is 300m (Traffic Signs Manual Chapter 8 guidance) requiring consecutive closures along the A1303 to deliver the works required.

Initial phases would comprise of lane restrictions with temporary two way traffic signals to enable works to be carried out in the eastbound and westbound verges to undertake utility diversions. Two way signals would then be utilised for the carriageway realignment into the westbound verge. The adjacent proposed footway/cycleway temporarily surfaced to carriageway level to allow vehicles to run on it would allow traffic to be moved towards the westbound side of the carriageway and maintain two-way traffic when works move to the eastbound verge to construct the busways.

A further phase would again utilise carriageway restrictions and temporary two-way traffic signals to install the footway/cycleway kerb line and raise levels of the footway/cycleway up to finished level.

A final carriageway resurfacing phase would be required utilising full carriageway closures with traffic diversions in place. Throughout the construction period temporary diversions of the existing footway/cycleway would be required.

Construction of the curved bridge crossing over the M11 will require M11 traffic management lane restrictions and full carriageway closures during the placement of the bridge deck.

Option D - Paired Two Way Flow with A1303 Traffic Segregated either side of the Busway

The busway would be constructed on the alignment of the existing A1303 carriageway. The arrangement would require widening into both the eastbound and westbound verges. Existing lay-by/bus-stop provision in each direction would be lost. A reduced dedicated right turn lane into Cambridge Road, Madingley and Cambridge Road, Coton would be provided. The existing open ditch (westbound verge) within the proposed corridor would be affected during site works.

The alignment would require existing utility services in both verges to be diverted or lowered. Existing carriageway drainage would need to be amended to accommodate the revised carriageway position.

This option could require extensive site earthworks to accommodate the southern connecting alignment running parallel to the existing M11 Junction 13 northbound slip road; additional land would be required to accommodate the off line busway. A new curved bridge structure over the M11 would be required for this connecting alignment.

Potential construction risks:

Encountering unknown utility services;

Existing drainage found to be unsuitable to connect the required drainage into;

Unsuitable ground conditions found within areas of required carriageway widening.

For further details refer to the following drawings in Appendix B:

- DWG 5040372/HW/FS/022 Rev A
- DWG 5040372/HW/FS/023 Rev A
- DWG 5040372/HW/FS/024 Rev A
- DWG 5040372/HW/FS/025 Rev A

Traffic management required to deliver Option D could comprise of a phased approach utilising temporary two way traffic signals and lane restrictions, temporary carriageway widening and full carriageway closures. Maximum permitted length of two-way signalised lane closures is 300m (Traffic Signs Manual Chapter 8 guidance) requiring consecutive closures along the A1303 to deliver the works required.

Initial phases would comprise of lane restrictions with temporary two way traffic signals to enable works to be carried out in the eastbound and westbound verges to undertake utility diversions. Two way signals would then be utilised for the carriageway realignment into the eastbound verge with the adjacent proposed footway/cycleway temporarily surfaced to carriageway level to allow vehicles to run on it. This would allow traffic to be moved towards the eastbound side of the carriageway and maintain two-way traffic when works move to the westbound verge to construct the westbound carriageway realignment.

Once the carriageway realignment works are complete the existing carriageway will require excavation to allow the busway to be constructed. The central position of the busway would require full closure and diversion westbound, with eastbound traffic running on the temporary widening. On completion of the busway the westbound carriageway would be opened, with eastbound carriageway closures and diversion to construct kerbing and raise the footway/cycleway to completed level. Throughout the construction period temporary diversions of the existing footway/cycleway would be required.

Construction of the curved bridge crossing over the M11 will require M11 traffic management lane restrictions and full carriageway closures during the placement of the bridge deck.

5.1.7 Summary. Guided Busway

All the options would require:

- Additional land to be purchased;
- Totally or partially excavation of the existing carriageway;
- Removal of the existing cycleway/footway to the south of the A1303;
- Access to properties and provision of signalised junction at Cambridge Road junction (Coton and Madingley) to accommodate the busway;
- Measures to reduce risks associated with vehicle exiting access, vehicles blocking the busway.

Option A, provides a segregated single-lane guided busway either side of the A1303, the arrangement would move the position of the A1303 carriageway to the south constructing into the existing westbound verge. Busway flow would be in line with A1303 traffic and bus stop provision would be easier to provide along this route, additionally safer crossing of the busway would be provided. The busway would however cross every junction and property access along the affected corridor, this would impact the bus speed, and therefore the journey time. Different risks were found related to left turning vehicles crossing the busway. A new footway/cycleway would be provided on the north side of the A1303, and the existing footway/cycleway to the south of the A1303 would be removed.

Option B, provides a segregated two-lane guided busway positioned to the south side of the A1303 carriageway, the arrangement would move the position of the A1303 carriageway to the north; requiring partial reconstruction of the new carriageway into the existing eastbound verge. In this case the busway would cross accesses and junction on the south side of the A1303. A combined bus stop provision could be provided with this option, which effectively would be a safer solutions for patrons. This arrangement would be unfamiliar in a rural area, furthermore having opposite traffic flows (i.e. between westbound traffic and eastbound busway) would require the provision of anti-dazzle screening. Increased risk with left-turning vehicles crossing the busway would need to be mitigated in this option. A new footway/cycleway would be provided on the north side of the A1303, and the existing footway/cycleway to the south of the A1303 would be removed.

Option C, provides a segregated two-lane guided busway positioned to the north side of the A1303 carriageway, the arrangement would move the position of the A1303 carriageway to the south; requiring partial reconstruction of the new carriageway into the existing westbound verge. In this case the busway would cross accesses and junction on the north side of the A1303. A combined bus stop provision could be provided with this option, which effectively would be a safer solutions for patrons. As in the option B, this arrangement would be unfamiliar in a rural area, additionally having opposite traffic flows (i.e. between eastbound traffic and westbound busway) would require the provision of anti-dazzle screening. Increased risk with left-turning vehicles crossing the busway would need to be mitigated in this option. A new footway/cycleway would be provided on the south side of the A1303, upgrading the existing footway/cycleway to the south of the A1303.

Option D, provides a segregated two-lane guided busway positioned centrally to the A1303 carriageway, this option would provide a central two way guided busway separating the east and westbound carriageways of the A1303. This option would require significant construction of the carriageway with new carriageway lanes constructed within the existing verges. A centralised busway would not conflict directly with any property accesses and turning vehicles, having a reduced number of junction crossing would allow the buses to maintain higher speeds, and

therefore improved journey times would be achieved. This arrangement would be particularly unfamiliar in a rural area and the bus stop arrangement would be more complex, requiring patrons to cross one lane of the A1303 to access the bus stop. A new footway/cycleway would be provided on the south side of the A1303, and the existing footway/cycleway to the south of the A1303 would be removed. The option prevents right turn manoeuvres in and out of property accesses along the section, potentially leading to frustration for local residents and businesses affected.

5.1.8 Guided Busway Overview

Guided busway options discussed in sections 5.1 were presented to the LLF in February 2017. The LLF presented alternative options comprising of an unsegregated tidal bus lane aligned to the centre of the A1303 Madingley Road referred to as Option 6. It was also requested that the do-minimum option comprising of an eastbound only unsegregated nearside bus lane, referred to as Option 1, be further developed to make a fair comparison with Option 6.

5.2 Non Guided Bus Lane

During the February 2017 LLF meeting it was requested that consideration be given to a different arrangement for bus provision on the A1303 Madingley Road, utilising unsegregated bus lanes. In this case the following design options have been considered:

- **Option 1** – Eastbound unsegregated Bus Lane between Madingley Mulch Roundabout and Lady Margaret Road; Option 1 had been previously identified in the overall Cambourne to Cambridge assessment as a do-minimum option. Following the LLF's proposal further development of the option has been carried out.
- **Option 6** – Central Tidal unsegregated Bus Lane between Madingley Mulch Roundabout and High Cross;

5.2.1 Design Approach

The design approach adopted for each route alignment considers the following criteria:

- Provision of bus lanes based on guidance within Local Transport Note (LTN) 1/97 – 'Keeping Buses Moving'. Where specific design guidance does not exist then guidance shall be taken from existing bus lanes and tidal flow lane arrangement within the UK;
- The proposed alignment shall remain within the existing A1303 highway corridor where practicable to minimise any unnecessary land take, including loss of amenity and wildlife habitat;
- The proposed alignment shall where possible minimise severance of access, public footpaths, rights of way, wildlife corridors, etc.;
- The proposed alignment shall consider new connections and improvements to existing connectivity for access, public footpaths, rights of way, wildlife corridors, etc.;
- The proposed alignment shall consider potential access and egress requirements along the route corridor;
- The Design Manual for Roads and Bridges (DMRB) shall be adhered to when constructing new sections of carriageway;
- The proposed alignment shall consider the existing constraints and any mitigating measures required to accommodate the works and
- A high quality 4m wide footway/cycleway will follow the alignment of the bus lane in common with proposed dual function footway/cycleway/maintenance track provision along the Cambourne to Cambridge bus link.

The Madingley Road bus lane links would connect with Madingley Mulch Roundabout at the west end of Madingley Road with signalisation of the roundabout. To the east Option 1 would require buses to run on the Madingley Road carriageway to JJ Thomson Road, where eastbound bus lanes would recommence to Lady Margaret Road. Option 6 bus lanes would cross the M11 via widening the existing M11 Junction 13 structure and continue to the High Cross junction, from where buses would enter the west Cambridge development or continue into Cambridge with general traffic.

5.2.2 Design Options

5.2.2.1 Option 1 – Eastbound Bus Lanes between Madingley Mulch Roundabout and Lady Margaret Road

Option 1 provides a 4.25m wide bus lane (eastbound direction only) positioned on the north side of the A1303 between Madingley Mulch and the M11 at Junction 13. Buses would then travel on Madingley Road, crossing the M11 to JJ. Thomson Avenue. An eastbound 4.25m bus lane would then recommence at JJ. Thomson Avenue to Lady Margaret Road, continuing on road into west Cambridge.

