Cambourne to Cambridge
Better Bus Journeys

Phase 1 – Option 3A Assessment Report

Greater Cambridge Partnership

August 2017
Cambourne to Cambridge Better Bus Journeys

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August 2017

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Executive summary

An assessment of proposed busway specific route alignments for the Cambourne to Cambridge Better Bus Journeys project has been carried out within the Option 3A catchment area for the section of the route identified as Phase 1, between the A1303 St Neots Road/Long Road junction and Grange Road.

This report does not represent detailed design proposals for Phase 1. Detailed design will only be developed once a single alignment has been selected for statutory approval. These detailed design proposals would form part of a further consultation which would take place should any option be put forward through the statutory consent process. The detailed design would also require road safety audits as well as specific survey and other information which has not been obtained for this stage of scheme development. However, this report does support the process of option assessment during the Full Outline Business Case process in order to identify constraints, risks and opportunities in relation to different alignments.

A variety of junction arrangements and link options have been assessed giving consideration to the following:

- Priority for buses
- Impact on existing traffic
- Provision of cycle and pedestrian facilities;
- Arrangement within existing available land;
- Additional land to be purchased;
- Impact on local properties;
- Increased safety risks;
- Environmental considerations.

At the Long Road Junction and Madingley Mulch Roundabout, thirteen proposals to provide bus priority were considered, with five proposals being taken forward to be further developed with traffic modelling undertaken. Proposal 1 provides a burst through junction and realigned carriageway near to the Long Road Junction. Being remote from Madingley Mulch Roundabout reduces the impact on traffic, but requires land in the Comberton plantation area of protected trees. Proposal 4 and 5 provide busways through Madingley Mulch Roundabout. Proposal 4 proving a route through an enlarged roundabout requiring additional land and Proposal 5 using the existing roundabout circulatory but requiring buses to use the public highway resulting in unreliable journey times. Proposals 9 and 10 remove Madingley Mulch Roundabout and instead provide signalised junction arrangements with bus priority routes through the junctions. The Proposal 9 and 10 arrangements require large amounts of additional land to provide the junction layouts and traffic modelling shows the proposals would have significant detrimental impacts on traffic flows through the junction.

Between the Long Road Junction/ Madingley Mulch Roundabout and Cambridge Road Coton, four Proposals were considered to provide bus priority. Proposals 1 and 2 provide busways through the catchment area which achieve the maximum 120kph design speed over much of the length with less consideration to land boundaries and partly within the visible range of local properties in Coton village. Proposal 3 provides a busway with reduced impact on land boundaries to provide even segregation of land, but results in a lower standard of alignment with a reduced design speed. Proposal 3 is the furthest south of the four proposals placing it within the visible range of Coton properties. Proposal 4 provides a busway to the north outside of the visibility of Coton village for much of the length, this results in a lower achievable design speed than Proposals 1 and 2.

At Cambridge Road Coton, four proposals to provide bus priority across the road were considered. One proposal was taken forward for further development and junction modelling. Proposal 1 provides a signalised burst-through crossing of Cambridge Road with the addition of curved entry
and exit kerb lines to allow vehicles to enter and exit the busway from Cambridge Road for increased flexibility.

Between the Cambridge Road Coton, crossing and the M11 crossing four proposals have been considered to provide bus priority through the Coton Orchard site. Proposals 1 and 4 are positioned close to the southern and northern edges of the Coton Orchard site respectively. This reduces severance of the orchards but is in closer proximity to properties in the village. Proposals 2 and 3 provide good alignments being positioned more centrally through the orchard site, but in doing so sever the orchards.

Three proposals for positioning a bridge over the M11 to provide a bus priority link from Coton Orchard with West Cambridge have been considered. Proposal A positioned to the north provides a direct link into the West Cambridge development, aligning with Charles Babbage Road, but would impact on existing properties in the West Cambridge development. Proposal B is the centre of the three Proposals providing a link into West Cambridge, but would impact on the Datacentre property in West Cambridge. Proposal C is the southern of the three proposals with a skewed bridge linking south of the West Cambridge development. Proposal C does not link the bus route into the West Cambridge employment area but benefits from not impacting directly on the development.

Seven proposals have been considered for providing a bus priority link from the M11 crossing with routes into Grange Road via West Cambridge. Proposals 1, 4 and 5 provide direct connection with the West Cambridge development but utilise on-road sections using Charles Babbage Road and/or Ada Lovelace Road, resulting in the potential for delays and slower bus speeds. Proposals 2a and 2b provide segregated routes through the West Cambridge development via a route north of the University sports centre. Proposal 2a is aligned to land boundaries resulting in a slow speed alignment, with Proposal 2b having a smoother alignment to the east but as result it would segregate open farmland. Proposals 3a and 3b provide segregated busways to the south of the West Cambridge development that follow field boundaries but do not provide direct connection with the West Cambridge development for patrons.
1 Purpose

Skanska has been commissioned by the Greater Cambridge Partnership (GCP) to investigate the provision of a high quality busway between Cambourne and Cambridge.

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

The purpose of this report is to provide a technical review of alternative busway alignments and junction proposals along the Phase 1 section between the A1303 St Neots Road/Long Road junction and Grange Road, within the Option 3A catchment area.

The Report reviews and summarises different busway alignments and junction proposals based on a guided busway arrangement, highlighting the engineering potential for bus rapid transit provision.

The review also considers, buildability, walking and cycling, traffic management for bus priority and safety of each proposal, identifying and comparing additional land requirements.

The term proposal is used in the report to describe a potential engineering solution in specific locations. It is used to differentiate these potential interventions from the wider ‘Options’ being considered in the Full Outline Business Case.
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 and 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 1.

Figure 1. Options Published for Consultation

In October 2016 five catchment area corridor options were presented to the GCP based on the six high-level options, with the Option 3 / Option 3A catchment area identified as the preferred option to be taken forward for further development.

In October 2016 the GCP instructed further development of busway alignments and junction options within the Option 3A catchment area corridor, with Option 3 to be developed should 3A not be feasible.

The proposed Cambourne to Cambridge busway has been divided into two sections, Phase 1 and a Future Investment Programme. Phase 1 discussed in this report is aligned to Area 1 between Long Road west of Madingley Mulch Roundabout and west Cambridge.

The proposed busway aims to:
- provide a dedicated and segregated public transport route from Cambourne into Cambridge;
- offer high quality cycling and walking infrastructure along its length;
- provide a new Park and Ride site that will intercept more car journeys from the A428 into Cambridge and help reduce congestion.
This Report will provide a technical review of each junction and link proposal within Phase 1 section of the potential busway route between the St Neots Road/Long Road junction, east of the village of Hardwick, and west Cambridge, discussing technical and engineering arrangements.

Phase 1 junction and link proposals along the corridor are described from west to east. These comprise of:
- Long Road Junction and Madingley Mulch Roundabout;
- Madingley Mulch to Cambridge Road, Coton;
- Cambridge Road, Coton;
- Cambridge Road, Coton to M11;
- M11 Crossing;
- M11 to west Cambridge.

![Figure 2 Busway Catchment Area Option 3A – Phase 1 Extents Long Road to West Cambridge](image-url)
3 Approach

Each junction or link proposal will be assessed for risk and impact against a number of criteria to identify the favourable proposals. Criteria used to assess each proposal are as follows:

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<td>Pedestrian safety</td>
<td>Standard of footpath provision on pedestrians.</td>
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<tr>
<td>Cyclist safety</td>
<td>Provision/non-provision of cycle facilities on cyclists.</td>
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<tr>
<td>Bus Priority</td>
<td>Impact on bus journey times of the arrangement once completed, risk of users delays from unsegregated arrangements.</td>
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<tr>
<td>Buildability/Construction</td>
<td>Impact of site constraints, requirements for traffic management, utility diversions and working area requirements for delivering the scheme.</td>
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<td>Traffic Impact</td>
<td>Assessment of the effect on traffic flow once works have been completed and any carriageway restrictions resulting from the works.</td>
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<tr>
<td>Property Impact</td>
<td>Land take requirements, impact on residents access, disruption to residents during the construction phase.</td>
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<tr>
<td>Highway Safety</td>
<td>Consideration of the impact of the proposed proposal arrangements on junctions, carriageway alignment and the safety of all users.</td>
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Design Approach

The design approach adopted for each busway 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 (CGB), 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 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, 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.
4 Cambourne to Cambridge Better Bus Journeys Phase 1 Alignment

The proposed Cambourne to Cambridge Phase 1 busway extends between the A1303 St Neots Road/Long Road junction to the west, across the M11 south of Junction 13 and on into west Cambridge at the eastern extent, connecting with Grange Road.

The proposed route is within the preferred Option 3A corridor, positioned north of the village of Coton and south of the A1303 Madingley Road, crossing the M11 south of Junction 13. The route continues into west Cambridge to links into Grange Road.

A number of junctions and carriageway features are present along the length of the busway route which would require realignment and alteration to existing infrastructure to allow a busway to be provided and give prioritised operation of the busway that is to conform to bus rapid transit (BRT) and high quality public transport (HQPT) requirements.

For the assessment of the busway route within this report, the alignment has been broken down into junctions and links between junctions.

4.1 Guided Busway Arrangement

The intention of the Cambourne to Cambridge busway is to replicate the success of the existing CGB by delivering an equivalent standard of public transport in terms of reliability, speed and frequency.

The CGB was opened in 2011 comprising of a 42km rapid transit system linking Huntingdon, St Ives and central Cambridge. The busway consists of 25km of guideways designed to prevent access by other vehicles and 17km of on-street provision offering a fast and reliable public transport service.

The CGB guideway was constructed utilising a Britpave concrete guided busway system. The typical system detail comprises of concrete guideway tracks and raised kerbs along which guide wheels mounted to the bus steering mechanism run to direct the bus without driver steering input. Guideway drainage is provided by a sustainable filtration bed system between the guide tracks linked either to soakaways or existing drainage outfalls. Where access to the guideway isn’t available from public highways or other routes a 4 metre wide maintenance track is provided alongside the busway for emergency access and maintenance use, separated by a
verge/evacuation strip. The maintenance track is utilised to provide high quality footway/cycleway provision alongside the busway.

The busway cross section arrangement is detailed in Figure 4. To maintain consistency with the existing CGB the Cambourne to Cambridge busway assessment has been based on the Britpave guided busway system and maintenance track arrangement (Fig 4). This arrangement would provide two adjacent guideways with one operating eastbound and one operating westbound. The 4.0 metre width maintenance track alongside would be utilised as a footway/cycleway alongside the busway from Cambourne to Cambridge.

![Figure 4 – Guided Busway and Maintenance Track Arrangement](image)

### 4.2. Design Methodology

Proposed busway alignments have been designed based on the Britpave Guided Busway Design Handbook design criteria and the Design Manual for Roads and Bridges (DMRB) TD9/93 Highway Link Design. The busway guideway alignments have been designed for maximum speed and passenger comfort. In accordance with the Britpave guidance the design speed for the busway is 120kph, reducing to 50kph at guideway entrances and exits and 85kph at signalised junctions. Existing constraints along the busway impact on the alignment and the design speed accordingly. Where possible the intention of the busway alignment is to minimise severance of accesses, public footpaths, wildlife corridors and land acquisition. This report considers a selection of proposals, with the impacts assessed for each proposal.

The Britpave design guidance recommends limiting superelevation around curves to 6% for passenger comfort. This should be further limited to 3.5% where double decker buses are proposed to be used. Aligned with the existing CGB for consistency the Cambourne to Cambridge busway would be used by double decker buses, therefore the limit of 3.5% superelevation should be imposed on the design.

For the purpose of this report the assessment of the busway design speed has been based on a 2.5% assisting superelevation around curves to provide design margin when determining the design speed of each alignment. This approach means the assessment is not to be based on designing to the limiting values of 3.5%, at the risk that unforeseen constraints may arise through further development of the design. These constraints might reduce the operational speed of the busway and as a result have influenced the choice of preferred alignment at assessment stage or make the proposal unviable for further development. Once detailed design of the busway is undertaken the limiting 3.5% superelevation could be utilised to increase the design speed of the busway through sections that cannot achieve 120kph with a 2.5% superelevation.
Where the busway is to cross or transition into public highways then details provided in the Britpave design guidance and commonly used on the CGB would be constructed. At crossings signalised burst-through arrangements would be provided allowing buses to cross the public highway as a priority manoeuvre. At transitions a transition gate would be provided to hold traffic and allow buses to join the public highway as a priority manoeuvre.

4.3. Junction Review

For each junction along the busway alignment a number of initial configurations have been identified to integrate the proposed busway into the junction. A workshop was carried out on 30th January 2017 attended by Cambridgeshire County Council, Skanska and Atkins to review the initial junction arrangements, identify the positive and negative factors of each proposal and agree final proposals for development and junction capacity modelling.

A comparison of the developed junction proposals has been carried out within this report reviewing the Strengths, Weaknesses, Opportunities and Threats (SWOT) of each junction arrangement.

4.4. Link Review

For each link between junctions a number of alignments have been identified based on the assessment criteria and connectivity with different junction arrangements. The positive and negative factors of each link alignment have been reviewed as well as identifying which junction arrangements the link would provide connectivity to.

A comparison of the developed link proposals has been carried out within this report reviewing the Strengths, Weaknesses, Opportunities and Threats (SWOT) of each junction arrangement.
5 Long Road Junction and Madingley Mulch Roundabout

5.1 Existing Arrangement

The Long Road junction is a priority T junction with a give way at its intersection with St Neots Road, East of the village of Hardwick, towards the eastern extent of the A1303 St Neots Road. St Neots Road and Long Road are both single carriageway roads. St Neots Road is subject to national speed limit from the limit of Hardwick village to the west, through the junction to Madingley Mulch Roundabout. Long Road is national speed limit to its junction with St Neots Road. Due to the straight alignment of Long Road, which encourages high speeds, additional highly conspicuous signs are provided in the eastbound verge of St Neots Road opposite the end of Long Road to indicate the presence of the junction and discourage vehicles overshooting into St Neots Road. The Long Road junction is unlit.

![Figure 5 - Long Road Junction and Madingley Mulch Roundabout](image)

To the east of the Long Road junction the Madingley Mulch roundabout is positioned at the eastern end of the A1303 St Neots Road. It is an existing five arm roundabout at the intersection between the A428 Madingley Interchange and the A1303. To the north-west are two single lane links to the entry and exit slip roads of the A428 Madingley Interchange; both are subject to national speed limits. The south western arm links to the A1303 St Neots Road towards Hardwick village. To the north Church Lane connects to the village of Madingley; both roads have national speed limits. The eastern arm is the continuation of the A1303, named Madingley Road, which leads towards the city of Cambridge. The road has a 50mph speed restriction commencing to the east of the Madingley Mulch Roundabout.