A new combined 4.0m footway/cycleway would be provided on the south side of the A1303 between Madingley Mulch Roundabout and Cambridge Rd (Coton), it would cross to the northern side of Madingley Road as existing, running east across the M11, and connecting to a 2-3m wide footway/cycleway into west Cambridge.

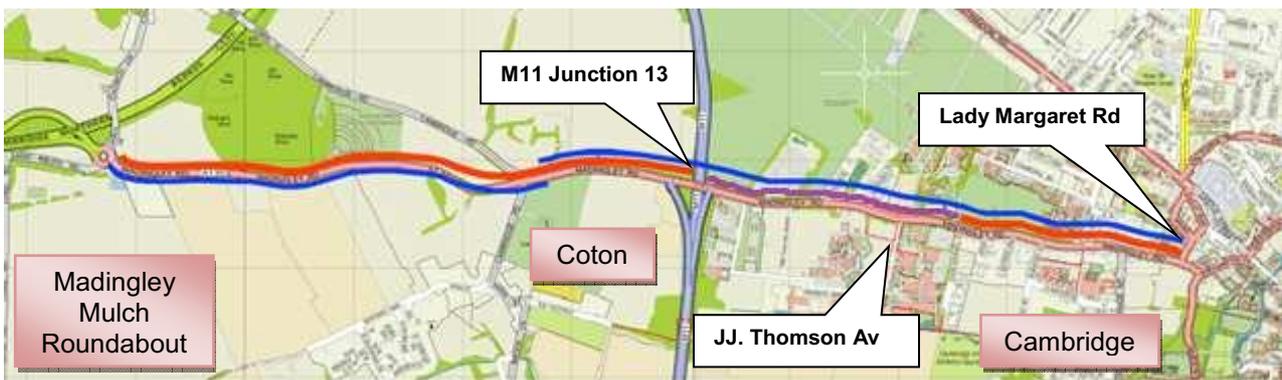


Figure 17. Option 1 Alignment Option. Eastbound Bus Lane Madingley Mulch Roundabout-Lady Margaret Road

- Eastbound Bus lane
- Footway/Cycleway
- Buses travel on Madingley Road

The typical configuration of the proposed bus lane section for Option 1 is shown in Figure 18 below.



Fig 18. Option 1 Cross Section⁴ (Eastbound Bus Lane). Madingley Mulch Roundabout - Cambridge Road (2)

The arrangement retains the existing A1303 alignment, maintaining the carriageway as existing where possible. This option would require the construction of the bus lane in the eastbound verge. Through the Madingley Hill section of the A1303 the existing carriageway has a substandard alignment with a tight radius bend and has been subject to previous mitigation measures. Option 1 would propose to improve the alignment of the Madingley Hill carriageway, constructing a newly aligned carriageway section to the north of Madingley Road through the existing Madingley Hill bend.

The proposed carriageway width shown is in accordance with the Design Manual for Road and Bridges (DMRB) Single (S2) carriageway width 3.65m carriageway lane. The busway shown indicates an eastbound 4.25m wide bus lane to the eastbound side of Madingley Road. The bus lane crosses several junctions and property accesses along the eastbound side of the A1303 – Madingley Road.

At the west end of the A1303 Madingley Road the interface with the Madingley Mulch Roundabout would require signalisation of the junction, this could provide connectivity of the bus lane with the proposed St Neots Road busway links continuation. The positioning of the bus way north of the A1303 would reduce the impact on residential and business property accesses on the southern side of Madingley Mulch Roundabout.

Widening of the existing footway/cycleway would be undertaken to provide a 4.0m width to align with Cambridge busway footway/cycleway provision. The footway/cycleway positioned to the southern side of the A1303 could give connectivity with the proposed continuation of the footway/cycleway to the west end into St Neots Road. The footway/cycleway would continue on the south side of the A1303 to Cambridge Road – Coton, where it would cross to the northern side of the A1303 via an un-signalised crossing. This would provide connectivity with the existing 2-3m footway/cycleway continuing alongside the A1303 Madingley Road into west Cambridge.

Option 1 presents the following advantages and disadvantages, these are summarised below in Table 8.

⁽⁴⁾ Footway/ Cycleway is on the north side from JJ. Thomson Av to Lady Margaret Road.

ADVANTAGES	DISADVANTAGES
Maintains the existing Madingley Road carriageway, constructing the bus lane in the eastbound nearside verge.	Risk associated with left turning vehicles crossing - bus lane would cross junctions and property accesses along the eastbound side of Madingley Road.
Position of the bus lane to the nearside of Madingley Road provides better access to bus stops.	No bus lane provided for westbound buses. Buses to utilise the public highway westbound.
Improved alignment to Madingley Road with the existing bend at Madingley Hill smoothed.	Potential delays and conflict with cyclist that use the bus lane.
Reduced impact on accesses and junctions by aligning the route to one side of the A1303	Additional land required to smooth Madingley Hill bend.
Reduced impact on utility plant with widening required only within the eastbound verge.	No bus lane provided between M11 and JJ. Thomson Avenue, bus required to travel on Madingley Road.
Bus lane will cross accesses and junctions on the eastbound side of the A1303 only.	Buses are not provided with signalised bus priority junctions, increasing the potential for bus delays.

Table 8. Advantages and disadvantages Option 1

5.2.2.2 Option 6 – Central Tidal Bus Lane between Madingley Mulch Roundabout and High Cross

Option 6 provides a 3.5m wide central tidal bus lane positioned centrally to the A1303 carriageway providing a tidal flow bus lane (i.e. eastbound and westbound direction) between Madingley Mulch Roundabout and the High Cross Junction. Widening of the existing bridge over the M11 would be required in order to provide the tidal bus lane. This option separates the east and westbound carriageway on the A1303 Madingley Road.

It is expected that the tidal flow of the bus lane would align to AM and PM peak traffic periods, with the bus lane operating in the eastbound direction AM and westbound PM. During these periods buses travelling westbound AM and eastbound PM would be required to utilise the Madingley Road carriageway lanes. Overhead gantries would be provided to indicate the operating direction of the bus lane to buses and road users. The position of overhead gantries is indicated on the Option 6 plans within Appendix B. The position of the gantries has been based on similar tidal carriageway lane gantries within the UK, with the gantries positioned so that one would be in sight of bus lane users and road users at all times. This requires 17no. gantries and be provided for Option 6, with a further 3no. cantilever gantries provided on major side road approaches onto the A1303.

A combined 4.0m footway/cycleway would be provided on the north side of the A1303 between Madingley Mulch Roundabout to the M11 Junction 13 from where it links with the existing footway/cycleway into Cambridge, the existing footway/cycleway to the south of the A1303 would be removed. The proposed alignment is shown below in Figure 19.

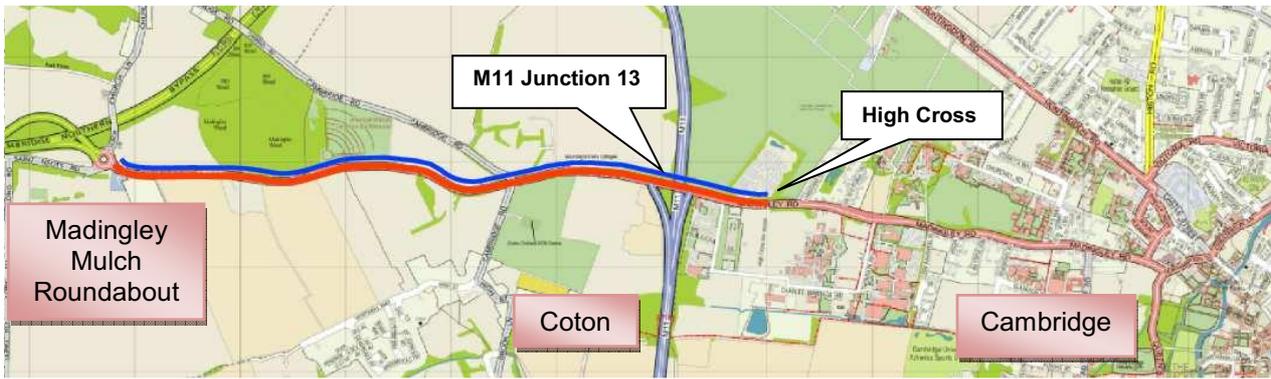


Figure 19. Option 6 Alignment Central Tidal Bus Lane Madingley Mulch Roundabout to High Cross

- Central Bus lane
- Footway/Cycleway

This option would require a signalised bus priority junction at Madingley Mulch Roundabout and overhead gantry signs (5.7m clearance) along the Madingley Mulch Road to indicate the operating direction of the bus lane.

The typical configuration of the proposed bus lane section for Option 6 is shown in Figure 20 below.