Madingley Mulch Roundabout and its immediate approaches are lit by column mounted street lighting.
A footway/cycleway is present on the south side of St Neots Road, crossing Long Road via an informal junction, continuing to the south of Madingley Road Roundabout and east along Madingley Road towards Cambridge.

From the north a further footway to the east side of Church lane passes to the east of the roundabout, crossing Madingley Road via an informal crossing a short distance east of the roundabout to link to the footway/cycleway south of the Madingley Road. This footpath connects to Madingley village to the north.

Direct access is provided to a number of private properties and the Madingley Mulch business adjacent to the westbound carriageway of the Madingley Road, immediately to the east of the roundabout. 2 no existing informal bus stops are located on the A1303 Madingley Road east of the roundabout.

5.2 Existing constraints;

5.2.1 Carriageway alignment and land constraints

To the east of Long Road is a covered reservoir and associated underground infrastructure managed by Cambridge Water.

South of St Neots Road, between Long Road and Madingley Mulch Roundabout within the north eastern extent of the reservoir site are a number of telecommunication masts and a water tower.
The existing Madingley Mulch Roundabout and approaches are street lit with verge mounted lighting columns and a feeder pillar located in the south-east verge. Buried supply cabling for the street lighting is present throughout the site.

Existing buried statutory undertakers services are located throughout the location along the southern side of the A1303 St Neots Road and Madingley Road corridors. These comprise of Cambridge Water mains, and various telecommunications services. Cambridge Water and BT telecommunications assets are located within the verges of Long Road running south from St Neots Road.

11kv overhead powerlines run across Long Road, through the reservoir site and through private residential gardens south of Madingley Road. A further overhead line spurs off north crossing Madingley Road to the east of the roundabout. It is expected that services would be required to be diverted or protected to facilitate the construction of the busway to varying levels depending on the proposed junction arrangement.

5.2.2 Non motorised users

An existing footway/cycleway is provided along the south side of the A1303 St Neots Road, Madingley Mulch Roundabout and Madingley Road. A footway to the east side of Church Lane passes to the east of the roundabout. Footway provision is to be retained and where possible enhanced by any alterations required by each junction proposal.

5.2.3 Environmental

The Cambridge Water underground reservoir site is bound by trees to the west and northern sides which form part of Comberton Plantation and are protected trees (South Cambs Tree Preservation Orders).
5.3 Long Road Junction and Madingley Mulch Roundabout Proposals

5.3.1 Proposal 1 – Signalised burst-through junction on a realigned St Neots Road

The proposal would provide a burst-through style crossing for the busway, crossing St Neots Road (between the Long Road T-junction and Madingley Mulch Roundabout). The St Neots Road carriageway would be realigned to provide an improved angle of crossing. East of the burst-through the busway would continue south through the covered reservoir site, continuing south of properties in Madingley Road.

![Figure 8 – Long Road / Madingley Mulch Roundabout Proposal 1](image)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal impact on the traffic flows to Madingley Mulch Roundabout as the busway crossing would be away from the roundabout</td>
<td>Severs Comberton Plantation (South Cambs TPOs)</td>
</tr>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>The realignment of St Neots Rd provides a poorer carriageway alignment than existing, with the Long Rd junction on a bend.</td>
</tr>
<tr>
<td>Good busway alignment enabling greater speed and passenger comfort.</td>
<td>Requires a large amount of land take and carriageway realignment.</td>
</tr>
<tr>
<td></td>
<td>Close proximity of the burst-through junction to Long Road could cause delays at the junction.</td>
</tr>
</tbody>
</table>

**Outcome**

Proposal 1 has minimal impact on Madingley Mulch Roundabout traffic flows with a junction arrangement compliant with a bus rapid transit system.
Proposal 1 taken forward for development and junction modelling analysis with amendment to move the burst-through crossing further from Long Road to improve visibility and reduce congestion at the junction.
5.3.2 Proposal 2 - Signalised burst-through junction combined with signalised Long Road Junction

The proposal would provide a burst-through style crossing of St Neots Road, combined with signalisation of the Long Road junction to provide one junction arrangement. A signalised footway/cycleway crossing would be positioned to the east of the crossing. East of the burst-through the busway would continue south through the covered reservoir site and south of properties in Madingley Road.

Figure 9 – Long Road / Madingley Mulch Roundabout Proposal 2

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal impact on the traffic flows as crossing would be away from Madingley Mulch Roundabout.</td>
<td>Severs Comberton Plantation (South Cambs TPOs)</td>
</tr>
<tr>
<td>Would retain the alignment of St Neots Road as existing reducing construction costs.</td>
<td>Signalisation of Long Road combined with the burst-through arrangement giving complex junction arrangement.</td>
</tr>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Oblique angle of busway crossing would provide a large signal offset potentially making the junction ineffective which could result in traffic delays.</td>
</tr>
<tr>
<td>Good busway alignment providing enabling greater speed and passenger comfort.</td>
<td></td>
</tr>
</tbody>
</table>

Outcome
Proposal 2 not taken forward for development. The impact of having a three-way junction combined with the busway burst-through the signalised footway/cycleway crossing would potentially make the junction ineffective and result in traffic delays.
5.3.3 Proposal 3 - Signalised burst-through junction of St Neots Road

The proposal would provide a burst-through style crossing of St Neots Road. The busway is aligned to provide the shortest crossing possible. East of the burst-through the busway continues south through the reservoir site, south of properties in Madingley Road. Footway/cycleway is aligned adjacent to St Neots Road with a signalised crossing provided at the busway burst-through.

**Figure 10 – Long Road / Madingley Mulch Roundabout Proposal 3**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal impact on the traffic flows as crossing would be away from Madingley Mulch Roundabout.</td>
<td>Tight curved alignment of the busway would be required to achieve crossing of St Neots Road giving poor busway alignment.</td>
</tr>
<tr>
<td>Retains the alignment of St Neots Road as existing reducing construction costs.</td>
<td>Slow bus speed required due to unguided busway due to the tight radius required.</td>
</tr>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td></td>
</tr>
<tr>
<td>Minimises the impact on Comberton Plantation (South Cambs TPO).</td>
<td></td>
</tr>
</tbody>
</table>

**Outcome**

Proposal 3 not taken forward for development. The tight curved section north of St Neots Road to achieve a short crossing length would provide poor passenger comfort and slow bus speeds, impacting on journey times.
5.3.4 Proposal 4 – Priority busway through the centre of Madingley Mulch Roundabout

The proposal would provide an elongated Madingley Mulch Roundabout with the busway passing through the roundabout circulatory with a signalised ‘hamburger’ type arrangement. A burst-through arrangement would be provided on Madingley Road east of the roundabout to align with the busway corridor to the south of Madingley Road. The footway/cycleway would be aligned to the south away from the busway, crossing St Neots Road close to the roundabout.

**Figure 11 – Long Road / Madingley Mulch Roundabout Proposal 4**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Large area of additional land take required east of the roundabout.</td>
</tr>
<tr>
<td>Increased ability for the roundabout to cope with future increase in traffic flow.</td>
<td>Alignment positioned close to Eight Hundred Wood (SSSI).</td>
</tr>
<tr>
<td>Busway positioned north of existing highway corridor away from residential properties.</td>
<td>Requires two crossings of the highway infrastructure via two separate signalised crossings.</td>
</tr>
<tr>
<td></td>
<td>Un-signalised footway/cycleway crossing of St Neots Road.</td>
</tr>
</tbody>
</table>

**Outcome**

Proposal 4 would provide a future proof junction arrangement with well aligned busway. The arrangement requires two carriageway crossings. Proposal 4 taken forward for further development and junction modelling analysis with a revised arrangement to align the busway south of a realigned Madingley Road, to improve the busway alignment.
5.3.5 Proposal 5. On carriageway bus lane provision with signalised roundabout circulatory

The proposal would utilise the existing roundabout circulatory to route the bus through the junction within bus lanes around the existing circulatory. From the west the busway would connect to the roundabout circulatory with priority signals to hold traffic. Bus lanes are provided adjacent to Madingley Road east of the roundabout. The footway/cycleway is aligned south of the roundabout with a signalised crossing on the St Neots Road arm.

![Figure 12 – Long Road / Madingley Mulch Roundabout Proposal 5](image)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced land take required.</td>
<td>Potential delays for buses due to the on-carriageway section at the roundabout.</td>
</tr>
<tr>
<td>Would utilise on carriageway bus provision and retain existing assets reducing construction costs.</td>
<td>No provision of busway east of the roundabout, instead utilising bus lanes.</td>
</tr>
<tr>
<td>Westbound bus lane positioned outside of property accesses.</td>
<td>Requires additional crossing of Madingley Road for eastbound buses to the south of Madingley Road to link to the Option 3A corridor</td>
</tr>
</tbody>
</table>

Outcome
Proposal 5 would provide bus prioritisation utilising existing carriageway assets. Proposal 5 taken forward for further development and junction modelling analysis with revised arrangement with buses utilising the existing carriageway around Madingley Mulch without bus lanes.
5.3.6 Proposal 6 – Provision of four-way signalised cross roads with busway burst-through replacing Madingley Mulch Roundabout

The proposal would replace the existing Madingley Mulch Roundabout with a signalised junction arrangement with the busway passing through the centre of the junction. Dedicated left turn traffic lanes are provided for Madingley Road westbound to St Neots Road, and for A428 eastbound to Church Lane. A further signalised burst-through arrangement would be provided on Madingley Road to enable the busway to cross to the south. Footway/cycleway provision is via a signalised crossing facility on St Neots Road.

![Figure 13 – Long Road / Madingley Mulch Roundabout Proposal 6](image)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Would remove existing assets completely replacing the roundabout with a large signalised crossroad junction.</td>
</tr>
<tr>
<td></td>
<td>Complex junction layout unlikely to function efficiently leading to user delays.</td>
</tr>
<tr>
<td></td>
<td>Requires two crossings of the highway infrastructure via two separate signalised crossings.</td>
</tr>
</tbody>
</table>

**Outcome**
Proposal 6 not taken forward for development. The arrangement would be complex and inefficient and could potentially lead to significant user delays.
5.3.7 Proposal 7 – Replacement of the existing roundabout with a repositioned roundabout combining the busway with highway access to the land area south

The proposal would provide a repositioned Madingley Road Roundabout to combine the busway and carriageway junction into one arrangement with provision to access the site south of Madingley Road via a fifth arm, to serve a potential Park & Ride site in the location. The busway would pass through the roundabout circulatory with a signalised ‘hamburger’ type arrangement. Footway/cycleway provision would follow the busway alignment with signalised crossings provided through the centre of the roundabout.

Figure 14 – Long Road / Madingley Mulch Roundabout Proposal 7

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Significant land take required to provide new roundabout and connecting arms.</td>
</tr>
<tr>
<td>Increased ability for the roundabout to cope with future increase in traffic flow.</td>
<td>Poor utilisation of existing assets, abandoning the existing roundabout and providing a new roundabout.</td>
</tr>
<tr>
<td>Busway positioned north of the existing highway corridor away from residential properties.</td>
<td>Poor alignment of repositioned Church Lane arm due to constraints.</td>
</tr>
<tr>
<td></td>
<td>Potential negative impact of the signalised footway/cycleway arrangement on traffic flow through the junction.</td>
</tr>
</tbody>
</table>

Outcome
Proposal 7 has not been taken forward for development. Whilst the arrangement suits a potential Park & Ride site south of Madingley Road, it requires significant land area and poorly utilises existing assets.
5.3.8 Proposal 8 – Replacement of the existing roundabout with a main through road and signalised junction

The proposal would comprise of removal of the existing Madingley Mulch Roundabout with the road re-aligned to provide a direct link from the A428 to the A1303 Madingley Road. A busway burst-through would be located to the south of the junction on the St Neots Road arm of the junction. An access only road is provided to properties along the alignment of the existing Madingley Road, linking to St Neots Road via a priority T junction. Footway/cycleway provision follows the busway alignment with a signalised crossing provided adjacent to the busway burst-through.

**ADVANTAGES**
- Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.
- Good busway alignment allows increased bus speed and improved passenger comfort.
- Busway has a single crossing of the highway.

**DISADVANTAGES**
- Removes existing assets completely replacing the roundabout with a large signalised crossroad junction.
- Complex junction layout unlikely to function efficiently leading to user delays.
- Significant land take required to provide realigned Madingley Road.

**Outcome**
Proposal 8 not taken forward for development. The arrangement would be complex and inefficient and could potentially lead to significant user delays, combined with significant land area required.
5.3.9 Proposal 9 – Replacement of the existing roundabout with a main through road and two signalised junctions, Church Lane junction to the west of St Neots Road junction

The proposal would comprise of removal of the existing Madingley Mulch Roundabout with the road re-aligned to provide a direct link from the A428 to the A1303 Madingley Road. Two signalised T junctions would be provided with Madingley Road. The junction to the west would be with Church Lane, and the junction to the east with St Neots Road. A further T junction could be provided on St Neots Road for access to a potential Park and Ride site south of Madingley Road. A busway burst-through is located on the St Neots Road at its junction with Madingley Road. Footway/cycleway provision follows the busway alignment with a signalised crossing provided adjacent to the busway burst-through.

**Figure 16 – Long Road / Madingley Mulch Roundabout Proposal 9**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the CGB.</td>
<td>Removes existing assets completely replacing the roundabout with two signalised junction arrangements at a greater cost than simpler proposals.</td>
</tr>
<tr>
<td>Good busway alignment allows increased bus speed and improved passenger comfort.</td>
<td>Significant land take required to provide realigned Madingley Road.</td>
</tr>
<tr>
<td>Busway has a single crossing of the highway.</td>
<td>Concern that queueing traffic on St Neots Road could impact on any potential Park and Road access junction.</td>
</tr>
<tr>
<td>Separation of Church Lane and St Neots Road into two signalised T junctions to improve junction operation.</td>
<td></td>
</tr>
</tbody>
</table>

**Outcome**

Proposal 9 provides a future proof junction arrangement and a well aligned busway with a single crossing of the highway.