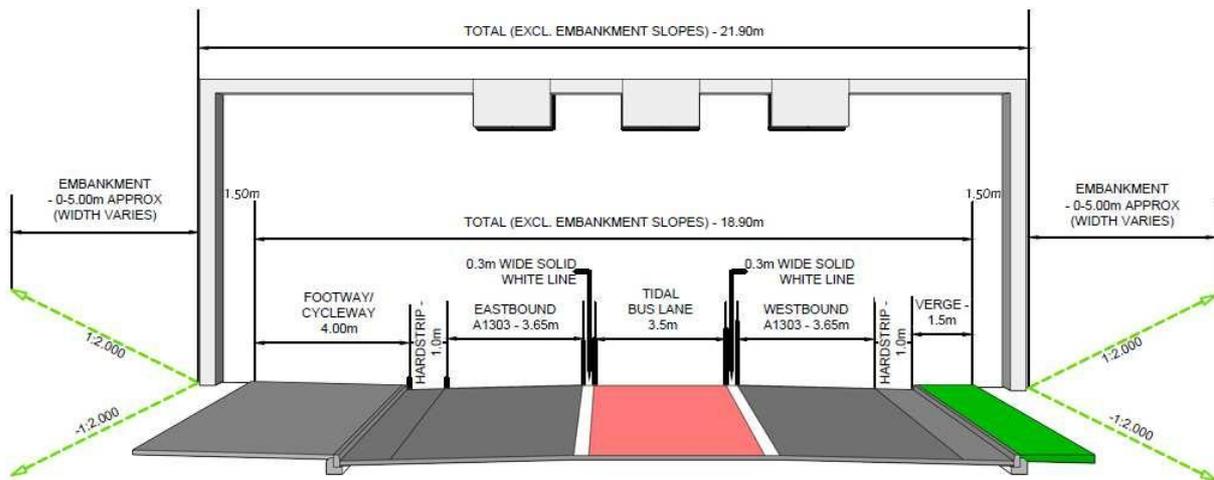


Figure 20. Option 6 Typical Cross Section (Central Tidal Bus Lane). Madingley Mulch Roundabout-High Cross Road

In this arrangement the bus lane alignment would be positioned within the existing carriageway, generally aligned along the existing eastbound carriageway lane alignment. The carriageway would be widened into the eastbound verge to provide a new eastbound carriageway lane giving the three lanes required (including a centralised tidal bus lane).

The provision of a central tidal lane bus lane arrangement is an unusual layout particularly in rural/semi-rural environment and would be unfamiliar to road users.

The proposed carriageway width shown in Figure 20 is in accordance with the Design Manual for Road and Bridges (DMRB) with 3.65m carriageway lanes and 1.0m hard strips. The centralised position of the busway does not provide well aligned links with the bus route at either end of the

A1303 corridor. At the east and west extents of the A1303 section all manoeuvres to and from the bus lane would be required to cross the A1303 carriageway.

With the central position of the bus lane new signalised junction arrangements would be necessary to allow the bus lane to pass through each junction. From the M11 Junction 13 to the High Cross junction five junctions are present within a 570m length of carriageway which would require signalisation or the existing signalised arrangements to be revised to incorporate the bus lane, junctions are shown in Figure 21 below. This would allow bus prioritisation, but at the detriment to traffic flows on Madingley Road and approaching side roads. A further signalised junction would be required at the Cambridge Road junctions.



Figure 21. Option 6 - Location of required signalised junctions

The proposed footway/cycleway is 4.0m width to align with Cambridge busway footway/cycleway provision. Providing the footway/cycleway to the northern side of the A1303 gives connectivity with the existing footway/cycleway at the east end of the site, where the existing footway/cycleway continues alongside the A1303 Madingley road into west Cambridge. Crossing facilities would additionally be provided at the proposed signalised Madingley Mulch Roundabout to provide connectivity to the footway/cycleway alignment south of the roundabout.

Option 6 presents the following advantages and disadvantages, these are summarised below in Table 9.

ADVANTAGES	DISADVANTAGES
Bus priority provided at each signalised junction;	Unfamiliar arrangement on rural semi-rural areas;
Central position of the bus lane reduced crossing of junctions and accesses reducing potential conflict and improving journey times;	Overhead gantries required along the length of the bus lane to indicate direction of tidal operation;
Eastbound and westbound bus lane provided utilising a single bus lane width with tidal operation;	Widening of Madingley Road eastbound and westbound carriageway lane required;
Reduced impact on utility plant with widening required only within the eastbound verge.	Multiple signalised junctions arrangement required between M11 and High Cross junction – delays to other road users;
	Reduced potential for bus stop provisions due to the location of the bus lane (i.e. central);
	Widening of M11 J13 bridge required;
	Bus lane operation is tidal. Buses opposing the flow of the tidal operation have to utilise the public highway westbound.

Table 9. Advantages and disadvantages Option 6

5.2.3 Environmental Impacts. Non Guided Bus Lane

Bus lane alignments Option 1 and 6 would each require the existing vegetated areas of trees and hedge with the eastbound verge of the Madingley Road corridor to be removed to varying extents, with localised sections requiring removal within the westbound verge, as indicated on bus lane alignments plans provided in Appendix B – Options 1 & Option 6. Environmental Impact Assessments would be required to determine the effect of each option.



Figure 22. A1303 Vegetation lining on either side of the highway

- Between Madingley Mulch and the M11, there is a significant amount of vegetation lining the highway on either side, both within and directly adjacent to the highway boundary;
- Provision of signing gantries necessary for Option 6 would potentially be intrusive in the rural setting of the western extent of Madingley Road between Madingley Mulch Roundabout and the M11.

Mitigation works due to vegetation loss as a result of these options are to be assessed outside of this report.

5.2.4 Land Availability and adjacent land requirements. Non Guided Busway

The land-take required for Options 1 and 6 has been calculated, modelling the option alignments against the existing topography of the area and the existing highway boundary. The land-take required for each of the options considered is summarised below in Table 10. A further 5m temporary working area would be required beyond extent of the proposed edge of construction to the eastbound side of the carriageway.

OPTION	1	6
Highway Width (m)	17.05	21.9
Corridor Width Required (m)	27.05	31.9
Length (m)	4966	3270
Land Take Required (m ²)	3940	3402

Table 10. Land-taken required

5.2.5 Safety Considerations. Non Guided Bus Lane

The utilisation of unsegregated bus lanes does not provide any physical means to prevent road users entering the bus lane. For Option 6 with the unusual central tidal arrangement this increases the risk of a road user entering the bus lane unaware that a bus could be approaching for the opposite direction. For this reason frequent signal gantries and signs to indicate the direction of bus operation in the lane would be required to inform both buses and other road users. Option 1 utilises a more familiar bus lane arrangement to the nearside of the eastbound carriageway, operating in an eastbound direction in line with the carriageway flow.

Some of the risk identified are summarised below:

- Vehicles exiting/entering the different accesses along the A1303 Madingley Road;
- Potential conflict between vehicle and cyclist blocking the cycleway;
- Public traffic accidentally entering the bus lane by confusion;
- Confusion of road users on the operating direction of the centralise bus lane (Option 6)
- Vehicles overtaking slow moving vehicles into the central bus lane conflicting with buses (Option 6)
- Vehicles turning left across the path of buses on the eastbound nearside bus lane (Option 1)

5.2.6 Buildability and Traffic Management. Non Guided Bus Lane

The provision of a non-guided bus lane along the A1303 corridor would require a varying degree of reconstruction of the carriageway for any of the option analysed in this assessment report.

All the options assessed would require the following:

- Additional land to be purchase, (both residential and agricultural land);
- Widening of the existing A1303 carriageway;
- Diversion or lowering or protection of existing services on both verges;
- Provision of temporary carriageway during construction to maintain access to properties.

Option 1 – Unguided Single Eastbound Bus Lane

The bus lane would be constructed in the eastbound verge of the A1303, maintaining the carriageway as existing throughout the majority of the length. Through the Madingley Hill section of the A1303 the existing carriageway has a substandard alignment with a tight radius bend and has been subject to previous mitigation works due to a history of accidents. Option 1 would realign this section of A1303 carriageway to the north to provide a smoother alignment. Dedicated right turn lanes into Cambridge Road Madingley and Cambridge Road Coton would be retained, with a break in the bus lane through the junction and a new dedicated left turn lane into Cambridge Road Madingley being provided for eastbound traffic. Lay-bys and bus-stop provision in the westbound direction would be retained.

The option does not provide any bus lanes from the M11 crossing to JJ Thomson Avenue due to limitations of available land from adjacent properties. Buses would run on the A1303 carriageway through the section and therefore no works are proposed to the M11 bridge crossing. East of the M11 crossing Option 1 provides bus lanes eastbound between JJ Thompson Avenue and Lady

Margaret Road into Cambridge. A number of signalised junctions are present through this length which would require alteration and realignment to incorporate the eastbound bus lane.

This option would require extensive site earthworks in the eastbound verge to accommodate the bus lane. Between the Cambridge Road junctions the M11 the provision of an eastbound bus lane will require the footway/cycleway to be located to the south of The A1303, requiring localised earthworks.

The alignment would require existing utility services in the eastbound verge to be diverted Existing carriageway drainage would need to be amended to accommodate the additional bus lane.

Potential construction risks:

Encountering unknown utility services;

Existing drainage found to be unsuitable to connect the required drainage into;

Unsuitable ground conditions found within areas of required carriageway widening.

For further details refer to the following drawings in Appendix B::

- DWG 5040372/HW/FS/040
- DWG 5040372/HW/FS/041
- DWG 5040372/HW/FS/042
- DWG 5040372/HW/FS/043
- DWG 5040372/HW/FS/044
- DWG 5040372/HW/FS/045
- DWG 5040372/HW/FS/046

Traffic management required to deliver Option 1 could comprise of a phased approach utilising temporary two way traffic signals and lane restrictions. Maximum permitted length of two-way signalised lane closures is 300m (Traffic Signs Manual Chapter 8 guidance) requiring consecutive closures along the A1303 to deliver the works required.

Initial phases would comprise of lane restrictions with temporary two way traffic signals to enable works to be carried out in the eastbound and westbound verges to undertake utility diversions. Two way signals would then be utilised for the construction of the proposed footway/cycleway in the westbound verge, switching to the eastbound side to construct the eastbound bus lane. Realignment of the carriageway at Madingley Hill would be carried out off line with tie-ins to the existing carriageway completed under full carriageway closures. Phased traffic management arrangements would be required at each junction realignment and on the Madingley Mulch roundabout for traffic signal installation. Throughout the construction period temporary diversions of the existing footway/cycleway would be required.

Option 6 – Tidal Busway

The bus lane would be constructed on the alignment of the existing A1303 carriageway requiring the widening of the new carriageway in the eastbound and westbound verges. All lay-bay/bus-stop provision on eastbound direction would be lost. A reduced dedicated right turn lane into Cambridge Road, Madingley and Cambridge Road, Coton on the A1303 would be provided, the lay-bay/bus-stop provision on the westbound direction would be retained, and the existing open ditch (westbound verge) within the proposed corridor would be affected during site works.