Proposal 9 taken forward for further development and junction modelling analysis with revised arrangement to align the busway burst-through further west away from the Madingley Road junction.
5.3.10 Proposal 10 – Replacement of the existing roundabout with a main through road and two signalised junctions, St Neots Road west of Church Lane

The proposal would comprise of removal of the existing Madingley Mulch Roundabout with the road re-aligned to provide a direct link from the A428 to the A1303 Madingley Road. Two signalised T junctions are provided with Madingley Road. The junction to the west with St Neots Road, and the junction to the east with Church Lane. A further T junction is provided on Madingley Road for access to a potential Park and Ride site south of Madingley Road. A busway burst-through is located on the St Neots Road arm at its junction with Madingley Road. An access road would be provided to properties on the existing Madingley Road. Footway/cycleway provision follows the busway alignment with a signalised crossing provided adjacent to the burst-through.

Figure 17 – Long Road / Madingley Mulch Roundabout Proposal 10

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Removes existing assets completely replacing the roundabout with two signalised junction arrangements at a greater cost than simpler proposals.</td>
</tr>
<tr>
<td>Good busway alignment allows increased bus speed and improved passenger comfort.</td>
<td>Significant land take required to provide realigned Madingley Road.</td>
</tr>
<tr>
<td>Busway has a single crossing of the highway.</td>
<td>Concern that the two junction arrangements are very close together and would not function efficiently.</td>
</tr>
<tr>
<td>Separation of Church Lane and St Neots Road into two signalised T junctions to improve junction operation.</td>
<td></td>
</tr>
</tbody>
</table>

Outcome
Proposal 10 provides a future proof junction arrangement and a well aligned busway with a single crossing of the highway. Proposal 10 taken forward for further development and junction modelling analysis with revised arrangement to align the Church Lane junction further to the east, away from the St Neots Road junction.
5.3.11 Proposal 11 – Replacement of the existing roundabout with a main through road, two un-signalised junctions and a new roundabout to the east.

The proposal would comprise of removal of the existing Madingley Mulch Roundabout with the road re-aligned to provide a direct link from the A428 to the A1303 Madingley Road. Two un-signalised T junctions are provided with Madingley Road for the western junction with Church Lane, and the junction to the east with St Neots Road. A three arm roundabout is provided on Madingley Road to the east to provide access to the potential Park and Ride site south of Madingley Road. A busway burst-through is located on the St Neots Road. Footway/cycleway provision follows the busway alignment with a signalised crossing provided adjacent to the burst-through.

Figure 18 – Long Road / Madingley Mulch Roundabout Proposal 11

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Removes existing assets completely replacing the roundabout with two un-signalised junctions and a new roundabout.</td>
</tr>
<tr>
<td>Junction utilises priority junctions saving the cost and maintenance requirements of traffic signals.</td>
<td>Priority T junctions are a lower standard of junction than the existing Madingley Mulch Roundabout.</td>
</tr>
<tr>
<td>Only left turn manoeuvres permitted from T junctions, greatly impacting on the function of the junction.</td>
<td></td>
</tr>
</tbody>
</table>

Outcome
Proposal 11 has not been taken forward for development. The effect of replacing the roundabout with unsignalised T junctions would cause delays to the traffic flow and would potentially have a negative impact on road user safety.
5.3.12 Proposal 12 – Signalised burst-through junction on St Neots Road/Long Road with revised alignment to provide through route with Long Road

The proposal would provide a burst-through style crossing for the busway, crossing St Neots Road/Long Road west of Madingley Mulch Roundabout. St Neots Road alignment is altered to provide a direct link with Long Road, providing a T junction to St Neots Road to the west. This gives a direct link to Comberton village. Footway/cycleway provision follows the busway alignment with a signalised crossing provided adjacent to the burst-through.

**Figure 19 – Long Road / Madingley Mulch Roundabout Proposal 12**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.</td>
<td>Concerns raised over the safety implications of introducing an un-signalised junction on a bend.</td>
</tr>
<tr>
<td>Revised alignment provides direct link to Comberton village from Madingley Mulch Roundabout.</td>
<td>Area of land required to realign the road and provide an area for junction visibility would remove most of the trees in Comberton Plantation (South Cambs TPO).</td>
</tr>
<tr>
<td>Arrangement provides a T junction to St Neots Road discouraging the use of the road as a through route.</td>
<td></td>
</tr>
</tbody>
</table>

**Outcome**
Proposal 12 has not been taken forward for development. The proposal introduces an alternative priority T junction arrangement where one already exists, with a poorer alignment than the existing Long Road junction.
5.3.13 Proposal 13 – Madingley Mulch Roundabout grade separated crossing

This proposal would provide a grade separated bridge crossing over Madingley Mulch Roundabout.

The proposed route would cross Madingley Mulch Roundabout via overbridge structures leaving the roundabout circulatory unaffected by the busway. A burst-through would be required further east of the roundabout to allow the busway to cross Madingley Road to align with the Option 3A corridor to the south.

![Figure 20 – Long Road / Madingley Mulch Roundabout Proposal 13](image)

A selection of the structural forms to provide the crossing have been considered to determine which might be suitable, outlining the advantages and potential issues associated with each one of the proposals. Refer to section 5.4 Madingley Mulch Roundabout Structure Proposals.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madingley Mulch Roundabout would be able to function as a priority junction as existing.</td>
<td>Elevated position of the busway would be visually intrusive.</td>
</tr>
<tr>
<td>Good busway alignment allows increased bus speed and improved passenger comfort.</td>
<td>Large area of additional land take required east of the roundabout.</td>
</tr>
<tr>
<td>Reduced impact on the existing highway network.</td>
<td>Significant works required with raised earthworks to align the busway over the roundabout</td>
</tr>
<tr>
<td></td>
<td>Burst-through arrangement required to align the busway to the south of Madingley Road.</td>
</tr>
</tbody>
</table>

**Outcome**

Proposal 13 has not been taken forward for development. The elevated position of the busway and the earthworks either side would require significant works and have a negative visual impact on the surrounding area.
5.4 Madingley Mulch Roundabout Structures –

5.4.1 Proposal 13 – Madingley Mulch Roundabout grade separated crossing

Initial Considerations

The proposed crossing point at Madingley Mulch Roundabout is anticipated to be an overbridge structure crossing the existing roundabout.

An underpass proposal has not been considered due to the following reasons:
- Excessive amount of soil to be excavated;
- Cost to build retaining walls;
- Required length of the underpass;
- Topographical constraints;
- Unknown soil properties at the time of writing this report.

Consequently the crossing proposal is restricted to a consideration of an overbridge only.

Grade-separated crossing of Madingley Mulch Roundabout - Overbridge

The proposed route crosses Madingley Mulch Roundabout at OS Grid Ref. (539350,259509). Different crossing proposals have been considered, the main difference between these proposals are the span length, intermediate support arrangement and the amount of land fill required to be imported/excavated.

Therefore, considering the required span lengths and the topographical information the following two structural forms have been considered:

- **Flyover Multi span Bridge**
  
  This proposal would consist of a three span continuous structure with a main span of 35m and two side spans of 30m length, with the embankment approaches constructed with imported fill.

  The superstructure could be supported on two reinforced intermediate concrete piers and seated onto reinforced concrete foundations. The abutments could be of concrete construction and supported on spread footings (subject to geotechnical investigation of underlying soil strata).

- **Two individual single span integral bridges connected by retaining walls**
  
  This proposal would consist of two individual single span integral bridges of 24m length – each, which would be connected by means of retaining walls. The integral bridges would be connected to the existing road with embankment approaches on the western side of the west integral bridge and on the eastern side of the east integral bridge. Full height frame integral abutments could be of concrete construction and supported on spread footings or founded on bored piles (subject to geotechnical investigation of underlying soil strata).

For both structures different bridge forms have been considered.

The foundation requirements would depend largely on the underlying soil strata and its associated bearing capacity. The soil conditions, and consequently specific foundation type, could only be confirmed via intrusive geotechnical ground investigation works.

Carriageway Width

A typical section 17m in width is considered for the proposed busway over the structure, taken to be 15.7m plus 0.65 parapet plinths on each side, as shown in Fig. 21.
Span Length and Structure Dimensions

The number of spans and approximate span lengths for the various crossing proposals are detailed in the table below.

<table>
<thead>
<tr>
<th>Flyover Bridge</th>
<th>Two Single Span Integral Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Spans</td>
<td>3</td>
</tr>
<tr>
<td>Span Length (m)</td>
<td>30m, 35m, 30m</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>24m, 24m</td>
</tr>
</tbody>
</table>

Table 1 - Span lengths required

Bridge Form – Proposals Considered

A number of solutions exist in terms of carrying a highway over Madingley Mulch roundabout – a selection of these are discussed below, each of these proposals are considered either for the flyover proposal or for the two individual integral bridges connected with a retaining wall.

For the purpose of this report the following bridge forms have been considered:

- Multi-Girder Composite Bridge Deck
- Ladder Bridge Deck
- Open-Box Trapezoidal Girders with in-situ top slab
- Pre-stressed Pre-Tensioned SY Beams with in-situ Concrete

The following tables summarise the advantages and disadvantages of the bridge forms considered.
Multi-Girder Composite Bridge Deck

This proposal would have a number of similar sized longitudinal plate girders arranged at uniform spacing across the width of the bridge deck which would be connected to a concrete deck slab. The composite action between the reinforced concrete deck slab and the longitudinal steel girder would be achieved by means of shear connectors welded on the top flanges of the steel girders. The deck slab would span transversely between the longitudinal girders and cantilevers transversely outside the outer girders. The girders would be braced together at supports and at intermediate positions (triangulated frame between adjacent girders).

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness – particularly effective where construction depth is limited, cost-effective solution</td>
<td>Materials – increased amount of steel in comparison with the ladder bridge deck</td>
</tr>
<tr>
<td>Ease - relatively easy to manufacture, transport to site and lift in place</td>
<td>Cost – steel girders are costly</td>
</tr>
<tr>
<td>Time - short installation duration, minimising impact on local community</td>
<td>Construction – problems during erection for the stability of the compression flanges.</td>
</tr>
</tbody>
</table>

Ladder Bridge Deck

This proposal would have two pairs of longitudinal girders with a reinforced concrete slab continuous across all four main girders. The deck slab is supported on cross girders that span transversely between the main girders. The cross girder would be connected to the transverse web stiffeners on the main girders. The cross girder over intermediate supports would be deeper than the intermediate cross girder in order to provide a stiffer pier diaphragm.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials – reduced amount of steel required, in comparison with the multi-girder proposal</td>
<td>Material cost - fabrication cost per tonne may be higher (relatively compared to the multi-girder proposal)</td>
</tr>
<tr>
<td>Less labour – use of permanent formwork reduces the reliance on labour for in-situ work (i.e. formwork construction)</td>
<td>Size - larger steel girder sections required in comparison with the multi-girder proposal</td>
</tr>
<tr>
<td>Construction – reduction in requirement for support points compared to the multi-girder proposal</td>
<td>Construction - problems during erection for the stability of the compression flanges</td>
</tr>
<tr>
<td>Time – short installation duration, minimising impact on local community</td>
<td>Maintenance - higher maintenance costs than pre-stressed concrete bridges or steel box girder proposal</td>
</tr>
<tr>
<td>Effectiveness – cost-effective solution</td>
<td>Additional design/construction – may require steel cantilevers which would have cost implications</td>
</tr>
</tbody>
</table>
Open-Box Trapezoidal Girders with in-situ top slab

This proposal would consist on two trapezoidal girders, each one of these would comprise a bottom flange, inclined steel webs and a narrow steel flange on top of each web. The closed cell would be formed by the reinforced concrete slab deck.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation – excellent high torsional stiffness, higher stability during erection and service compared to the multi-girder proposal</td>
<td>Cost - more expensive to fabricate and requires more time to design compared to plate girder</td>
</tr>
<tr>
<td>Aesthetics – excellent appearance</td>
<td>Stability - Provisions are needed to preserve stability during erection</td>
</tr>
<tr>
<td>Construction - reduction in requirement to support points compared to the multi-girder proposal</td>
<td>Increased fabrication cost - greater fabrication costs owing to the reduced scope for automated fabrication and greater difficulty of handling and rotating during fabrication and coating</td>
</tr>
<tr>
<td>Durability - improved durability and reduced maintenance of protective coatings</td>
<td>Risk - working in confined spaces (special access arrangement and more onerous requirements in terms of future internal inspection &amp; maintenance).</td>
</tr>
</tbody>
</table>

Pre-stressed Pre-Tensioned SY Beams with in-situ Concrete

This proposal would have a number of similar sized longitudinal pre-stressed pre-tensioned SY beams arranged at uniform spacing across the width of the bridge deck with the voids between the beams filled with in-situ concrete thus forming a solid deck. The SY beams were selected as these are suitable for span lengths up to of 40m.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetics – clean and aesthetic lines</td>
<td>Construction – special equipment needed for lifting pre-cast units</td>
</tr>
<tr>
<td>Cost – cost-efficient solution</td>
<td>Supervision – strict supervision required during construction</td>
</tr>
<tr>
<td>Maintenance – improved durability and reduced maintenance (i.e. no painting required)</td>
<td>Transport – special arrangement required for transportation by road of pre-cast units longer than 27.5m</td>
</tr>
<tr>
<td>Time – rapid construction and better quality control (fabrication of pre-cast units under controlled conditions).</td>
<td></td>
</tr>
</tbody>
</table>
5.4.2 Bridge Form – Discounted Proposals

In addition to the above, the following bridge forms were initially considered but were discounted for the reasons listed below:

<table>
<thead>
<tr>
<th>Form of Bridge</th>
<th>Reasons for Rejection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Truss (half-trough girders)</td>
<td>This are not recommended for Highways Bridges because of the risk of collapse due to traffic collision with the main girder. Regular maintenance required to the exposed steel.</td>
</tr>
<tr>
<td>Steel Arch Bridge</td>
<td>Increased construction cost and maintenance cost.</td>
</tr>
<tr>
<td>Pre-Stressed Post-Tensioned Beams with in-situ slab</td>
<td>Difficult to construct due to the site constraints</td>
</tr>
</tbody>
</table>

Table 2 – Discounted Bridge Proposals

5.4.3 Bridge Summary

Due to the nature of the space crossing two main structures types have been considered:
- Flyover Multi span Bridge
- Two Single Span Integral Bridges

For each one of these types, several bridge forms were considered in order to provide an efficient crossing solution at Madingley Mulch Roundabout.

The length of the structure and its approaches have been calculated, together with the land acquisition requirements and the volume of fill to be imported.

The following table summarises these values for each of the structural forms considered.

### Flyover Multi span Bridge

<table>
<thead>
<tr>
<th>Structure Length (m)</th>
<th>Approaches Length (m)</th>
<th>Land taken (m²)</th>
<th>Imported Fill (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>358</td>
<td>13000</td>
<td>52000</td>
</tr>
</tbody>
</table>

Table 3 - Flyover Multi span Bridge

### Two Single Span Integral Bridges

<table>
<thead>
<tr>
<th>Structure Length† (m)</th>
<th>Retaining Wall Length (m)</th>
<th>Approaches Length (m)</th>
<th>Land Taken (m²)</th>
<th>Imported Fill (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>42</td>
<td>332</td>
<td>11700</td>
<td>43200</td>
</tr>
</tbody>
</table>

Table 4 – Two Single Span Integral Bridges

† Note: the structure length for the two single-span comprises two single span integral bridges (i.e. 24m+24m=48m).

A multi span overbridge proposal would require further requirements from a maintenance perspective as additional costs would arise associated with expansion joints and bearings replacement. The advantages of integral construction are greater durability and lower maintenance costs when compared with jointed bridges (i.e. flyover multi span bridge).

The elevated position of the overbridge structures and the earthworks either side would require significant works and have a negative visual impact on the surrounding area.
### Summary

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Description</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Signalised burst-through junction on a realigned St Neots Road</td>
<td>Proposal 1 taken forward for further development and junction modelling</td>
</tr>
<tr>
<td>2</td>
<td>Signalised burst-through junction combined with signalised Long Road Junction</td>
<td>Proposal 2 not taken forward</td>
</tr>
<tr>
<td>3</td>
<td>Signalised burst-through junction of St Neots Road</td>
<td>Proposal 3 not taken forward</td>
</tr>
<tr>
<td>4</td>
<td>Priority busway through the centre of Madingley Mulch Roundabout</td>
<td>Proposal 4 taken forward for further development and junction modelling</td>
</tr>
<tr>
<td>5</td>
<td>On carriageway bus provision with signalised roundabout circulatory</td>
<td>Proposal 5 taken forward for further development and junction modelling</td>
</tr>
<tr>
<td>6</td>
<td>Provision of four-way signalised cross roads with busway burst-through replacing Madingley Mulch Roundabout</td>
<td>Proposal 6 not taken forward</td>
</tr>
<tr>
<td>7</td>
<td>Replacement of the existing roundabout a repositioned roundabout combining the busway with highway access to the land area south</td>
<td>Proposal 7 not taken forward</td>
</tr>
<tr>
<td>8</td>
<td>Replacement of the existing roundabout with a main through road and signalised junction</td>
<td>Proposal 8 not taken forward</td>
</tr>
<tr>
<td>9</td>
<td>Replacement of the existing roundabout with a main through road and two signalised junctions, Church Lane junction to the west of St Neots Road junction</td>
<td>Proposal 9 taken forward for further development and junction modelling analysis.</td>
</tr>
<tr>
<td>10</td>
<td>Replacement of the existing roundabout with a main through road and two signalised junctions, St Neots Road west of Church Lane</td>
<td>Proposal 10 taken forward for further development and junction modelling analysis.</td>
</tr>
<tr>
<td>11</td>
<td>Replacement of the existing roundabout with a main through road, two un-signalised junctions and a new roundabout to the east.</td>
<td>Proposal 11 not taken forward</td>
</tr>
<tr>
<td>12</td>
<td>Signalised burst-through junction on St Neots Road/Long Road with revised alignment to provide through route with Long Road</td>
<td>Proposal 12 not taken forward</td>
</tr>
<tr>
<td>13</td>
<td>Madingley Mulch Roundabout grade separated crossing</td>
<td>Proposal 13 not taken forward</td>
</tr>
</tbody>
</table>
6 Long Road Junction and Madingley Mulch Roundabout Junction Proposal Development

The Cambourne to Cambridge busway junction proposals workshop held on 30th January 2017 identified a number of preferred proposals as outlined in sections 5.3 - 5.5 of this report. These proposals have been taken forward for development including amendments and alterations identified at the workshop.

Development of each preferred proposal identifies the most suitable junction arrangement at the Long Road Junction and Madingley Mulch Roundabout, and includes the following;

- Traffic modelling of each junction arrangement for am and pm peak periods to determine the capacity at which the junction would operate;
- Safety assessment of each proposal by a qualified Road Safety Engineer.
- Construction methodology.
- Strengths Weaknesses Opportunities Threats - SWOT analysis of each proposal;
6.1 Proposal 1. - Signalised burst-through junction on a realigned St Neots Road

Arrangement

- Proposal 1 provides a burst-through junction on St Neots Road between the Long Road junction and Madingley Mulch Roundabout.
- To provide a shorter length of burst-through crossing the alignment of St Neots Road is revised to enable the busway to cross as close as possible to 90 degrees to reduce the offset distance of the signal heads, and reduce the impact of the junction on St Neots Road traffic.
- A repositioned T junction arrangement is provided with Long Road
- The Madingley Mulch Roundabout would be unaffected by the proposed junction arrangement;
- The proposed footway/cycleway would use a signalised crossing at the location of the burst-through.

![Figure 22 – Long Road / Madingley Mulch Roundabout Proposal 1 development](image)

6.1.2 Transport Modelling Assessment

Traffic modelling for Proposal 1 has been carried out for peak am and pm traffic flow periods to determine the impact of the busway on the operation of the proposed junction.

Of the five developed proposals identified for the Long Road/Madingley Mulch Roundabout Proposal 1 shows a 22% degree of saturation during am peak and 19% at pm peak which is the best performing of the proposals modelled. This is below the maximum 80% saturation defined as being the upper limit and therefore indicates the junction arrangement is operating well within capacity. The position of the burst-through junction to the west of Madingley Mulch Roundabout on St Neots Road reduces the potential to impact on traffic flows at the roundabout.
6.1.3 Safety Assessment

- There is currently a shared use footway/cycleway along the southern side of St Neots Road/Madingley Road. This provides access for residents on the southern side of the route. The new alignment of St Neots Road should also include this footway/cycleway provision.
- Traffic flows in/out of the Long Road junction need to be reviewed. There may be a need to provide a right turn lane (with associated traffic islands and double white line system to prevent overtaking) to protect right turning vehicles waiting on St. Neots Road.
- Visibility splays across the bend and at the junction need to be clear of from obstructions and maintained.

6.1.4 Construction Methodology

Proposal 1 is constructed off the line of the existing A1303 St Neots Road carriageway. The revised alignment intersects the existing St Neots Road at a number of points along its length. As a result traffic management and carriageway lane restrictions would be required on St Neots Road and Long Road to construct the realigned carriageway and the busway.

Construction activities are indicated below. The list is not exhaustive and subject to confirmation of details required from ground investigations that would be carried out during detailed design.

- Carry out site clearance of areas along the proposed realigned carriageway and busway, including necessary constraints on clearance of areas of Comberton Plantation.
- Expose and protect or divert statutory undertakers’ plant within the construction extents (preferably delivered pre works phase). Overhead power lines within the extents of the proposed realigned carriageway would need to be diverted.
- Install and maintain traffic management.
- Excavate existing ground along the proposed carriageway and busway alignments.
- Construct carriageway drainage system and install ducting for traffic signals.
- Excavate to formation level and lay sub-base.
- Install new kerbing.
- Construct carriageway, busway and footway/cycleway.
- Install traffic signal equipment
- Install traffic signs and road markings
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

6.1.5 Construction Risks

- Temporary carriageway closures and diversions of Long Road and St Neots Road would be required during the construction phase to enable the construction works to be completed, with associated Temporary Traffic Regulation Orders.
- Diversion of existing statutory undertakers’ services, including 11kV overhead power lines running east to west across the site are likely to be required.
- Consent required to remove protected trees within the Comberton Plantation.
- Habitat assessment would be required before works can be carried out in Comberton Plantation to identify any environmental or ecological mitigation works required.

6.1.6 Property and Environmental Impacts

Proposal 1 requires land take from the north area of the Cambridge Water covered reservoir site to construct the busway burst-through junction and realign St Neots Road.

The proposed busway and carriageway realignment would require removal of trees within the Comberton Plantation (South Cambs TPO) which is located to the north and west sides of the covered reservoir site.
6.1.7 Proposal 1 SWOT Assessment

**Strengths**
- Low impact on traffic flow at the Madingley Mulch roundabout.
- The use of a ‘burst through’ type detail is a simple and familiar arrangement utilised on other sections of busway in the Cambridge area;
- The alignment of the burst through allows for a short junction reducing traffic delays on St Neots Road;
- Smooth busway alignment providing greater passenger comfort;
- Safer footway/cycleway crossing and less exposure of users to the public highway than other proposals.

**Weaknesses**
- Requires a large amount of land purchase for the realignment of St Neots Road in the area of the privately owned underground reservoir site;
- The realignment of St Neots Road provides poor carriageway alignment, with the junction to Long Road being positioned on a bend - required to reduce the potential requirement for further land take;
- Loss of trees due to the road and busway alignments which cut through a large amount of Comberton Plantation.

**Opportunities**
- Potential for increased area of land purchase within the reservoir site to provide additional planting and environmental mitigation.

**Threats**
- Possible environmental constraints imposed to reduce the impact on the Comberton Plantation;
- Possible constraints on land take from the reservoir site.

**Outcome**
- Proposal 1 requires considerable alteration to the highway to provide a well aligned busway route;
- Junction modelling shows Proposal 1 to be the best performing arrangement during am and pm peak periods.
6.2 Proposal 4. Priority busway through the centre of Madingley Mulch Roundabout

6.2.1 Junction Arrangement

- Proposal 4 would provide a guided busway intersecting the Madingley Mulch roundabout with a signalised ‘hamburger’ style arrangement to allow buses to pass through the junction unobstructed;
- The roundabout circulatory would be enlarged to provide extra capacity and to assist with providing capacity required for the busway crossing;
- Stop lines would be positioned on the roundabout circulatory to hold traffic and allow priority for buses passing through the interchange without the need for signalising each roundabout arm individually, allowing the roundabout to operate as a priority junction;
- Madingley Road east of the roundabout is realigned to the north to allow the busway to be positioned south, removing the need for a further crossing of the carriageway.
- A proposed footway/cycleway crossing is provided by an un-signalised crossing of the west St Neots Road arm, reducing the potential impact of the crossing on traffic flow.

![Figure 23 - Long Road / Madingley Mulch Roundabout Proposal 4 development](image)

6.2.2 Transport Modelling Assessment

Traffic modelling for Proposal 4 shows the junction to be operating at a 36% degree of saturation during am peak which is the second lowest of the five developed proposals and the lowest of the proposals which directly affects Madingley Mulch Roundabout. The figure is below the maximum 80% saturation defined as being the upper limit, and therefore indicates the junction proposal is operating within capacity. During am peak the majority of traffic flow is from the west towards Cambridge. Traffic entering the junction from the A428 through to the A1303 Madingley Road would be unaffected by the busway operation. During PM peak the junction performs less well, with a 63% degree of saturation, below the 80% upper limit, but indicating the junction is closer to capacity. During pm peak traffic flows predominantly westbound, with traffic from the A1303 Madingley Road passing through two sets of busway signals to reach the A428, impacting on the operation of the junction.
6.2.3 Safety Assessment

- Potentially confusing layout on the northern side of the roundabout. Unclear who has priority, slip road traffic or vehicles exiting the roundabout. The layout could lead to high speed, high severity collisions.
- Close proximity of the Madingley Road (new) approach and circulatory signals could increase the risk of nose to tail collisions and road users failing to stop for the lights as they would be concentrating on looking right as they enter the circulatory.
- Existing footway around on the eastern side of the roundabout from Madingley Road (old) to Church Lane. Footway provision should be retained, including crossings on both Madingley Road new and old alignments.

6.2.4 Construction Methodology

Proposal 4 is predominantly constructed off the line of the existing A1303 Madingley Road carriageway. The traffic management and carriageway lane restrictions would be required to construct the enlarged roundabout and carriageway tie-ins to the eastern extent of the junction.

Construction activities are indicated below. The list is not exhaustive and subject to confirmation of details required from ground investigations that would be carried out during detailed design.

- Carry out site clearance of offline carriageway realignment and busway areas.
- Expose and protect or divert statutory undertakers’ plant within the construction extents (preferably delivered pre works phase).
- Construct carriageway drainage system and ducting for street lighting and traffic signals.
- Excavate to formation level and lay carriageway sub-base.
- Install new kerbing, construct bound carriageway and footpath layers.
- Site clearance of remaining vegetation, street lighting assets and street furniture to existing roundabout and at carriageway tie-in.
- Break out and excavate the existing carriageway in phased approach to allow traffic routes to be maintained
- Construct new roundabout circulatory and tie-ins to adjacent carriageway section and bus guideway section in phased approach to maintain traffic routes.
- Install street lighting, and traffic signal equipment.
- Install traffic signs and road markings
- Excavate redundant Madingley Road carriageway and carry out construction works to form access road.
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

6.2.5 Construction Risks

- Temporary traffic management comprising of lane closures, carriageway closures and diversions would be required due to the on-line nature of the scheme, with associated Temporary Traffic Regulation Orders.
- Peak traffic flows on the A428 and A1303 are likely to restrict available working hours.
- Land acquisition would be required within land areas to the east and west of Madingley Mulch Roundabout to allow construction of the busway, and the realigned Madingley Road to the east.
- The roundabout alignment would be amended, constructing into the verges north and south of the exiting roundabout, impacting of buried services within the verges, requiring diversion or protection.
6.2.6 Property and Environmental Impacts

Proposal 4 requires land take to provide a busway through Madingley Mulch Roundabout and to realign Madingley Road. Properties south of Madingley Road would benefit from being further from the Madingley Road and would be provided with an access road off the revised roundabout.
6.2.7 Proposal 4 SWOT Assessment

**Strengths**
- Increased size of roundabout circulatory providing increased capacity;
- Offline cycleway provision around the south side of the roundabout;
- Smooth busway alignment providing greater passenger comfort;
- Madingley Road realigned to provide improved approach angle into the roundabout, provides greater distance between Madingley Road and residential properties;
- Dedicated access road provided for local residential properties and the Madingley Mulch business south the roundabout.