This option would require widening of the existing M11 J13 bridge structure to accommodate the bus lane and overhead gantry signs along the Madingley Mulch Road to indicate the operating direction of the bus lane.

The alignment would require existing utility services in the eastbound verge to be diverted. Existing carriageway drainage would need to be amended to accommodate the additional bus lane.

Potential construction risks:

Encountering unknown utility services;

Existing drainage found to be unsuitable to connect the required drainage into;

Unsuitable ground conditions found within areas of required carriageway widening.

HE approval for structural amendments

Amendments to the existing structure would be complex

For further details refer to the following drawings in Appendix B:

- DWG 5040372/HW/FS/035 Rev A
- DWG 5040372/HW/FS/036 Rev A
- DWG 5040372/HW/FS/037 Rev A
- DWG 5040372/HW/FS/038 Rev A
- DWG 5040372/HW/FS/039 Rev A

Traffic management required to deliver Option 6 could comprise of a phased approach utilising temporary two way traffic signals and lane restrictions, temporary carriageway widening and full carriageway closures. Maximum permitted length of two-way signalised lane closures is 300m (Traffic Signs Manual Chapter 8 guidance) requiring consecutive closures along the A1303 to deliver the works required.

Initial phases would comprise of lane restrictions with temporary two way traffic signals to enable works to be carried out in the eastbound verge to undertake utility diversions. Two way signals would then be utilised for the carriageway realignment into the eastbound verge and construction of the adjacent proposed footway/cycleway. A final carriageway resurfacing phase with installation of coloured bus lane surfacing would be required utilising full carriageway closures with traffic diversions in place. Install of signals to the Madingley Mulch roundabout would require localised land restrictions of carriageway closures. Throughout the construction period temporary diversions of the existing footway/cycleway would be required.

5.2.7 Summary. Non Guided Bus Lane

Option 1 provides a wide eastbound bus lane between Madingley Mulch Roundabout and the M11 Junction 13. No bus lane is provided between the M11 and JJ. Thomson Avenue; buses would be required to travel on road. The eastbound bus lane recommences east of JJ Thomson Avenue continuing to Lady Margaret Road, from where buses would join the carriageway to continue into Cambridge. In this option the alignment would be positioned on the eastbound side of the A1303 requiring the construction of the bus lane on the eastbound verge. Providing the bus on the eastbound side of the A1303 would reduce the impact on accesses on the southern side of the A1303. In this option, no bus lane is provided for the westbound direction. Risks associated with left-turning vehicles crossing the bus lane would need to be mitigated in this option, however the nearside bus lane is a standard arrangement familiar to most road users. An upgraded footway/cycleway would be provided on the south side of the A1303.

Option 6 provides a central tidal bus lane (positioned centrally to the A1303 carriageway), providing a bus link between Madingley Mulch Roundabout and High Cross Junction. In this option,

signalised bus priority junction and overhead gantry signs along the Madingley Road would be provided in order to indicate the direction of the buses. A central tidal bus lane is an unfamiliar arrangement to motorists, and it would therefore be necessary to provide frequent sign gantries along the bus lane to indicate the direction of operation and the purpose of the bus lane. The frequency of the gantries would be potentially visually intrusive and give an urbanised appearance to the generally rural setting of the western extent of Madingley Road. To provide continuity of the bus lane across the M11 the existing M11 Junction 13 structure would require widening which is technically challenging would require traffic management restrictions on both the A1303 and the M11 during construction. A new footway/cycleway would be provided on the eastbound side of the A1303, with the existing footway/cycleway to the westbound side of the A1303 from the Cambridge Road junction to Madingley Mulch also being retained.

6 Options Comparison

An initial high level comparative assessment relating to Options 1, 6 and 3a. It seeks to provide a relative assessment of the benefits and impacts of each of the options to inform the decision making and option development process in a consistent fashion. The assessment takes the form of an abridged and updated Multi-Criteria Assessment Framework (MCAF), based on that suggested by the LLF. It does not currently represent an assessment of the full costs and benefits / advantages and disadvantages of each scheme, nor does it apportion any relative importance or 'weight' in terms of the criteria used for assessment.

6.1 Option Descriptions

Option 1 is an online option that proposes no new infrastructure up to Madingley Mulch Roundabout, after which it provides:

- An Eastbound nearside bus lane along Madingley Road between Madingley Mulch and M11 bridge. Bus gate provided at the bridge, so buses run with general traffic up to High Cross. Existing carriageway retained and bus lane constructed adjacent, apart for a section where the alignment is smoothed to meet standards for ride quality
- An Eastbound nearside bus lane along Madingley Road between JJ Thompson Avenue and Lady Margaret Road. Bus priority at Grange Road and bus gate at Lady Margaret Road. Narrowing of footway/cycleway in places.
- A Park and Ride site, currently located within the vicinity of Madingley Mulch.

Option 1 is proposed to provide 9 buses an hour online on the A428 between Cambourne and Cambridge. 3 services will continue to Cambridge North Station. 6 services will access the City Centre of which 3 would continue to Addenbrookes. Should the Western Orbital Scheme come forward the latter Addenbrookes services would operate along the Western Orbital.

Option 6 is also an online option, suggested by the LLF. It is an alternative proposal to the assessed Option 1 and includes the following aspects:

- The same service pattern as Option 1 with stopping and express services;
- A Park and Ride site at Scotland Farm;
- A bus lane on the A428 eastbound off-slip approach to Madingley Mulch roundabout;
- Signals on Madingley Mulch roundabout to give bus priority;
- A central bus lane between Madingley Mulch roundabout and High Cross which is inbound only with an alternative scheme of a tidal lane.

Option 3a takes the form of an offline Busway between Cambourne and the City Centre. At this stage it is also assumed to have the same service pattern as Options 1 and 6. It includes a Park and Ride site, currently located within the vicinity of Madingley Mulch.

Tables 11, 10 and 13 provide a full description of each of the three options assessed in this report, by the following sections along the A428 corridor:

- Cambourne to Madingley Mulch
- Madingley Mulch to High Cross and
- High Cross to Drummer Street/City Centre.

Criteria	Option 1	Option 6	Option 3a
Route Description	From Cambourne High Street through Cambourne East to Broadway, through Bourn Airfield along St Neots Road to Madingley Mulch roundabout	From Cambourne High Street through Cambourne East to Broadway, through Bourn Airfield along St Neots Road to Madingley Mulch roundabout	From Cambourne High Street through Cambourne East to Broadway, through Bourn Airfield then offline adjacent to St Neots Road to Madingley Mulch roundabout
Cost	Not applicable as no new infrastructure is being provided on this section	Not applicable as no new infrastructure is being provided on this section	£38,912,000
Design	On road, no infrastructure provided	On road, no infrastructure provided	Off line 2-way guided busway as per the existing Cambridgeshire Guided Busway screened from Hardwick using existing trees. Numerous signalised junctions with buspriority
Other Modes	Pedestrian/cycle provision through Cambourne is as existing, Bourn Airfield will provide pedestrian/cycle routes through to St Neots Road where existing infrastructure is provided	Pedestrian/Cycle provision through Cambourne is as existing, Bourn Airfield will provide pedestrian/cycle routes through to St Neots Road where existing infrastructure is provided	Pedestrian/cycle provision through Cambourne is as existing, Bourn Airfield will provide pedestrian/cycle routes through to St Neots Road where an offline footway/cycleway is provided adjacent to the busway

Table 11. Cambourne to Madingley Mulch

Criteria	Option 1	Option 6	Option 3a
Route Description:	From Madingley Mulch roundabout East along Madingley Road, over the existing M11 Junction 13 bridge to High Cross	From Madingley Mulch roundabout East along Madingley Road, over the existing modified M11 Junction 13 bridge to High Cross	From Madingley Mulch across agricultural fields between Madingley Road and Coton to the M11 where a new bridge would accommodate the busway over the M11 to Cambridge West
Cost	£6,739,000	£18,972,000	£26,997,000
Design	Eastbound nearside bus lane along Madingley Road between Madingley Mulch and M11 bridge. Bus gate provided at the bridge, so buses run with general traffic up to High Cross. Existing carriageway retained and bus lane constructed adjacent, apart for a section where the alignment is smoothed to meet standards for ride quality	Central tidal bus lane along Madingley Road between Madingley Mulch and High Cross will require widening of the existing carriageway. Widening of the M11 bridge required to meet standards. Overhead gantries may be needed along the route to indicate direction of flow. Numerous signalised junctions required. Current Madingley Road doesn't meet alignment standards for ride quality	Off line 2-way guided busway as per the existing Cambridgeshire Guided Busway. New structure over the M11 and a signalised junction required on Cambridge Road, Coton.
Other Modes	A footway/cycleway will be provided adjacent to the Madingley Road connecting with existing provision at the M11 J13 bridge	A footway/cycleway will be provided adjacent to the Madingley Road across the M11 J13 bridge and connecting with existing provision at High Cross	A footway/cycleway will be provided adjacent to the busway providing traffic free routes

Table 12. Madingley Mulch to High Cross

Criteria	Option 1	Option 6	Option 3a
Route Description:	From High Cross East along Madingley Road to Northampton Street and on to the City Centre. Potential loop through Cambridge West	From High Cross East along Madingley Road to Northampton Street and on to the City Centre. Potential loop through Cambridge West	From Cambridge West, heading south east across the west fields and on to Grange Road.
Cost	£4,7929,000	Not applicable as no new infrastructure is being provided on this section	£11,276,000
Design	Eastbound nearside bus lane along Madingley Road between JJ Thompson Avenue and Lady Margaret Road. Bus priority at Grange Road and bus gate at Lady Margaret Road. Narrowing of footway/cycleway in places	On road, no infrastructure provided	Off line 2 way guided busway as per the existing Cambridgeshire Guided Busway screened from view over the west fields. Signalised junction required on Grange Road
Other Modes	Some sections of pedestrian/facilities narrowed to keep within the highway boundary/reduce land take	Cycle and walking provision as existing along Madingley Road and towards the city centre	A footway cycleway will be provided adjacent to the busway providing traffic free routes into Cambridge West and to Grange Road

Table 13. High Cross to Drummer Street/City Centre

7 Comparative Assessment Methodology

7.1 Overview

In order to compare the relative characteristics, benefits and impacts of each scheme a MCAF has been developed, based on the original SOBC methodology and updated to only include those criteria presented for assessment by the LLF. The assessment considers a range of criteria that have been quantified using either formal assessment or available evidence.