**Weaknesses**
- Realignment of Madingley Road to the north requires land purchase.
- Busway intersecting the roundabout could negatively impact traffic flows on the busy Madingley Mulch Roundabout;
- Footway/cycleway alignment away from the busway utilises an un-signalised crossing of the St Neots arm of the roundabout;
- Potential for considerable traffic disruption during construction period.

**Opportunities**
- Upgrading of existing highway at Madingley Mulch Roundabout to improve junction capacity;
- Would provide a conspicuous presence of the busway to motorists.
- Screening could be provided for residential properties from the busway and also Madingley Road.

**Threats**
- Possible constraints on land take required for the busway alignment and realignment of Madingley Road;
- Objection from local residents & businesses.

**Outcome**
- Proposal 4 provides a future proof junction arrangement with segregated and prioritised transit for buses.
6.3 Proposal 5. On carriageway bus lane provision with signalised roundabout circulatory

6.3.1 Junction Arrangement

- Proposal 5 provides an on carriageway bus route around the Madingley Mulch roundabout with segregated busway to the west and bus lanes along Madingley Road to the east.
- Stop lines are positioned on the roundabout circulatory to hold traffic and allow priority for buses to enter the roundabout without the need for signalising each roundabout arm individually, allowing the roundabout to operate as a priority junction.
- The proposed footway/cycleway crossing is provided by a signalised crossing on the St Neots Road arm,

![Figure 24 – Long Road / Madingley Mulch Roundabout Proposal 5 development](image)

6.3.2 Transport Modelling Assessment

Traffic modelling for Proposal 5 shows the junction to be operating at a 38% degree of saturation during am peak which is the third lowest of the modelled proposals and only marginally more than Proposal 4. The figure is below the maximum 80% saturation defined as being the upper limit, and therefore indicates the junction proposal is operating within capacity. During pm peak the junction is operating at 65.9% saturation, again marginally more than Proposal 4 and third lowest of the junction proposals. As with Proposal 4 during am peak eastbound flows from the A428 to the A1303 Madingley Road would be unaffected by the busway signals. During pm peak the predominantly westbound flows would be required to pass through two sets of busway signals, resulting in poorer operation of the junction.
6.3.3 Safety Assessment

- Location of the crossings on the southern (St Neots Road) arm need to be reviewed in terms of proximity to the roundabout entry and exit. On the entry road users could fail to give way due to close proximity of the crossing to the roundabout give way line. On the exit there may be an increased risk of nose to tail collisions if vehicles waiting at the crossing queue back to the circulatory.
- The westbound guided busway exit is very close to roundabout give way line. Increased risk of collisions of road users overshooting by even a very small distance.
- Verge separator on the Madingley Road exit should be removed so that if road users enter the bus lane in error when exiting the roundabout they can then re-join the main carriageway.

6.3.4 Construction Methodology

Proposal 5 is predominantly constructed on the line of the existing Madingley Road Roundabout and Madingley Road carriageway, and as a result would require traffic management and carriageway lane restrictions to construct the arrangement.

Construction activities are indicated below. The list is not exhaustive and subject to confirmation of details required from ground investigations that would be carried out during detailed design.

- Carry out site clearance offline for construction of the busway.
- Expose and protect or divert statutory undertakers’ plant within the construction extents (preferably delivered pre works phase).
- Install and maintain traffic management.
- Site clearance of remaining vegetation, street lighting assets and street furniture.
- Excavate existing soft verge for construction of the busway.
- Construct carriageway drainage system and ducting for street lighting and traffic signals.
- Excavate to formation level and lay carriageway sub-base.
- Install new kerbing, construct bound carriageway and footpath layers.
- Install traffic signs and road markings.
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

6.3.5 Risks to Construction

- Temporary traffic management comprising of lane closures, carriageway closures and diversions would be required due to the on-line nature of the scheme, with associated Temporary Traffic Regulation Orders.
- Peak traffic flows on the A428 and A1303 are likely to restrict available working hours.
- The roundabout alignment would be amended, constructing into the verges north and south of the exiting roundabout, impacting of buried services within the verges, requiring diversion or protection.
- Construction of bus lanes within the verges of Madingley Road, may impact on buried statutory undertakers’ services with the Madingley Road verges and would effectively widen the carriageway towards properties south of Madingley Road.

6.3.6 Property and Environmental Impacts

Proposal 5 requires land take to provide a busway west of Madingley Mulch Roundabout. Properties south of Madingley Road would have the westbound bus lane constructed within the verge outside the property frontages.
### 6.3.7 Proposal 5 SWOT Assessment

#### Strengths
- Low cost proposal with buses utilising the existing Madingley Mulch Roundabout circulatory;
- Busway constructed off line of the public highway on west side of the junction;
- Roundabout functions as a priority junction rather being signalised, reducing the impact on the function of the roundabout;
- Offline cycleway provision around the south side of the roundabout.

#### Weaknesses
- Slower bus transit as buses are required to utilise the public highway.
- Buses exiting the roundabout into the busway could confuse motorists due to unfamiliar arrangement increasing the risk of authorised vehicles existing via the busway;
- Additional signalised junction to enable buses to cross Madingley Road required;
- Roundabout may not handle the required extra capacity from the busway and future traffic flows.

#### Opportunities
- Reduced costs by utilising on-road bus transit;
- Upgrading of existing highway at Madingley Mulch Roundabout to improve junction capacity.

#### Threats
- Possible constraints on land take required for the busway alignment;
- Residents and businesses may not favour the changes outside their properties and the proximity of the cycleway and bus lane to their accesses.

#### Outcome
- Proposal 5 provides a low cost junction arrangement with bus provision.
- Increased bus journey times due to the junction arrangement make it less favourable.
6.4 Proposal 9. Replacement of the existing roundabout with a main through road and two signalised junctions, Church Lane junction to the west of St Neots Road junction

6.4.1 Junction Arrangement

- Proposal 9 is a burst-through junction on St Neots Road, with the busway aligned east of properties of Madingley Road;
- Madingley Road Roundabout is entirely removed by the arrangement, replaced by two separate signalised junctions;
- The existing A1303 St Neots Road to Madingley Road link is realigned to connect the A428 Madingley Interchange slip roads to Madingley Road, to encourage the use of the A428 by through traffic.
- A further signalised junction on St Neots Road is indicated for a link to a potential Park and Ride site south on Madingley Road.

\[\text{Figure 26 – Long Road / Madingley Mulch Roundabout Proposal 9 development}\]

6.4.2 Transport Modelling Assessment

Traffic modelling of Proposal 9 shows the junction to be operating at a 78% degree of saturation during am peak and 77% of saturation during PM peak. This is the second highest of the five junction proposals and shows the junction to be operating very close to the maximum 80% saturation defined as being the upper limit. The arrangement utilising two signalised junctions in place of the Madingley Mulch Roundabout has significant impact on the operation of the junction. The busway burst-through positioned away from the main A428 to A1303 Madingley Road would have a lesser impact on the traffic flow than the signalised junctions.
6.4.3 Safety Assessment

- Replacing the Madingley Mulch Roundabout with multiple signal controlled junctions on high speed roads is likely to result in both an increased number and severity of collisions, with the potential for high speed side impact collisions.
- The need for footway/cycleway routes and crossings needs to be considered on the southern side of St. Neots Road, across both the guided busway and potential Park and Ride entrance, as well as across Madingley Road to Church Lane.
- Close proximity of the potential Park and Ride junction signals and Madingley Road signals could result in junctions becoming blocked and the increased risk of nose to tail collisions.

6.4.4 Construction Methodology

Proposal 9 is predominantly constructed off the line of the existing carriageway. Traffic management and carriageway lane restrictions would be required to construct tie-ins to the existing carriageway.

Construction activities are indicated below. The list is not exhaustive and subject to confirmation of details required from ground investigations that would be carried out during detailed design.

- Carry out site clearance of verge areas along the proposed carriageway and busway alignments.
- Expose and protect or divert statutory undertakers’ plant within the construction extents (preferably delivered pre works phase).
- Install and maintain traffic management.
- Excavate proposed carriageway alignment to level site and form haul roads.
- Construct carriageway drainage system alterations and install ducting for traffic signals and street lighting.
- Excavate to formation level and lay sub-base.
- Install new kerbing, construct bound carriageway and footpath layers.
- Install traffic signal equipment.
- Construct tie-ins to existing carriageway and footway.
- Install traffic signs, street lighting and road markings.
- Excavate existing redundant roundabout construction.
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

6.4.5 Risks to Construction

- Temporary traffic management comprising of lane closures, carriageway closures and diversions would be required. The significant alteration to the highway alignment would require long periods of closure to construct tie-ins between the existing and proposed carriageway, with associated Temporary Traffic Regulation Orders.
- Peak traffic flows on the A428 and A1303 are likely to restrict available working hours for constructing on-line works.
- Land acquisition would be required within land areas to the east and west of Madingley Mulch Roundabout to allow construction of the busway, and the new carriageway alignment.

6.4.6 Property and Environmental Impacts

Proposal 9 requires land take to provide a busway and realign the A1303 carriageways. A significant quantity of carriageway construction is required in close proximity to the Eight Hundred Wood site (SSSI) to the north of the A1303 Madingley Road, which may impose restrictions on site activities.
6.4.7 Proposal 9 SWOT Assessment

**Weaknesses**
- High cost with significant changes to the public highways at the expense of the project.
- A large area of land take required for realignment of carriageways.
- Poor performance from junction modelling with multiple signalised junctions potentially leading to delays during peak periods.
- The arrangement is close to capacity and may not handle future traffic flows.

**Strengths**
- Provides amended carriageway priority linking the A428 to the A1303 Madingley Road.
- Busway constructed off line of the public highways to the south of the junctions.
- Busway has good alignment and only one priority burst-through crossing.
- Cycleway is able to stay alongside the busway.
- Significant amount of construction is offline reducing impact on traffic flow.

**Opportunities**
- Upgrading and realignment of the A428 to Madingley Road carriageway link could allow downgrading of St Neots Road to discourage use as a through route.
- Proposal 9 provides realigned carriageways with signalised junctions and priority busway.
- The arrangement requires significant changes to the public highway, the performance of which is not supported by junction modelling analysis.

**Threats**
- St Neots Road potentially becoming congested.
- Residents and Madingley mulch may not favour the changes outside their properties.
6.5 Proposal 10. Replacement of the existing roundabout with a main through road and two signalised junctions, St Neots Road west of Church Lane

6.5.1 Junction Arrangement

- Proposal 10 would remove Madingley Road Roundabout entirely, replaced by two separate signalised junctions;
- A busway burst-through junction is provided on St Neots Road at the junction with Madingley Road.
- The existing A1303 St Neots Road to Madingley Road link is realigned to connect the A428 Madingley Interchange slip roads to Madingley Road, to encourage the use of the A428 by through traffic.
- A further signalised junction on Madingley Road is indicated for a link to a potential Park and Ride site south of Madingley Road.
- A separate access road would be provided for properties south of Madingley Road to St Neots Road.

![Figure 27 – Long Road / Madingley Mulch Roundabout Proposal 10 development](image)

6.5.2 Transport Modelling Assessment

Traffic modelling for Proposal 10 shows the junction to be operating at an 89% degree of saturation during am peak and 106% degree of saturation during pm peak which is the highest the modelled proposals. The figure is above the maximum 80% saturation defined as being the upper limit, and therefore indicates the junction proposal is over capacity and not a viable proposal. Similar to Proposal 9 the introduction of two signalised junctions in place of the Madingley Mulch Roundabout has a significant impact on traffic flow on the A428 to A1303 Madingley Road through route during peak periods. Proposal 10 however provides a busway burst-through combined with the St Neots Road junction, reducing the effectiveness of the junction, and having a significant effect on its operation.
6.5.3 Safety Assessment

- Replacing the Madingley Mulch Roundabout with multiple signal controlled junctions on high speed roads is likely to result in both an increased number and severity of collisions, with the potential for high speed side impact collisions.
- The need for footway/cycleway routes and crossings need to be considered on the southern side of St. Neots Road, across both the guided bus way and potential Park and Ride entrance, as well as across Madingley Road to Church Lane.
- Road users exiting the old stopped up section of Madingley Road may find it difficult at peak times, particularly if queues extend back from the traffic signals. This could result in the increased risk of failure to give way collisions.

6.5.4 Construction Methodology

Proposal 10 is predominantly constructed off the line of the existing carriageway. Traffic management and carriageway lane restrictions would be required to construct tie-ins to the existing carriageway.

Construction activities are indicated below. The list is not exhaustive and subject to confirmation of details required from ground investigations that would be carried out during detailed design.

- Carry out site clearance of verge areas along the proposed carriageway and busway alignments.
- Expose and protect or divert statutory undertakers’ plant within the construction extents (preferably delivered pre works phase).
- Install and maintain traffic management.
- Excavate proposed carriageway alignment to level site and form haul roads.
- Construct carriageway drainage system alterations and install ducting for traffic signals and street lighting.
- Excavate to formation level and lay sub-base.
- Install new kerbing, construct bound carriageway and footpath layers.
- Install traffic signal equipment.
- Construct tie-ins to existing carriageway and footway.
- Install traffic signs, street lighting and road markings.
- Excavate existing redundant roundabout construction.
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

6.5.5 Risks to Construction

- Temporary traffic management comprising of lane closures, carriageway closures and diversions would be required. The significant alteration to the highway alignment would require long periods of closure to construct tie-ins between the existing and proposed carriageway, with associated Temporary Traffic Regulation Orders.
- Peak traffic flows on the A428 and A1303 are likely to restrict available working hours for constructing on-line works.
- Land acquisition would be required within land areas to the east and west of Madingley Mulch Roundabout to allow construction of the busway, and the new carriageway alignment.

6.5.6 Property and Environmental Impacts

Proposal 10 requires land take to provide a busway and realign the A1303 carriageways. A significant quantity of carriageway construction would be required in close proximity to the Eight Hundred Wood site (SSSI) to the north of the A1303 Madingley Road, which may impose restrictions on site activities.
6.5.7 Proposal 10 SWOT Assessment

**Strengths**
- Provides amended carriageway priority linking the A428 to the A1303 Madingley Road.
- Busway constructed off line of the public highways to the south of the junctions.
- Busway has good alignment and only one priority burst-through crossing.
- Cycleway is able to stay alongside the busway.
- Significant amount of construction is offline reducing impact on traffic flow.

**Weaknesses**
- High cost with significant changes to the public highways at an expense to the project.
- A large area of land take required for realignment of carriageways.
- Poor performance from junction modelling with multiple signalised junctions potentially meaning the proposal is unviable based on junction modelling analysis.