Note that due to Option 6 having not been part of the initial SOBC options that were formally assessed, Landscape/Heritage/Environmental/Noise scores have been based on a review of the scheme design by relevant discipline experts. In these cases, the available evidence has been used to ascertain whether Option 6 is likely to perform better / neutral / worse than Options 1 and 3a.

7.2 Criteria and metrics

Table 14 outlines the criteria to be used to assess the options as well as the metrics and data sources. These criteria were identified by the LLF.

Criteria	Metric	Data Source
Journey Times	Inbound – AM Peak Outbound – PM Peak	Journey times will be calculated based on existing data for buses on Madingley Road, on the Cambridgeshire Guided Busway and on bus lanes
Bus Frequency	AM Peak, buses per hour, inbound	All options are assessed as providing the same bus frequency: 9 busses per hour
Journey time variability (based on current traffic conditions)	A comparison of the potential improvement in journey time variability compared to the current Citi4 service, based on existing traffic conditions during peak hours.	Historical real time bus data (VIX).
Capital out-turn costs	£(2010 capital out turn basis)	As estimated by our surveyors F&G
BCR	To be included following completion of SOBC for all options	
Landscape and Visual / Heritage	Relative change from current situation; desk-top assessment	Taken from Economics Case within the SOBC – on a scale from Large Adverse – Large Beneficial
Air Pollution	Relative change from current situation; desk-top assessment	Taken from Economics Case within the SOBC – change in CO2 emissions and total change in air quality over 60-year appraisal period
Noise Impact	Relative change from current situation; desk-top assessment	Taken from Economics Case within the SOBC - change in noise impacts on households
Constructability Risk	As per Oct-2016 Business Case criteria (complexity of delivery)	No full assessment of construction disruption has been undertaken, however the construction impact on Madingley Hill (option 6) is likely to be similar to that caused on the M11 due to the construction of a new bridge.
Deliverability	As per Oct-2016	Deliverability risk (in terms of planning

Risk	Business Case criteria (planning / consents)	requirements and permissions) is expected to be lowest where schemes are based on upgrades to existing infrastructure. New infrastructure on greenfield sites is expected to have the highest risk.
Time to full implementation	Years	Year of scheme opening
Modal Shift	% of commuters from communities along the A428 corridor (Cambourne, Bourn, Caldecote etc) travelling to Cambridge employment sites using bus services.	CSRM2
Connectivity	To Western Orbital – assuming on-road and off-road	Desktop appraisal of connectivity of options with the proposed Western Orbital Scheme. Options will consider an online, off-line east and off-line west Western Orbital.
Policy Fit	With broader GCP, Combined Authority and Mayor’s transport schemes	Understanding of key policy documents including: Cambridgeshire LTP3 Highways England RIS Greater Cambridge and Peterborough SEP Greater Cambridge Partnership Local Plans for South Cambridgeshire and Cambridge Mayor’s Transport Schemes (subject to availability)
Stakeholder Support	Based on 2015 consultation responses	Based on 2015 consultation responses and subsequent stakeholder engagement. Note that Option 6 has not been ‘tested’ through stakeholder consultation.

Table 14. Criteria & metrics

Relative scores from 1 to 5 were attributed to each metric, with 5 being the best performing and 1 being the worst performing, and 3 being neutral. This initial scoring was carried out at an Internal Atkins/Skanska workshop on 15th June 2015 by five members of staff with experience working on the A428 Cambourne to Cambridge Better Bus Journeys Scheme. Scoring is relative; it compares the relative performance of options against one another, for each metric. No prominence or importance of each criteria has been considered and as such scores have not been weighted.

It should be noted that the criteria and metrics used in the assessment were developed by the LLF for Option comparison and that they do not provide a holistic and full comparison of option performance. The resilience of infrastructure, for example, has not been included. Further work will be required to present a full and balanced assessment of all options.

8 Results

The results of the assessment are shown in Table 15. Data from additional quantitative assessments (e.g. variability / punctuality / BCR) were not available at the time of writing. Further work will be required to incorporate additional modelling metrics and subsequently updating the overall relative scores for each scheme. Whilst pending additional data and any additional weighting considerations, the options have not been assigned a total score for holistic comparison, and at this stage the MCAF only provides a relative assessment of option performance against each metric.

Section 8.38.2 provides additional rationale and justification for the relative scores attributed to environmental metrics, for each option. Additional environmental assessments have not formally been undertaken so discipline experts have reviewed the Option 6 design in order to allow assessment and ranking based on their professional judgement and input.

8.1 Comparison of Options and rationale

Table 15. Option 1, 6 and 3a Comparative Performance MCAF using LLF Criteria

DRAFT		Option 1				Option 6			Option 3a		
Criteria	Notes / Data	Details / Metrics	Metric	Score	Rationale	Metric	Score	Rationale	Metric	Score	Rationale
Journey Times	Journey times have been calculated based on existing on-board real-time bus data for buses on Madingley Road, on the Cambridgeshire Guided Busway and on bus lanes. The assessment assumes an allowance for acceleration and deceleration between stops. Inbound and outbound journey times have been assessed separately. If there was an express service for all options which travelled between Cambourne a Park and Ride Site, West Cambridge and Grange Road the journey times in the AM peak inbound are likely to be as follows: Option 1 = 22mins, Opt 6 = 21, Opt 3a = 17 mins.	Inbound – AM/PM Peak (Stopping)	30	3	Options 1 and 6 have journey times within two minutes of one another. It has been concluded that there is insufficient perceivable difference in the journey time for this stage of assessment. They are therefore considered neutral.	28	3	Options 1 and 6 have journey times within two minutes of one another. It has been concluded that there is insufficient perceivable difference in the journey time for this stage of assessment. They are therefore considered neutral.	20	5	Option 3 offers a significant (highly perceivable) reduction in journey times compared to Options 1 and 6. The journey time is considered 'very good'.
		Outbound – AM/PM Peak (Stopping)	33	3		31	3		26	5	
		Average Score	31.5	3		29.5	3		23	5	
		Fast service - theoretical non-stop journey time for all options based on a route of Cambourne to Cambridge stopping at a Park and Ride Site and West Cambridge.	Inbound – AM/PM Peak (Express)	22		3	21		4	17	
Outbound – AM/PM Peak (Express)	21	19	17								
Bus Frequency	It is proposed that 9 buses an hour will route between Cambourne and Cambridge. 3 will continue to Cambridge North Station. 6 services will access the City Centre of which 3 would continue to Addenbrookes. Should the Western Orbital Scheme come forward the latter services would operate along the Western Orbital	AM Peak, buses per hour, inbound Note that this does not indicate the capacity of each Option, which will be assessed separately.	9	3	Initial agreed assumption.	9	3	Initial agreed assumption.	9	3	Initial agreed assumption.
Journey time variability (based on current traffic conditions)	A comparison of the potential improvement in journey time variability compared to the current Citi4 service, based on existing traffic conditions during peak hours.	Potential % improvement in journey time variability in the peak hour, compared to Citi4		TBC			TBC			TBC	
				TBC			TBC			TBC	
Capital out-turn costs (not including cost of Park and Ride site)	Surveyor assessment. Not equivalent to Value for Money (see BCR below) These costs include all infrastructure costs between Cambourne and Cambridge and do not include land costs	£(2010 basis)	£11,531,900	5	Score based on linear interpolation.	£18,972,000	4	Score based on linear interpolation.	£77,185,000	1	Score based on linear interpolation.
High Level BCR		To be included following further analysis	TBC	TBC		TBC	TBC		TBC	TBC	
Landscape and Visual / Heritage	As per assessment in the SOBC – on a 7-point scale (Large Adverse – Large Beneficial) (pre-mitigation)	Relative change from current situation; desk-top assessment	Slight Adverse	3	Some visual intrusion and impacts on vegetation specifically at the Park and Ride site, details below	Moderate Adverse	2	Greater visual intrusion and change of landscape character as a result of the required gantries	Moderate Adverse	1	Impact on public open space and agricultural land on the offline alignment.
Air Pollution	As per assessment in the SOBC – on a 7-point scale– change in CO2 emissions and total change in air quality over 60-year appraisal period. Assumed Option 6 is Similar to Option 1 with respect to air pollution.	Relative change from current situation; desk-top assessment	Moderate Adverse	3	Potential for an adverse impact in Cambridge city centre as a result of an increase in bus traffic. Potential offset due to mode shift and reduction in veh-km have not been considered at this stage.	Moderate Adverse	3	Potential for an adverse impact in Cambridge city centre as a result of an increase in bus traffic. Potential offset due to mode shift and reduction in veh-km have not been considered at this stage.	Moderate Adverse	3	Potential for an adverse impact in Cambridge city centre as a result of an increase in bus traffic. Potential offset due to mode shift and reduction in veh-km have not been considered at this stage.
Noise Impact	As per assessment in the SOBC – on a 7-point scale - change in noise impacts on receptors, such as households	Relative change from current situation; desk-top assessment	Slight Adverse	3		Slight Adverse	3		Moderate Adverse	2	

DRAFT

DRAFT			Option 1			Option 6			Option 3a		
Criteria	Notes / Data	Details / Metrics	Metric	Score	Rationale	Metric	Score	Rationale	Metric	Score	Rationale
Constructability Risk	No full assessment of construction disruption has been undertaken, however the construction impact on Madingley Hill (option 6) is likely to be similar to that caused on the M11 due to the construction of a new bridge.	As per assessment criteria in the SOBC (complexity of delivery)	Medium	2	Significant risk relating to stats diversions and traffic management issues.	High	1	Construction of a mid-carriageway tidal flow lane would be associated with significant disruption, stats issues and traffic management issues. M11 Bridge widening is cheaper than a new bridge, but more complex to deliver (condition of existing structure, hydro demolition etc.).	Lowest	4	New Bridge more straightforward than widening). Fewer stats issues due to greenfield land. Fewer traffic management issues.
Deliverability Risk	Deliverability risk (in terms of planning requirements and permissions) is expected to be lowest where schemes are based on upgrades to existing infrastructure. New infrastructure on greenfield sites is expected to have the highest risk.	As per Oct-2016 Business Case criteria (planning / consents)	Low-Medium	4	CPO required for private land / gardens. Delivered through HA/CPO. Likely to require the least amount of land take.	Medium-High	3	Potential requirement for more land take than Option 1, and related acquisition issues. Delivered through Highways Act / CPO.	Medium-High	2	Potential to negotiate greenfield land without CPO. Delivered through TWA. Requires the most land take.
Time to full implementation	Year of scheme opening	Years	2021	4	c. 18 months for HA / CPO. No Public Enquiry. Established design and planning procedures and experience.	2022	3	c. 18 months for HA / CPO, however the additional land take could increase the time required. No public Enquiry. Design and planning process expected to take longer due to the more complex nature of the scheme, compared to Option 1.	2024	2	TWA slightly quicker than HA/CPO, but objections will lead to public enquiry.
Modal Shift	CSRM2 output	% of commuters from communities along the A428 corridor (Cambourne, Bourn, Caldecote etc.) travelling to Cambridge employment sites using bus services - AM inbound.	27%	3		28%	3		31%	4	
Connectivity	Desktop appraisal of connectivity of options with the proposed Western Orbital Scheme. Options will consider an online, off-line east and off-line west Western Orbital.	To Western Orbital – assuming on-road and off-road		3	Longer travel distance to get to hub, but possible to get directly onto M11. All score neutral due to level of certainty around the hub.		3	Longer travel distance to get to hub, but possible to get directly onto M11. All score neutral due to level of certainty around the hub.		3	Direct access to 'hub' and then onto M11. All score neutral due to level of certainty around the hub.
Policy Fit	Analysis of key policy documents including: Cambridgeshire LTP3 Highways England RIS Greater Cambridge and Peterborough SEP Greater Cambridge Partnership Local Plans for South Cambridgeshire and Cambridge	With broader GCP, Combined Authority	Medium	2	Potential to deliver a HQPT service, however buses are not fully segregated from general traffic and are more likely to suffer from reliability issues as a result.	Medium	2	Potential to deliver a HQPT service, however buses are not fully segregated from general traffic and are more likely to suffer from reliability issues as a result. The Option does not consider wider connectivity, especially towards the Centre, following termination of the Tidal lane. There are more limited opportunities to improve cycle connectivity.	Very Good	5	High strategic fit in terms of delivery of HQPT and segregation of buses from general traffic. Future proofing with respect to development sites and adopting alternative transport systems. Supports connectivity throughout the route.
Stakeholder Support	Based on 2015 consultation responses and subsequent stakeholder engagement. For Option 6 this is based on support from LLF.	Based on 2015 consultation responses and LLF support.		4	More popular than offline		2	Not tested in public consultation.		1	Less popular than online.
Simple total - Not weighted according to any specific criteria		Total (unweighted)		51		Total (unweighted)	45		Total (unweighted)	51	

8.2 Informing the Environmental Assessments

8.2.1 Landscape

As part of a formal assessment within the SOBC, Option 1 scored slight adverse. While most the route corridor is located alongside, or follows the same broad corridor as existing transport infrastructure and is not very visually intrusive to new receptors and landscape features, there are the following considerations:

- There is potential for loss of vegetation and localised effects on the overall landscape and character of the alignment. This is because the Park & Ride and route corridor would replace a section of greenfield land near Madingley Mulch roundabout;
- There is the loss of some existing vegetation, including part of a group of Tree Preservation Orders (TPOs) and part of a traditional orchard;
- There is an increase in the prominence of the A1303 within the landscape;
- There is an impact on certain views into and across the area; and
- The option will affect the setting of areas of recognised landscape quality in the form of the American Military Cemetery and Madingley Hall Registered Parks and Gardens.

There are opportunities to mitigate these to some degree and integrate the proposal into the landscape through careful consideration of the layout, design, retention of boundary vegetation and limiting the height of lighting proposals. The area west of the proposed Park & Ride would require the most careful consideration to avoid and reduce potential landscape severance and tranquillity past Coton and between the M11 and western edge of Cambridge.

Through formal assessment, Option 3a scored moderate adverse due to its alignment across the public open space west of Cambourne and the extent to which it creates a new infrastructure that transects the agricultural field pattern, passes through a traditional orchard and is situated near the Conservation Areas of Coton and Hardwick. Further, as discussed above the Park & Ride and route corridor would replace a section of greenfield land near Madingley Mulch roundabout. There is also an impact on existing vegetation, including part of a group TPO and part of a traditional orchard that will be lost.

Based on a review of the Option 6 design, it is considered likely to score slight adverse overall with similar rationale to Option 1 discussed above. Option 6, however, shows additional vegetation loss and greater impact around the entrance to the Grade 1 Registered Park and Garden. In addition, the provision of gantries for the tidal system would add new features to the road corridor resulting in a more urban and highway dominated character. In terms of relative ranking Option 6 is therefore considered to have a greater impact than Option 1 (even though the overall impact category is likely to be the same), but less than Option 3a.

8.2.2 Air pollution

All options will have an impact on air quality with the result a balance of the combination of the following impacts:

- Improved air quality where mode shift the private car to public transport or active modes;
- Worsened air quality where there are increased emissions from buses; and
- Worsened air quality where there is increased congestion to general traffic.

In overall terms, if there is a significant future increase in bus availability and take-up from the towns along the route corridor, there is potential to reduce the number of vehicles travelling along the Cambourne to Cambridge corridor and thus reduce congestion, air pollution and noise impacts on residents along the corridor. However, the air quality impact on Cambridge city centre is assessed as adverse due to the addition of bus services to an already congested urban area. Mitigation of this through access control measures (limiting the amount and type of traffic entering the centre) would reduce this negative impact. Further, there is a worsening of local air quality across all three options driven by an increase in traffic on road links with new or increased bus traffic. Assessment scores are worse for option 3a with offline sections, as properties are affected by the introduction of a new pollutant source.

For Option 6, Air quality impacts are not anticipated to alter significantly between the online Option 1 (adjacent to the existing carriageway) and online Option 6 (within the existing carriageway lanes) as no additional vehicles are being proposed from one option over the other, in addition no route deviations are proposed other than the shorter route for Option 6. A full assessment of air pollution would be required to fully understand these impacts.

8.2.3 Noise

Noise impacts upon sensitive features such as schools, hospitals and residents are likely to be similar for both Options 1 and 6 for most the route as they involve additional land take on broadly similar corridors, with the same assumed bus frequency. It is therefore likely that the distance between the receptors and the noise source will be similar for both options. As per the SOBC option 3a will impact upon new noise receptors, so the overall impact is expected to be worse. A full assessment of noise would be required to fully understand these impacts.

9 Response from the LLF

Outcomes of the MCAF were shared with the technical group of the LLF who have provides commentary on them, as follows (in italics):

Having worked collaboratively with the appointed consultants to establish the criteria by which Options 1, 3a and 6 would be compared, the LLF (technical subgroup) is disappointed with the final ‘scoring’ of the options. The figures favour Option 3a, with multiple scores in criteria that benefit it (four individual scores for journey time; whereas just one each for environment/heritage, stakeholder support and cost.) Even scoring rationales provided in the previous MCAF report (September 2016; noise impact, air pollution and constructability risk) are now contradicted. This assessment should be objective; the relative weighting of the various criteria to be decided by the Executive Board. The main areas of contention are as follows:

1. Journey times

The LLF strongly disagrees with the inclusion of four separate scores for journey time (inbound, outbound, average of inbound/outbound and express), and so has discounted the latter two. We consider it unreasonable to include ‘average’ (what does that add?), and since the ‘express service’ is purely theoretical, it should not be included either. All options should be compared on the basis of the five stops previously agreed. However, the express service that runs along the existing A428 dual carriageway, and is a fundamental part of Option 6, should be included in this analysis as it stops five times and is directly comparable to Option 3a. Without it Option 6 is little different from Option 1.

2.

		Option 1	Option 6	Option 3a
Atkins scoring		12	13	20
LLF scoring		4	8	10

3. Landscape and Visual Heritage

The LLF considers the environmental and heritage impacts of on-road options 1 and 6 are considerably lower than for Option 3a:

	Option 1	Option 6	Option 3a
Atkins scoring	3	2	1
LLF scoring	4.5	4	1

4. Air pollution and noise impact

The LLF has not changed the Atkins scoring (all options almost identical), but is sceptical. Why has the scoring has changed so markedly from the previous MCAF report (Option 3a = 2 points; Option 1 = 5 points). Is this because the buses are to be electric?

5. Constructability Risk

The SOBC-S (Strategic Business Outline Case) states that ‘delivery will be most complex where the route options include a new bridge over the M11’ (Table 10-2, page 78). In the original MCAF of September 2016, Option 3 scored 1 (highest risk) versus 2 (Medium-high) for option 1. How can Option 3a now score 4 (low risk)? The LLF agrees with the original MCAF assessment.