**Opportunities**
- Upgrading and realignment of the A428 to Madingley Road carriageway link could allow downgrading of St Neots Road to discourage use as a through route.

**Threats**
- St Neots Road potentially becoming congested.
- Residents and Madingley Mulch may not favour the changes outside their properties.

**Outcome**
- Proposal 10 provides realigned carriageways with signalised junctions combined with a priority busway.
- The proposal requires significant changes to the public highway, the junction modelling analysis indicates poor performance during peak periods.
6.6 Long Road Junction and Madingley Mulch Roundabout Junction Summary

Proposal 1 would provide a simple burst-through junction arrangement away from Madingley Mulch Roundabout reducing the impact on traffic flow. The required realignment of St Neots Road to provide a suitable crossing for the busway would require additional land area and would have a greater impact on the Comberton Plantation. The benefit of the realigned St Neots Road is an alignment that may assist in reducing vehicle speeds on St Neots Road through the Long Road junction.

Proposal 4 would provide an enlarged Madingley Road Roundabout circulatory to enable a ‘hamburger’ arrangement to be constructed with the busway running through the centre of the roundabout, and a realigned Madingley Road arm to the east. This arrangement would provide a greater capacity to the roundabout helping to reduce the impact of the busway on the public highway.

Proposal 5 would utilise the existing Madingley Road Roundabout circulatory with a low cost proposal but would not provide any additional capacity to the roundabout. Proposal 5 would not provide a segregated busway through the roundabout and would therefore present a risk to journey time reliability for buses from traffic congestion at the junction.

Proposals 9 and 10 would completely remove Madingley Mulch Roundabout, replacing it with signalised junction arrangements with priority burst-through busways, and also reconfiguring the existing carriageway alignment to provide a direct link between the A428 and the A1303 Madingley Road. The proposals provide good busways through the junction but at the detriment of traffic flow on the A1303/A428. Junction modelling shows that neither proposal would perform well during peak periods and are likely to result in traffic delays.

In summary Proposals 1, Proposal 4, Proposal 9 and Proposal 10 would provide segregated bus priority junctions. Proposal 1 would provide the junction away from Madingley Mulch Roundabout reducing the impact of the busway on the A428 to A1303 Madingley Road route into Cambridge. Proposals 9 and 10 would remove Madingley Mulch Roundabout, replacing it with signalised junction arrangements, having a negative impact on traffic flow through the junction. Proposals 9 and 10 would have greater cost due the amount of carriageway realignment required. Proposal 5 would not provide bus priority through the junction making it susceptible to delay.
7 Long Road/Madingley Mulch to Cambridge Road, Coton Link

7.1 Existing Arrangement

The Option 3A busway corridor between Long Road/Madingley Mulch and Cambridge Road, Coton is located in the area known as Madingley Hill. The area is predominantly arable farmland with the village of Coton to the south. To the north is the A1303 Madingley Road, with a commercial business park – Crome Lea Business Park. Further east a number of large residential properties are located at discrete locations along the length, some with grounds extending south towards the busway corridor. The link is 2km in length.

Mid-way between Madingley Mulch and Cambridge Road the open farmland is divided by an underground reservoir to the south, near the village of Coton, and the grounds of Coton Court. A narrow strip of land is provided between the grounds and the reservoir to connect the agricultural fields either side. The area of Coton Court’s grounds at the southern end of the property is divided into small holding plots.

The Option 3A busway route looks to utilise alignments through the area of open land between the Long Road/Madingley Mulch and Cambridge Road Coton. There are a number of alignment proposals available between junctions through the area. To reduce the impact on land through which the busway alignment would pass and avoid excessive land segregation the link alignments have been based on achieving good alignment and following boundaries and the edge of land areas where possible to reduce land-take requirements. Sight lines have also be considered to reduce the visibility of the proposed infrastructure from surrounding residential properties. For each link proposal the junction proposals with which they align have been identified.
7.2 Existing constraints

7.2.1 Carriageway alignment and land constraints

The area of land to the north is constrained by grounds belonging to Coton Court private residential property. At time of writing the southern extent of this land has been established as four small holding plots and paddocks containing live stock. The land further north comprises of the grounds to Coton Court and is laid to lawn.

The area to the south at Coton is constrained by a covered reservoir and associated infrastructure managed by Cambridge Water. The reservoir is located directly south of Coton Court grounds with an environmental margin provided between, which can be utilised to connect agricultural land either side of Coton Court.

Existing buried statutory undertakers' services are located within the area. A Cambridge Water main traverses the land connecting the underground reservoir adjacent to Long Road with the reservoir at Coton. An underground UK Power Network main runs from properties south of Madingley Mulch Roundabout to the Coton reservoir, returning north along the eastern boundary of Coton Court. National Grid Low Pressure Gas and Cambridge Water mains are located along the Cambridge Road corridor at the eastern extent of the link.

7.2.2 Non motorised users

An existing Public Right of Way is present running along the eastern boundary of the Coton Court property, linking the A1303 Madingley Road to the north, with the village of Coton to the south. This Public Right of Way would be required to cross the busway where it meets with any proposed busway alignment.

7.2.3 Environmental

There are no statutory environmental designations on the land area identified for the busway. Land within the extent of the link between Long Road/Madingley Mulch and Cambridge Road Coton is generally arable farmland.
7.2.4 Link alignment development

Early stage busway alignments identified for the section between Long Road/Madingley Mulch and Cambridge Road were designed to commence east of properties at Madingley Mulch Roundabout and to align to the south of the Option 3A corridor to run south of Coton Court and north of the Coton Reservoir, link to Cambridge Road Coton north of Coton village.

Further development of the proposals was carried out in spring 2017 to smooth potential busway alignments to ensure that maximum design speed for the busway (120kph) could be achieved to provide bus rapid transit. The potential to provide busway alignments through the Cambridge Water owned covered reservoir site east of the Long Road junction provided additional alignment proposals to avoid impacting directly on Madingley Mulch Roundabout and allow busways to traverse the Madingley Hill at a more gradual angle and to assist with achieving 120kph design speed.

An assessment of the visibility envelope from Coton village has been carried out by consultants Atkins to help inform the busway alignment designs. Designs have been adjusted to provide proposals to the north of the Option 3A corridor to reduce the potential visual impact on residential properties in Coton village.

Four potential busways proposals have been identified and are discussed in this report based on potential design speed and land/environmental impacts.
7.3 Madingley Mulch to Cambridge Road Coton, Link Proposals

Proposal 1 – Busway aligned to the north designed for high operational speeds.

- The proposal would provide a busway from Long Road/Madingley Mulch Roundabout at the western end through to Cambridge Road, Coton. The link would be aligned towards the north to be positioned outside of the visibility envelope of Coton village.
- At the western end, junction proposals which traverse the A1303 at the Long Road junction through the reservoir site align with this link to the south of residential and business at Madingley Mulch Roundabout. An alternative alignment to the east of the properties would be required to connect to Madingley Mulch junction proposals.
- The alignment cuts through the small holding/paddock area at the southern end of Coton Courts grounds linking to a busway crossing of Cambridge Road.
- The proposed footway/cycleway follow adjacent to the busway the full length.

![Figure 30 – Long Road/Madingley Mulch to Cambridge Road, Coton Link - Proposal 1 Alignment](image)

7.3.1 Link Alignment

The alignment of the Proposal 1 (green) link has been designed to achieve the maximum design speed with consideration to property boundaries and being positioned to the north to be outside of the visibility of the village of Coton. Due to constraints of the Long Road reservoir and adjacent properties south of Madingley Road, the link from the Long Road junction proposals provides an 820m radius giving a 70kph design speed. Alternative alignments are required to connect with Madingley Mulch junction proposals. East of the Madingley Mulch properties the alignment provides radii in excess of 2040m, providing a maximum 120kph design speed based on a guideway constructed with a 2.5% super-elevation as detailed in section 2 of this report. The busway cuts across the small holding/paddock area south of Coton Court to maintain alignment for maximum design speed, connecting to a northern positioned busway crossing of Cambridge Road, Coton. The alignment crosses both the Cambridge Water main and the UKPN underground supply requiring localised protection or diversionary works.
7.3.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

7.3.3 Construction Risks
- Land acquisition required from the privately owned covered reservoir site and the Coton Court small holding area.
- Diversionary works may be required to cross the large Cambridge Water underground main which traverses the Madingley Hill between Long Road Reservoir and Coton Reservoir

7.3.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 1 (green) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 1 busway would be aligned. Assessment of sightlines from Coton village show the alignment to be outside of the visibility of most of the village, with the exception of the eastern section to the west of the crossing of Cambridge Road.

The alignment would cut through the area of land at the south of the Coton Court property utilised as a holding/paddock area, requiring the land to be acquired to construct the busway.

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<tr>
<th>Junction Proposals Compatible</th>
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<td>Junction proposals compatible</td>
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<tr>
<td>Junction proposals not compatible</td>
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7.3.5 Proposal 1 SWOT Assessment

- **Strengths**
  - Good alignment providing 120kph + design speeds for the majority of the route between junction Proposals.
  - Positioned outside of Coton village visibility aligning with the topography of the land.

- **Weaknesses**
  - Traverses the area without consideration to existing land boundaries and land segregation.
  - Requires acquisition of the Coton Court small holding/paddock area.
  - Positioned close to Coton Court garden boundary.

- **Opportunities**
  - Provision of additional landscaping and screening along the busway corridor to enhance the environment.
  - Area of land segregated by the busway could be acquired for environmental improvement or public amenity.

- **Threats**
  - Land purchase required from the Coton Court.

**Outcome**
- Proposal 1 provides smooth alignment and reduced visual impact.
- The arrangement segregates land and with a less favourable crossing alignment of Cambridge Road which creates land parcels.
7.4 Proposal 2 – Busway aligned for high operational speeds, with reduced alignment towards Cambridge Road, Coton

- The proposal would provide a busway from Long Road/Madingley Mulch Roundabout at the western end through to Cambridge Road, Coton and is aligned towards the north to be positioned outside of the visibility envelope of Coton village whilst maintaining the smoothest alignment achievable.
- At the western end, junction proposals which traverse the A1303 at the Long Road junction through the reservoir site align with this link to the south of residential and business at Madingley Mulch Roundabout. An alternative alignment to the east of the properties would be required to connect to Madingley Mulch junction proposals.
- The alignment cuts through the small holding/paddock area at the southern end of Coton Court’s grounds linking to a southern positioned busway crossing of Cambridge Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

Figure 32 - Long Road/Madingley Mulch to Cambridge Road, Coton Link - Proposal 2 Alignment

7.4.1 Link Alignment

The alignment of the Proposal 2 (Blue) link has been designed to achieve the maximum design speed whilst maintaining a position north of the visibility envelope of the village of Coton. Due to the constraints of the Long Road reservoir and adjacent properties south of Madingley Road at the Madingley Mulch Roundabout, the link from Long Road junction proposals provide a 1020m radius giving an 85kph design speed, in doing so this brings the busway close to the Madingley Mulch property. Alternative alignments are required to connect with Madingley Mulch junction proposals. East of the Madingley Mulch properties the alignment provides a straight guideway alignment to provide a maximum 120kph design speed placing the alignment close to the Coton Court property garden boundary. The busway cuts across the small holding/paddock area south of Coton Court to maintain maximum design speed. To the eastern extent of the link alignment the design speed reduces to 85kph with a corresponding 1180m radius. This alignment provides connection to a southern Cambridge Road busway crossing position closer to properties in...
Cambridge Road, reducing the creation of land parcels along Cambridge Road. The alignment crosses both the Cambridge Water main and the UKPN underground supply requiring localised protection or diversionary works.

7.4.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

7.4.3 Construction Risks
- Land acquisition required from the privately owned covered reservoir site and the Coton Court small holding area.
- Diversionary works may be required to cross the large Cambridge Water underground main which traverses the Madingley Hill between Long Road Reservoir and Coton Reservoir.

7.4.4 Property and Environmental constraints

A search of environmental designations for the proposed Proposal 2 (Blue) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 2 busway would be aligned. Assessment of sightlines from Coton village show the alignment to be outside of the visibility of most of the village, with the exception of the eastern section to the west of the crossing of Cambridge Road.

The alignment would cut through the area of land at the south of the Coton Court property utilised as a holding/paddock area, requiring the land to be acquired to construct the busway.

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<th>Junction Proposals Compatible</th>
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<tbody>
<tr>
<td>Junction proposals compatible</td>
</tr>
<tr>
<td>o Long Road/Madingley Mulch – All (subject to alternative connecting alignments)</td>
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<tr>
<td>o Cambridge Road – Southern junction positions</td>
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<tr>
<td>Junction proposals not compatible</td>
</tr>
<tr>
<td>o Long Road/Madingley Mulch – None</td>
</tr>
<tr>
<td>o Cambridge Road – Northern junction positions</td>
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</table>
7.4.5 Proposal 2 SWOT Assessment

**Weaknesses**
- Traverses the area without consideration to existing land boundaries, land segregation or topography.
- Requires acquisition of the Coton Court small holding/paddock area.
- Positioned close to Coton Court garden boundary.

**Strengths**
- Good alignment providing 120kph + design speeds for the majority of the route between junction proposals with few curves, improving passenger comfort.
- Positioned outside of Coton village visibility.
- Aligns favourably with Cambridge Road crossing alignments, limiting segregation of land on the edge of Coton village.

**Opportunities**
- Provision of additional landscaping and screening along the busway corridor to enhance the environment.
- Area of land segregated by the busway could be acquired for environmental improvement or public amenity.

**Threats**
- Land purchase required from the Coton Court.

**Outcome**
- Proposal 2 provides smooth alignment and reduced visual impact, aligning with a southern crossing position on Cambridge Road.
- Segregates land and the linear alignment could be more intrusive to the landscape.
7.5 Proposal 3 – Busway aligned to limit land take.