	Option 1	Option 6	Option 3a
Atkins scoring	2	1	4
LLF scoring	2	2	1

6. Deliverability Risk

The LLF has lowered the score for Option 3a due to high risk of legal challenge that will cause delays.

	Option 1	Option 6	Option 3a
Atkins scoring	4	3	2
LLF scoring	4	3	1

7. Time to full implementation

The score for Option 3a must be lower than Option 6 as it will take two years longer to complete.

	Option 1	Option 6	Option 3a
Atkins scoring	4	3	3
LLF scoring	4	3	2

8. Policy Fit

The LLF considers Option 6 at least as good a policy fit as Option 3a because, although it is slightly slower and slightly less reliable, it is far cheaper and frees up funds which can be used on other GCP schemes. It can also be argued that Option 6 marries far better than Option 3a with the Mayor’s thinking because it offers flexibility whilst longer-term, more strategic, transport solutions are developed.

	Option 1	Option 6	Option 3a
Atkins scoring	2	2	5
LLF scoring	2	3	3

9. Stakeholder Support

Given Option 6 has almost unanimous support within the LLF (the elected representatives of 35,000 residents on route.), and provides a better service than Option 1 (the most popular in public consultation). It must therefore score at least the same as Option 1.

	Option 1	Option 6	Option 3a
Atkins scoring	4	2	1
LLF scoring	4	4	1

10. TOTAL SCORE

The LLF believes the following scores are now objective, but accepts they will change when criteria weighting is added by the Executive Board.

	Option 1	Option 6	Option 3a
Atkins scoring	51	45	52
LLF scoring	44.5	46	35

A marked-up copy of the MCAF table by the LLF is included in Appendix C.

10 Conclusions and Next Steps

There is a need to undertake a transparent and objectivity based comparison of Options 1, 6 and 3A based on the readily available data and WebTag complaint multi-modal transport model. This report presents an unweighted comparison of options based on metrics developed based on LLF criteria. Pending additional data, the assessment currently shows that:

- Option 3A has a marginally higher score than Option 1 and a higher score than Option 6, reflecting high expected performance on HQPT metrics and low relative performance on costs and environmental impacts.
- Option 1 has a higher score than Option 6, due to its low costs and relatively neutral performance across a range of criteria.
- Option 6 has a lower score than both Option 1 and 3a due to neutral performance across a range of criteria, it's relatively higher delivery risk in terms of construction compared to Option 1 and lower expected levels of modal shift.

It is important to note that this current assessment does not capture the full range of scheme benefits and impacts. Webtag and best practice describe an application of a proportionate and appropriate analysis to compare options based on the available data. In addition to the criteria suggested by the LFF some or all of the following criteria could enhance the analysis undertaken and increase the robustness of the conclusions:

- Network capacity availability to accommodate 9 buses per hour;
- Additional assessment of journey time variation and punctuality;
- Consideration of operating costs to consider full scheme costs;
- The relative ability to future proof the transport corridor in terms facilitating new transport system developments;
- Segregation of HQPT elements;
- Re-routing and veh-km impacts;
- Accident and safety;
- Disruption to traffic during construction and maintenance/renewals;
- Land take area and CPO requirements;
- VfM assessment; and
- Full consideration of stakeholders.

In addition, in its current form this assessment does not weight the relative prominence of criteria and is pending additional data (in particular reliability metrics). An enhanced version of the MCAF process will deliver a sound and robust analysis to compare the three route options.

Appendix A – Comparison Table

A1303 Madingley Road Corridor Assessment – Bus Link Option Review						
Criteria	Option A	Option B	Option C	Option D	Option 1	Option 6
Route Description	From Madingley Mulch Roundabout to west Cambridge (Guided)	From Madingley Mulch Roundabout to west Cambridge (Guided)	From Madingley Mulch Roundabout to west Cambridge (Guided)	From Madingley Mulch Roundabout to west Cambridge (Guided)	From Madingley Mulch Roundabout East along Madingley Road, over the existing M11 Junction 13 bridge to the City Centre (non-guided)	From Madingley Mulch Roundabout East along Madingley Road, over the existing M11 Junction 13 bridge (widened) to the west Cambridge (non-guided)
Buildability	The A1303 carriageway would be aligned south of the existing carriageway. Traffic management restrictions and public disruptions during construction. Utility diversions will be required. Total or partial road closure of M11 required during construction of M11 crossing	Traffic management restrictions and public disruptions during construction. Utility diversions will be required. Provision of lane width restrictions. The A1303 carriageway would be aligned north of the existing carriageway. Total or partial road closure of M11 required during construction of M11 crossing	Traffic management restrictions and public disruptions during construction. Utility diversions will be required. Provision of lane width restrictions. The A1303 carriageway would be aligned south of the existing carriageway. Total or partial road closure of M11 required during construction of M11 crossing	Road closures/traffic management restrictions and public disruption during construction. Utility diversions will be required. The existing A1303 carriageway will be mostly excavated during to provide the central busway. Total or partial road closure of M11 required during construction of M11 crossing	Traffic management restrictions and public disruption during construction minimised. Utility diversions will be required in the eastbound verge only. The carriageway will be realigned at Madingley Hill, realigned section constructed offline.	Road closures/traffic management restrictions and public disruption during construction. Utility diversions will be required in the eastbound verge only. Widening of the existing M11 crossing requiring Traffic Management on the M11.
Road Safety	Crossing of numerous junctions and accesses both sides of the A1303. Conflict with cyclists and vehicles turning across the busway Footway/cycleway crosses numerous junctions and accesses.	Crossing of numerous junctions and accesses south of the A1303. Conflict with cyclists and vehicles turning across the bus way. Unfamiliar arrangement in a rural area. Footway/cycleway crosses numerous junctions and accesses.	Crossing of numerous junctions and accesses north of the A1303. Conflict with cyclists and vehicles turning across the bus way. Unfamiliar arrangement in a rural area. Footway/cycleway crosses numerous junctions and accesses.	Unfamiliar bus lane arrangement on rural areas. Requires patrons to cross the carriageway to access buses. Footway/cycleway crosses numerous junctions and accesses.	Crossing of numerous junctions and accesses. Conflict with cyclist using the bus lane and vehicles turning across the bus lane. Footway/cycleway crosses numerous junctions and accesses.	Conflict with vehicles turning right out of side roads and properties. Unfamiliar bus lane arrangement in a rural area. Signals required to indicate the direction of bus lane operation. Footway/cycleway crosses numerous junctions and accesses.

Appendix B – Drawings

GUIDED BUSWAY

- **Option A. Single Lane Busway**
 - DWG 5040372/HW/FS/010 Rev A
 - DWG 5040372/HW/FS/011 Rev A
 - DWG 5040372/HW/FS/012 Rev A
 - DWG 5040372/HW/FS/013 Rev A
- **Option B. Two Busway**
 - DWG 5040372/HW/FS/014 Rev A
 - DWG 5040372/HW/FS/015 Rev A
 - DWG 5040372/HW/FS/016 Rev A
 - DWG 5040372/HW/FS/017 Rev A
- **Option C. Two Way Busway**
 - DWG 5040372/HW/FS/018 Rev A
 - DWG 5040372/HW/FS/019 Rev A
 - DWG 5040372/HW/FS/020 Rev A
 - DWG 5040372/HW/FS/021 Rev A
- **Option D. Paired Two Way**
 - DWG 5040372/HW/FS/022 Rev A
 - DWG 5040372/HW/FS/023 Rev A
 - DWG 5040372/HW/FS/024 Rev A
 - DWG 5040372/HW/FS/025 Rev A

NON-GUIDED BUS LANE

- **Option 1. Eastbound Bus Lane**
 - DWG 5040372/HW/FS/040 Rev A
 - DWG 5040372/HW/FS/041 Rev A
 - DWG 5040372/HW/FS/042 Rev A
 - DWG 5040372/HW/FS/043 Rev A
 - DWG 5040372/HW/FS/044 Rev A
 - DWG 5040372/HW/FS/045 Rev A
 - DWG 5040372/HW/FS/046 Rev A

- **Option 6. Central Tidal Bus Lane**
 - DWG 5040372/HW/FS/035 Rev A
 - DWG 5040372/HW/FS/036 Rev A
 - DWG 5040372/HW/FS/037 Rev A
 - DWG 5040372/HW/FS/038 Rev A
 - DWG 5040372/HW/FS/039 Rev A