- The proposal would provide a busway from Long Road/Madingley Mulch Roundabout at the western end through to Cambridge Road, Coton, and is aligned to land boundaries where possible to prevent creating slivers of land through segregation of the area.
- At the western end, junction proposals which traverse the A1303 at the Long Road junction through the reservoir site align south of residential and business properties at the Madingley Mulch Roundabout, with the link alignment designed to be distant from Madingley Mulch property boundaries. An alternative alignment to the east of the properties would be required to connect to Madingley Mulch junction proposals.
- The alignment avoids the small holding/paddock area at the southern end of the Coton Court grounds, utilising the existing environmental margin between Coton Court and the Coton reservoir.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 34 - Long Road/Madingley Mulch to Cambridge Road, Coton Link - Proposal 3 Alignment](image)

7.5.1 Link Alignment

The alignment of the Proposal 3 (Red) busway has been designed to achieve the maximum use of available land whilst avoiding impacting on property boundaries. The resulting alignment has reduced design speeds and is positioned further south than other proposals, encroaching into the visibility envelope of Coton village. To maintain a minimum of 50m clearance from boundaries to properties on Madingley Road at Madingley Mulch Roundabout, the Proposal 3 route alignment has been aligned to the south. The resulting curve in the alignment utilises a 330m radius which provides a design speed of below 50kph with a 2.5% superelevation, and a 50kph speed limit with a 3.5% superelevation. To align with the environmental margin south of Coton Court, radii of 405m and 430m are utilised respectively providing a design speed of 50kph based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this report.

![Figure 35 Proposal 3 Busway Section](image)
This alignment provides connection to a southern Cambridge Road busway crossing position closer to properties in Cambridge Road, reducing the creation of land parcels along Cambridge Road. The alignment crosses both the Cambridge Water main and the UKPN underground supply requiring localised protection or diversionary works.

7.5.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

7.5.3 Construction Risks
- Land acquisition required from the privately owned covered reservoir site and the Coton Court small holding area.
- Diversionary works may be required to cross the large Cambridge Water underground main which traverses the Madingley Hill between Long Road Reservoir and Coton Reservoir.

7.5.4 Property and Environmental constraints

A search of environmental designations for the proposed Proposal 3 (Red) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 3 busway is aligned. Assessment of sightlines from Coton village show the alignment to be within of the visibility of the village where the alignment is positioned south to utilise the environmental margin in addition to the area towards the crossing of Cambridge Road. The alignment does not impact on the Coton Court land utilised as a holding/paddock area.

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<th>Junction Proposals Compatible</th>
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<td>Junction proposals not compatible</td>
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7.5.5 Proposal 3 SWOT Assessment

**Strengths**
- Traverses the area with consideration to existing land boundaries, land segregation and topography.
- Utilises environmental strip between Coton Court and Coton reservoir.
- Aligns favourably with Cambridge Road crossing alignments, limiting segregation of land on the edge of Coton village.
- Reduces the segregation of land areas into small plots.

**Weaknesses**
- Alignment provides a slow design speed not in line with the requirements of bus rapid transit.
- Positioned within Coton village visibility.

**Opportunities**
- Provision of additional landscaping and screening along the busway corridor to enhance the environment.

**Outcomes**
- Proposal 3 is aligned to prevent segregation of land.
- The proposal has numerous curves to align with land boundaries resulting in low design speeds, and falls within the visibility of Coton village.

**Threats**
- Objections from local residents as busway alignment would be within the view of Coton village.
7.6 Proposal 4 – Busway aligned to the north to limit land take

- The proposal would provide a busway from Long Road/Madingley Mulch at the western end and is aligned to the most northern extent of the Option 3A busway corridor.
- The alignment links with junction proposals through Madingley Mulch Roundabout, aligning to the east of properties at the Madingley Mulch Roundabout and west of the Crome Lea Business Park.
- The alignment cuts through the small holding/paddock area at the southern end of Coton Courts grounds linking to a northern positioned busway crossing of Cambridge Road.
- The proposed footway/cycleway follows adjacent to the busway the full length of the busway.

![Figure 36 - Long Road/Madingley Mulch to Cambridge Road, Coton Link - Proposal 4 Alignment](image)

7.6.1 Link Alignment

The alignment of the Proposal 4 (Pink) link has been designed to position the busway as far north within the busway Option 3A corridor as possible and therefore reduce the impact of the busway on properties. The resulting alignment has reduced design speeds and is positioned further north than other proposals. The proposal is compatible with less junction proposals at the Long Road/Madingley Mulch Roundabout to prevent the alignment running south of residential properties at the junction. From Madingley Road the alignment utilises a 1020m radius which provides a design speed of below 85kph with a 2.5% superelevation, this aligns across the small holding/paddock area south of Coton Court based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report.

This alignment provides connection to a north Cambridge Road busway crossing position which would position the busway close to the Coton Orchard garden centre, being in closer proximity to the property but reducing severance of the orchard. The alignment crosses both the Cambridge Water main and the UKPN underground supply requiring localised protection or diversionary works.

![Figure 37 Proposal 4 Busway Section](image)
7.6.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

7.6.3 Construction Risks
- Land acquisition required from the privately owned covered reservoir site and the Coton Court small holding area.
- Diversionary works may be required to cross the large Cambridge Water underground main which traverses the Madingley Hill between Long Road Reservoir and Coton Reservoir.

7.6.4 Property and Environmental constraints
A search of environmental designations for the proposed Proposal 4 (Pink) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 4 busway would be aligned. Assessment of sightlines from Coton village show the alignment to be outside of the visibility of most of the village, with the exception of the eastern section to the west of the crossing of Cambridge Road. The alignment would cut through the area of land at the south of the Coton Court property utilised as a holding/paddock area, requiring the land to be acquired to construct the busway.

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<th>Junction Proposals Compatible</th>
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<tr>
<td>Junction proposals compatible</td>
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<tr>
<td>o Long Road/Madingley Mulch – Proposals 4, 5, 8 &amp; 9</td>
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<tr>
<td>o Cambridge Road – Northern junction position</td>
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<tr>
<td>Junction proposals not compatible</td>
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<tr>
<td>o Long Road/Madingley Mulch – Proposal 1</td>
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<tr>
<td>o Cambridge Road – Southern junction position</td>
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### Proposal 4 SWOT Assessment

<table>
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<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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| - Aligns the busway to the northern boundary of the busway corridor to position it as far from the main residential area (Coton village) as possible.  
- Positioned outside of Coton village visibility. | - Reduced design speed to provide the northern alignment.  
- Aligns with a northern Cambridge Road crossing position which would be in closer proximity to the garden centre.  
- Compatible with fewer junction arrangements at Long Road/Madingley Mulch Roundabout |

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<tr>
<th>Opportunities</th>
<th>Threats</th>
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| - Provision of additional landscaping and screening along the busway corridor to enhance the environment. | - Objections from local residents as alignment is within their view.  
- Land purchase required from the Cotn Court. |

### Outcome
- Proposal 4 has reduced visual impact in relation to other proposals.  
- The proposal aligns with a northern crossing position on Cambridge Road and could be more intrusive to Coton Orchard garden centre.
7.7 Madingley Mulch to Cambridge Road, Coton Link Summary

Proposal 1 (Green) and Proposal 2 (Blue) provide smooth alignments through the Option 3A busway corridor to achieve higher design speeds and are positioned to be outside of the visible area from Coton village through much of the length of the links. The links require land acquisition from the area at the southern extent of Coton Court.

Proposal 1 (Green) would provide a higher design speed alignment at the Cambridge Road, Coton approach than Proposal 2 (Blue), but would require the crossing of Cambridge Road to be in a less favourable position further north, segregating land to the west of Cambridge Road and favouring a crossing position which would segregate the Coton Orchards to the east.

Proposal 3 (Red) is aligned to reduce the impact of the busway on property boundaries. The limitation of the alignment is that to align south of the Coton Court small holding area the busway would be within the visible range of Coton village, increasing the impact of the busway on the village. The curving alignment would provide low design speeds less appropriate for bus rapid transit.

Proposal 4 (Pink) provides a busway alignment than would reduce the visual impact of the route of Coton village but with a reduced design speed to enable the alignment to be provided. The proposal would link with a crossing of Cambridge Road positioned north away from Coton village.

In summary Proposals 1 and 2 would provide segregated busways achieving the maximum 120kph design speed over much of the link, with reduced consideration to land boundaries and visibility from local properties. Proposal 3 would have a reduced impact on land boundaries and provide even segregation of land, but would provide a lower standard of alignment with a reduced design speed. Proposal 4 positions the busway away from the visibility of Coton village, this results in a lower design speed than Proposals 1 and 2. As with Proposals 1 and 2 the alignment of Proposal 4 gives less consideration to land boundaries.
8 Cambridge Road, Coton

8.1 Existing Arrangement

Cambridge Road Coton is a single two way carriageway linking the village of Coton to the south with the A1303 Madingley Road to the north. Cambridge Road has a straight alignment within the area of the proposed busway crossing. The speed limit is 30mph.

To the east of Cambridge Road is Coton Orchard nursery with an access road junction to the garden centre at the site. To the south of the proposed busway crossing are residential properties located along Cambridge Road within Coton village; these are set back from the road with gardens fronting the carriageway. A number of the properties utilise on street parking. A footway is located on the western side of Cambridge Road linking Coton to the south with the A1303 Madingley Road to the north.

Figure 38 - Cambridge Road, Coton

Figure 39 - Cambridge Road, Coton – looking north
8.2 Existing constraints

8.2.1 Carriageway alignment and land constraints

To the east and west sides of Cambridge Road, south of the proposed busway crossing are residential properties at the northern extent of the Coton residential area. The alignment of the busway would run parallel to the property and gardens of most northerly properties which are currently bounded to the north by open fields on the west side and the Coton Orchard on the east side.

To the east side of Cambridge Road is the Coton Orchard and nurseries. The busway crossing would pass directly into the Coton Orchards requiring land acquisition from within the orchard boundary.

Existing buried statutory undertakers' services are located to the west side of Cambridge Road running parallel to the carriageway. These comprise of National Grid gas low pressure mains and Cambridge Water. Column mounted street lighting is provided to the west side of Cambridge Road, with electrical supply cabling buried within the verge. It is expected that services would be required to be diverted or protected to facilitate the construction of the busway to varying levels depending on the proposed junction arrangement. Detailed investigation into the exact position and depth of the services would need to be undertaken during detailed design stage to provide the appropriate mitigation works.

8.2.2 Non motorised users

An existing footway is provided on the west side of Cambridge Road connecting Coton with the A1303. Footway provision is to be retained and where possible enhanced in the vicinity of the busway crossing.

8.2.3 Environmental

A search of environmental designations along Cambridge Road within the extent of Option 3A busway corridor has found no statutory designations assigned to the area.
8.3 Cambridge Road Proposal 1

8.3.1 Proposal 1 – Provision of a burst-through busway junction on Cambridge Road with curved entry and exit kerbing

The proposal uses a burst-through junction on Cambridge Road with curved entry and exit kerb lines to enable buses to turn into and out of the busway from Cambridge Road. The crossing is located close to the edge of the Coton village most northerly properties within Cambridge Road. Footway/cycleway provision follows the busway alignment with signalised crossings provided at the burst-through crossing.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing Cambridge Guided Busway.</td>
<td>Busway in close proximity to residential properties.</td>
</tr>
<tr>
<td>Curved entry and exit kerb lines enable buses to enter and exit the guideway from Cambridge Road increasing flexibility.</td>
<td>Northbound stop line close to property accesses, queuing vehicles may block accesses whilst the crossing is in use.</td>
</tr>
<tr>
<td>Minimises land take keeping the busway alignment close to property boundaries.</td>
<td></td>
</tr>
</tbody>
</table>

Outcome
Proposal 1 provides flexibility with minimal land take.
Proposal 1 taken forward for further development and junction modelling analysis.
8.3.2 Proposal 2 – Provision of a burst-through busway crossing of Cambridge Road

The proposal would use a burst-through busway crossing on Cambridge Road. The crossing is located close to the edge of the Coton village and the most northerly properties within Cambridge Road. Footway/cycleway provision follows the busway alignment with signalised crossings provided at the burst-through crossing.

![Figure 41 – Cambridge Road Coton - Proposal 2](image)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing Cambridge Guided Busways.</td>
<td>Busway in close proximity to residential properties.</td>
</tr>
<tr>
<td>Minimises land take keeping the busway alignment close to property boundaries.</td>
<td>Non provision of curved entry and exit kerb lines restricts burst-through to a crossing of Cambridge Road only, reducing flexibility of the arrangement.</td>
</tr>
<tr>
<td>Position of the stop line close to the burst-through allows greater queuing length northbound, reducing the potential for queuing vehicles across property accesses.</td>
<td></td>
</tr>
</tbody>
</table>

Outcome
Proposal 2 has not been taken forward for development. The arrangement is less flexible than other proposals, providing only a crossing of Cambridge Road.
8.3.3 Proposal 3 – Provision of a burst-through busway crossing of Cambridge Road positioned 40m north of Coton village properties

The proposal uses a burst-through busway crossing on Cambridge Road. The crossing is located north of the edge of the Coton village, passing into the Coton Orchard area east of Cambridge Road. Footway/cycleway provision follows the busway alignment with signalised crossings provided at each burst-through crossing.

![Figure 42 – Cambridge Road Coton - Proposal 3](image)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burst-through type detail is a simple and familiar arrangement utilised on the existing Cambridge Guided Busways.</td>
<td>Greater segregation of agricultural land to the west of Cambridge Road.</td>
</tr>
<tr>
<td>Position of busway is away from residential properties at the northern extent of Coton village and allows a greater queuing length northbound.</td>
<td>Greater segregation and impact on Coton Orchard east of Cambridge Road.</td>
</tr>
<tr>
<td>Locations of the burst-through allows for smoother busway alignment either side of the crossing.</td>
<td>Non provision of curved entry and exit kerb lines restricts burst-through to a crossing of Cambridge Road only, reducing flexibility of the arrangement.</td>
</tr>
</tbody>
</table>

**Outcome**
Proposal 3 has not been taken forward for development. The arrangement is less flexible than other proposals, providing only a busway crossing of Cambridge Road, and has greater land take requirements.
8.3.4 Proposal 4 – Cambridge Road, Coton - Structure Crossing

The proposal would provide a grade-separated bridge crossing over or under Cambridge Road. The crossing would be located north of the edge of the Coton village positioned to reduce the impact of the structure on properties within Cambridge Road. The structure would pass into the Coton Orchard area east of Cambridge Road. Footway/cycleway provision follows the busway alignment.

At the location considered, Cambridge Road has a width of 6m with a designated footway 1.5m to the west. The combined width of the carriageway and footway is 7.5m. The site is generally at grade.