Appendix C – LLF MCAF Comments

MCAF Table. LLF comments in BOLD

Criteria	Notes / Data	Details / Metrics	Option 1			Option 6			Option 3a			LLF COMMENTS
			Metric	Score	Rationale	Metric	Score	Rationale	Metric	Score	Rationale	
Journey Times	Journey times have been calculated based on existing on-board real-time bus data for buses on Madingley Road, on the Cambridgeshire Guided Busway and on bus lanes. The assessment assumes an allowance for acceleration and deceleration between stops. Inbound and outbound journey times have been assessed separately. If there was an express service for all options which travelled between Cambourne a Park and Ride Site, West Cambridge and Grange Road the journey times in the AM peak inbound are likely to be as follows: Option 1 = 22mins, Opt 6 = 21, Opt 3a = 17 mins.	Inbound – AM/ PM Peak (Stopping)	30	3/2	Options 1 and 6 have journey times within two minutes of one another. It has been concluded that there is insufficient perceivable difference in the journey time for this stage of assessment. They are therefore considered neutral. The LLF does not agree with this statement: see box to right.	28 22	3/4	Options 1 and 6 have journey times within two minutes of one another. It has been concluded that there is insufficient perceivable difference in the journey time for this stage of assessment. They are therefore considered neutral. The above statement is only true because the express service that runs along the existing A428 dual carriageway, and is a fundamental part of Option 6, is not included in this analysis (inbound peak journey time of 22 mins; outbound 26 mins; 5 stops). It should be included in this comparison as otherwise Option 6 is little different from Option 1.	20 19	5	Option 3 offers a significant (highly perceivable) reduction in journey times compared to Options 1 and 6. The journey time is considered 'very good'. The consultant has miscalculated the journey times for option 3a, and the LLF has corrected this from 20 to 19 minutes inbound, and from 26 to 24 minutes outbound. This figure takes account of what was agreed with Atkins on 27/6 - that the Option 3a journey time between Madingley Mulch to Grange Road should be an average of the four possible routes. This adds 1 minute to journey time.	
		Outbound – AM/ PM Peak (Stopping)	33	3/2		34 26	3/4		26 24	5		
		Average Score	31.5	3/0		29.5 24	3/0		23 21.5	5/0		
	Fast service - theoretical non-stop journey time for all options based on a route of Cambourne to Cambridge stopping at a Park and Ride Site and West Cambridge.	Inbound – AM/ PM Peak (Express)	22	3/0		21	4/0		17	5/0		This 'express service' is purely theoretical and should not be included. All options should be compared on the basis of the five stops previously agreed.
Outbound – AM/ PM Peak (Express)		21	19			17						
Bus Frequency	It is proposed that 9 buses an hour will route between Cambourne and Cambridge. 3 will continue to Cambridge North Station. 6 services will access the City Centre of which 3 would continue to Addenbrookes. Should the Western Orbital Scheme come forward the latter services would operate along the Western Orbital	AM Peak, buses per hour, inbound Note that this does not indicate the capacity of each Option, which will be assessed separately.	9	3	Initial agreed assumption.	9	3	Initial agreed assumption.	9	3	Initial agreed assumption.	
Journey time variability (based on current traffic conditions)	A comparison of the potential improvement in journey time variability compared to the current Citi4 service, based on existing traffic conditions during peak hours.	Potential % improvement in journey time variability in the peak hour, compared to Citi4		TBC			TBC			TBC		
				TBC			TBC			TBC		

Criteria	Notes / Data	Details / Metrics	Option 1			Option 6			Option 3a			LLF COMMENTS
			Metric	Score	Rationale	Metric	Score	Rationale	Metric	Score	Rationale	
Capital out-turn costs (not including cost of Park and Ride site)	Surveyor assessment. Not equivalent to Value for Money (see BCR below) These costs include all infrastructure costs between Cambourne and Cambridge and do not include land costs	£(2010 basis)	£11,531,900	5	Score based on linear interpolation.	£18,972,000	4	Score based on linear interpolation.	£77,185,000	1	Score based on linear interpolation.	This figure does not include land acquisition costs.
High Level BCR		To be included following further analysis	TBC	TBC		TBC	TBC		TBC	TBC		
Landscape and Visual / Heritage	As per assessment in the SOBC – on a 7-point scale (Large Adverse – Large Beneficial) (pre-mitigation)	Relative change from current situation; desk-top assessment	Slight Adverse Slight	3 4.5	Some visual intrusion and impacts on vegetation specifically at the Park and Ride site, details below	Moderate Slight-moderate	2 4	Greater visual intrusion and change of landscape character as a result of the required gantries	Moderate Adverse	1	Impact on public open space and agricultural land on the offline alignment.	The environmental and heritage impacts of on-road options 1 and 6 are considerably lower than for Option 3a.
Air Pollution	As per assessment in the SOBC – on a 7-point scale– change in CO2 emissions and total change in air quality over 60-year appraisal period. Assumed Option 6 is Similar to Option 1 with respect to air pollution.	Relative change from current situation; desk-top assessment	Moderate Adverse	3	Potential for an adverse impact in Cambridge city centre as a result of an increase in bus traffic. Potential offset due to mode shift and reduction in veh-km have not been considered at this stage.	Moderate Adverse	3	Potential for an adverse impact in Cambridge city centre as a result of an increase in bus traffic. Potential offset due to mode shift and reduction in veh-km have not been considered at this stage.	Moderate Adverse	3	Potential for an adverse impact in Cambridge city centre as a result of an increase in bus traffic. Potential offset due to mode shift and reduction in veh-km have not been considered at this stage.	If based on the original MCAF calculation of September 2016, these scores should be 2 for Option 3a, and 5 for both Option 1 and Option 6. The LLF would like to know why has this changed so markedly? Is it because these buses will be electric?
Noise Impact	As per assessment in the SOBC – on a 7-point scale - change in noise impacts on receptors, such as households	Relative change from current situation; desk-top assessment	Slight Adverse	3		Slight Adverse	3		Moderate Adverse	2		If based on the original MCAF calculation of September 2016, these scores should be 2.5 for Option 3a, and 5 for both Option 1 and Option 6. Why has this also changed so markedly? Is it because these buses will be electric?
Constructability Risk	No full assessment of construction disruption has been undertaken, however the construction impact on Madingley Hill (option 6) is likely to be similar to that caused on the M11 due to the construction of a new bridge.	As per assessment criteria in the SOBC (complexity of delivery)	Medium	2	Significant risk relating to stats diversions and traffic management issues.	High Medium	4 2	Construction of a mid-carriageway tidal flow lane would be associated with significant disruption, stats issues and traffic management issues. M11 Bridge widening is cheaper than a new bridge, but more complex to deliver (condition of existing structure, hydro demolition etc.). Option 6 does not necessarily require widening the M11 bridge (see Rectory Farm Bridge Study) but reconfiguring the lanes and removing the south side footway.	Low High	4 1	New Bridge more straightforward than widening). Fewer stats issues due to greenfield land. Fewer traffic management issues.	The SOBC-S states that ‘delivery will be most complex where the route options include a new bridge over the M11’ (Table 10-2, page 78). In the original MCAF of September 2016, Option 3 scored 1 (highest risk) versus 2 (Medium-high) for option 1. How can it now score 4 (low risk), and have changed so markedly? The LLF agrees with the original MCAF assessment.

Criteria	Notes / Data	Details / Metrics	Option 1			Option 6			Option 3a			LLF COMMENTS
			Metric	Score	Rationale	Metric	Score	Rationale	Metric	Score	Rationale	
Deliverability Risk	Deliverability risk (in terms of planning requirements and permissions) is expected to be lowest where schemes are based on upgrades to existing infrastructure. New infrastructure on greenfield sites is expected to have the highest risk.	As per Oct-2016 Business Case criteria (planning / consents)	Low-Medium	4	CPO required for private land / gardens. Delivered through HA/ CPO. Likely to require the least amount of land take.	Medium-	3	Potential requirement for more land take than Option 1, and related acquisition issues. Delivered through Highways Act / CPO.	High	21	Potential to negotiate greenfield land without CPO. Delivered through TWA. Requires the most land take.	Scoring for Option 3a reduced as subject to high risk of legal challenge that will cause delays.
Time to full implementation	Year of scheme opening	Years	2021	4	c. 18 months for HA / CPO. No Public Enquiry. Established design and planning procedures and experience.	2022	3	c. 18 months for HA / CPO, however the additional land take could increase the time required. No public Enquiry. Design and planning process expected to take longer due to the more complex nature of the scheme, compared to Option 1.	2024	32	TWA slightly quicker than HA/ CPO, but objections will lead to public enquiry.	The score for Option 3a must be lower than Option 6 as it will take two years longer to complete.
Modal Shift	CSRM2 output	% of commuters from communities along the A428 corridor (Cambourne, Bourn, Caldecote etc.) travelling to Cambridge employment sites using bus services - AM inbound.	27%	3		28%	3		31%	4		
Connectivity	Desktop appraisal of connectivity of options with the proposed Western Orbital Scheme. Options will consider an online, off-line east and off-line west Western Orbital.	To Western Orbital – assuming on-road and off-road		3	Longer travel distance to get to hub, but possible to get directly onto M11. All score neutral due to level of certainty around the hub.		3	Longer travel distance to get to hub, but possible to get directly onto M11. All score neutral due to level of certainty around the hub.		3	Direct access to 'hub' and then onto M11. All score neutral due to level of certainty around the hub.	
Policy Fit	Analysis of key policy documents including: Cambridgeshire LTP3 Highways England RIS Greater Cambridge and Peterborough SEP Greater Cambridge City Deal Local Plans for South Cambridgeshire and Cambridge	With broader City Deal, Combined Authority	Medium-low	2	Potential to deliver a HQPT service, however buses are not fully segregated from general traffic and are more likely to suffer from reliability issues as a result.	Medium	23	Potential to deliver a HQPT service, however buses are not fully segregated from general traffic and are more likely to suffer from reliability issues as a result. The Option does not consider wider connectivity, especially towards the Centre, following termination of the Tidal lane. There are more limited opportunities to improve cycle connectivity.	Medium	53	High strategic fit in terms of delivery of HQPT and segregation of buses from general traffic. Future proofing with respect to development sites and adopting alternative transport systems. Supports connectivity throughout the route.	The LLF considers Option 6 at least as good a policy fit as Option 3a because, although it is slightly slower and slightly less reliable, it is far cheaper and frees up funds which can be used on other GCP schemes. It can also be argued that Options 6 marries far better than Option 3a with the Mayor's transport schemes because it offers flexibility whilst longer-term transport

			Option 1			Option 6			Option 3a			LLF COMMENTS
Criteria	Notes / Data	Details / Metrics	Metric	Score	Rationale	Metric	Score	Rationale	Metric	Score	Rationale	
												solutions are developed.
Stakeholder Support	Based on 2015 consultation responses and subsequent stakeholder engagement. For Option 6 this is based on support from LLF.	Based on 2015 consultation responses and LLF support.		4	More popular than offline		2 4	Not tested in public consultation.		1	Less popular than online.	Given Option 6 has almost unanimous support within the LLF (the elected representatives of 35,000 residents on route.), and provides a better service than Option 1 (the most popular in public consultation). Option 6 must therefore score at least the same as Option 1.
Simple total - Not weighted according to any specific criteria		Total (unweighted)		51 44.5		Total (unweighted)	45 46		Total (unweighted)	52 35		