![Figure 43 – Cambridge Road Coton - Proposal 4](image)

A selection of the structural forms to provide the crossing have been considered to determine which might be suitable, outlining the advantages and potential issues associated with each one of the proposals. Refer to section 8.4 Cambridge Road Structure Proposals.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segregation of busway from Cambridge Road traffic.</td>
<td>Technically more challenging than other proposals at the location.</td>
</tr>
<tr>
<td>Smooth busway alignment achieving maximum design speed (120kph)</td>
<td>High costs from construction of new structure over/under Cambridge Road.</td>
</tr>
<tr>
<td>Construction of earthworks embankments (overbridge) or cuttings (underbridge) required on both sides of Cambridge Road due to the at-grade topography of the site – increasing the footprint of the arrangement and the required land required.</td>
<td>Visually intrusive to properties in Coton and requires greater land acquisition from Coton Orchard than other proposals.</td>
</tr>
</tbody>
</table>

**Outcome**
Proposal 4 has not been taken forward for development. The earthworks required to align the busway over or under the structure and the impact on surrounding land and properties make the proposal unfavourable. Cambridge Road has low traffic flows and provision of a structure to carry the busway over the road is deemed to be excessive.
8.4 Cambridge Road, Coton Structures -

8.4.1 Proposal 4 – Cambridge Road, Coton - Structure Crossing

Initial considerations

The proposed crossing point at Cambridge Road is anticipated to be a grade-separated arrangement, i.e. an overbridge or underpass.

Grade – separated crossing of St Neots Road

The proposed route crosses Cambridge Road at OS Grid Ref. (541188, 259089). The width of the carriageway and footway 7.5m. The alignment of the crossing allows for minimal skew (<10°).

For the overbridge proposal, a minimum 1.2m set-back from the existing carriageway has been assumed for the abutments / support members on each side. A conservative estimate for the span length, allowing for skew, set-back and construction activities is therefore taken as 12m.

For an underpass the skew is negligible, however the length would be marginally longer to allow for side slope of the soil cover to the structure. With 1 in 3 slope at the edge of carriageway (each side) the overall length of the structure would be 18m (assuming 1m cover). The span of the underpass would be defined by the section of the busway – assumed to be 17m based on Figure 44.

Due to the relatively short span required to traverse Cambridge Road and the adjoining footway and the nature of the single carriageway arrangement, a single span structure is deemed suitable (i.e. no requirement for intermediate support lines) for both the overbridge and underpass proposals.

- **Overbridge Proposal**
  Headroom requirements, structural form and vertical alignment criteria would govern the height and profile of the approach/departure embankments.

- **Underpass Proposal**
  Associated approaches & departure embankments would be the construction of an underpass. In general, the bridge forms discussed could be adapted to an underbridge solution.

The foundation requirements would depend largely on the underlying ground conditions and its associated bearing capacity. In the case of an overbridge, for good soil conditions, a mass concrete or strip foundation may be suitable. It is anticipated that an underpass would be supported on integral shallow spread foundations. The soil conditions, and consequently appropriate foundation type, could only be confirmed via intrusive geotechnical ground investigation works.

![Figure 44 – Carriageway Cross Section (overbridge section shown, underpass section similar)](image-url)
Span Length and Structure Dimensions

The approximate span lengths and geometry for the underbridge crossing is detailed in Table 5.

<table>
<thead>
<tr>
<th></th>
<th>Overbridge Proposal</th>
<th>Underpass Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width carriageway and footway crossed (m)</td>
<td>7.5m</td>
<td>7.5m</td>
</tr>
<tr>
<td>Min set-back (each side) (m)</td>
<td>1.2m</td>
<td>3m</td>
</tr>
<tr>
<td>Span† (over) / Length† (under) (m)</td>
<td>12m</td>
<td>18m</td>
</tr>
<tr>
<td>Width (over) / Span (under) (m)</td>
<td>17m</td>
<td>17m</td>
</tr>
<tr>
<td>Skew Angle (°)</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

Table 5 - Span lengths & structure dimensions

† The envisaged span (over) / length (under) allows for minor skew, set-back from edge of carriageway / footway and construction / groundworks activities.

Bridge Forms – Proposals Considered

A number of proposals exist for carrying a busway over or under Cambridge Road – a selection of these are discussed below, each of these bridge forms have been considered either for the overbridge and the underpass structure arrangement.

- In-situ Reinforced Concrete Slab
- Pre-cast concrete rectangular beam
- Pre-stressed Concrete I-beam
- Steel Structure
- Post-tensioned Slab
- Pre-cast Reinforced Concrete Portal Frame

Consideration should be given to the above guidance in the design of any new overbridge or underpass. The following tables highlight the advantages and disadvantages of each one of the bridge forms considered.
### In-situ Reinforced Concrete Slab (Overbridge)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum depth for short spans – minimising material requirements (well suited to spans ranging between 5m – 15m)</td>
<td>Construction time – in-situ construction requires temporary formwork (length of construction time increased compared to pre-cast beams)</td>
</tr>
<tr>
<td>Ease of design &amp; detail – relatively straightforward and well established design detail</td>
<td>Limited span length – conventionally reinforced slab suitable for spans up to ~15m</td>
</tr>
<tr>
<td>Ideal for small crossings – unobtrusive, slender detail</td>
<td></td>
</tr>
</tbody>
</table>

### Pre-cast Concrete Rectangular Beam (Overbridge)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction time – pre-cast nature of beams would inevitably reduce construction time (compared with cast in-situ proposal). Shorter duration, less disruptive Traffic Management.</td>
<td>Geometry – cannot easily be curved to suit challenging geometries</td>
</tr>
</tbody>
</table>

### Proposal C1 – Pre-stressed Concrete I-Beam (Overbridge)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durability &amp; Maintenance – relatively low maintenance solution</td>
<td>Materials &amp; dimensions – beams are of greater depth (i.e. potentially increasing height of embankments, plan area and footprint / volume of fill)</td>
</tr>
<tr>
<td>Standardised detail – beam detail is fairly standard for given span</td>
<td>Logistics – potential constraints on use of longer beams due to transport/logistics and accessibility</td>
</tr>
<tr>
<td>Economical design – generally considered to be most economical solution for spans between 15m – 50m (note: overbridge span is 12m)</td>
<td></td>
</tr>
<tr>
<td>Geometry – Adaptable and can be designed to suit challenging geometric layouts</td>
<td></td>
</tr>
</tbody>
</table>

### Steel Structure (Overbridge)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material properties – lighter material than concrete construction</td>
<td>Cost – represents an expensive solution</td>
</tr>
<tr>
<td></td>
<td>May be considered visually obtrusive (e.g. weathering steel may not be seen as appealing)</td>
</tr>
<tr>
<td></td>
<td>Additional maintenance cost – regular/routine maintenance. Regular painting (if weathering steel not used)</td>
</tr>
</tbody>
</table>
- **Post-tensioned slab (Overbridge)**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced cost – Economical solution. Post-tensioned slabs represents a good solution to provide a stronger structure at affordable cost. Typically used where there is a requirement to support additional load (i.e. ‘heavy duty’)</td>
<td>Maintenance – tendons require special inspection and maintenance (need to be inspected for corrosion)</td>
</tr>
<tr>
<td>Design flexibility – slender slab profile when compared to similar conventionally reinforced or voided slab</td>
<td>Design Complexity – more onerous to design and install</td>
</tr>
</tbody>
</table>

- **Pre-cast Reinforced Concrete Portal Frame (Overbridge)**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of installation &amp; buildability – pre-cast structure can be installed relatively easy and quick in comparison to in-situ construction forms (fabricated off-site)</td>
<td>Functional, but not always considered visually attractive in certain settings</td>
</tr>
<tr>
<td>Less labour – the labour requirements are less intensive compared to alternative forms</td>
<td></td>
</tr>
<tr>
<td>High quality control – pre-fabricated structures are cast under quality controlled factory conditions</td>
<td></td>
</tr>
<tr>
<td>Programme – prefabricated off-site, less dependent on weather and skilled labour on-site</td>
<td></td>
</tr>
<tr>
<td>Wide availability – Numerous companies can provide ‘off the shelf’ pre-cast units (reducing design costs)</td>
<td></td>
</tr>
<tr>
<td>Installation – can be ‘dropped in’ from above or moved into position from below (e.g. via self-propelled modular transporter)</td>
<td></td>
</tr>
<tr>
<td>Reduced maintenance activity – no articulation, no transverse movement joints or bearings to inspect, refurbish/replace (formation of secondary defects associated with failed joints / bearings is reduced)</td>
<td></td>
</tr>
</tbody>
</table>
### In-situ Reinforced Concrete Slab (Underpass)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of design &amp; detail – relatively straightforward and well established design</td>
<td>Requires deeper slab than equivalent overbridge – well suited to spans ranging between 5m – 15m, but indicative span would be 18m</td>
</tr>
<tr>
<td>Ideal for small crossings – unobtrusive, relatively slender detail (although, deeper section than for corresponding overbridge of similar construction form)</td>
<td>Construction time – in-situ construction requires temporary formwork (length of construction time increased compared to pre-cast beams)</td>
</tr>
<tr>
<td>Ideal for small crossings – unobtrusive, relatively slender detail (although, deeper section than for corresponding overbridge of similar construction form)</td>
<td>Limited span length – conventionally reinforced slab suitable for spans up to ~15m, but indicative span would be 18m.</td>
</tr>
</tbody>
</table>

### Pre-cast Concrete Rectangular Beam (Underpass)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction time – pre-cast nature of beams would inevitably reduce construction time (compared with cast in-situ proposal). Shorter duration, less disruptive TM</td>
<td>Geometry – cannot easily be curved to suit challenging geometries</td>
</tr>
<tr>
<td></td>
<td>Time - additional time required to tie into in-situ cast abutments / end supports</td>
</tr>
<tr>
<td></td>
<td>Number of beams – length of the underpass would require a large number of short transverse beams</td>
</tr>
</tbody>
</table>

### Pre-stressed Concrete I-Beam (Underpass)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durability &amp; Maintenance – relatively low maintenance solution</td>
<td>Materials &amp; dimensions – beams are of greater depth (i.e. potentially increasing height of embankments, plan area and footprint / volume of fill)</td>
</tr>
<tr>
<td>Standardised detail – beam detail is fairly standard for given span</td>
<td>Number of beams – length of the underpass would require a large number of short transverse beams</td>
</tr>
<tr>
<td>Economical design – generally considered to be most economical solution for spans between 15m – 50m</td>
<td>Logistics – potential constraints on use of longer beams due to transport/logistics and accessibility</td>
</tr>
</tbody>
</table>
**Steel Structure (Underpass)**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material properties – very much lighter than concrete construction</td>
<td>Cost – represents an expensive solution</td>
</tr>
<tr>
<td></td>
<td>Materials – likely to require more steel members (bracing etc.) owing to additional dead load (soil cover &amp; earth pressure) and increased length</td>
</tr>
<tr>
<td></td>
<td>Suitability – Steel structures not typically used for ‘buried’ type solution. Issues with moisture / corrosion</td>
</tr>
<tr>
<td></td>
<td>May be considered visually obtrusive (e.g. weathering steel may not be seen as appealing)</td>
</tr>
<tr>
<td></td>
<td>Maintenance – requires painting (if weathering steel not used) and regular/routine maintenance</td>
</tr>
<tr>
<td></td>
<td>Construction time &amp; TM – longer construction duration and additional traffic management (closure of road above) in compare to pre-cast portal frame form</td>
</tr>
</tbody>
</table>

**Post-tensioned slab (Underpass)**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced cost – Economical solution</td>
<td>Maintenance – tendons require special inspection and maintenance (need to be inspected for corrosion)</td>
</tr>
<tr>
<td>Design flexibility – slender slab profile when compared to similar conventionally reinforced or voided slab</td>
<td>Accessibility of the tendons – in the case of buried structure/underpass with cover accessibility to the tendons (for inspection purposes) may be difficult</td>
</tr>
<tr>
<td></td>
<td>Design Complexity – more onerous to design and install</td>
</tr>
<tr>
<td></td>
<td>Construction time &amp; TM – longer construction duration and additional traffic management (closure of road above) in compare to pre-cast portal frame form</td>
</tr>
</tbody>
</table>
• **Pre-cast Reinforced Concrete Portal Frame (Underpass)**

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of installation &amp; buildability – pre-cast structure can be installed relatively easy and quick in comparison to in-situ construction forms (fabricated off-site)</td>
<td>Functional, but not always considered visually attractive in certain settings</td>
</tr>
<tr>
<td>Less labour – the labour requirements are less intensive compared to alternative forms</td>
<td>Section dimension / materials – deeper section required (more concrete and potentially more reinforcement) than for overbridge of same form owing to additional loads (cover and soil pressures)</td>
</tr>
<tr>
<td>High quality control – pre-fabricated structures are cast under quality controlled factory conditions</td>
<td>Deep excavation – a deep excavation is required compared with overbridge proposal (which is set on embankments)</td>
</tr>
<tr>
<td>Programme – prefabricated off-site, less dependent on weather and skilled labour on-site</td>
<td>Construction – may require fill to distribute loads</td>
</tr>
<tr>
<td>Wide availability – Numerous companies can provide ‘off the shelf’ pre-cast units (reducing design costs)</td>
<td></td>
</tr>
<tr>
<td>Installation – can be ‘dropped in’ from above or moved into position from below (e.g. via self-propelled modular transporter)</td>
<td></td>
</tr>
<tr>
<td>Reduced maintenance activity – no articulation, no transverse movement joints or bearings to inspect, refurbish/replace (formation of secondary defects associated with failed joints / bearings is reduced)</td>
<td></td>
</tr>
</tbody>
</table>

8.4.2 Bridge Form - Summary

Given the relatively short span and minimal skew required to maintain busway alignment for higher bus speeds, the underpass could be designed as an integral structure with fixed connection between the deck and substructure elements, removing the need for bridge bearings.

The integral nature of the bridge would minimise future maintenance activities associated with expansion joints & bearings and limit formation of secondary defects arising from percolation of salt-laden water onto the substructure elements below.

The 4% (1 in 25) vertical gradient criteria outlined in the Guided Busway Design Handbook, the profile of the approach and departure to the bridge would require a minimum of 150m length of transition either side.

A slender structure form, such as a slab or portal frame would ensure the relative levels of the respective carriageways (above and below) would be kept to a minimum with due regard for headroom requirements. This ensures that the cutting depth and associated volume of excavation is minimised.

Considering first, an overbridge, the approximate area of each embankment footprint is estimated as 4,300m². Therefore, the total plan area of the footprint for two embankments (east & west side of Cambridge Road) plus the bridge deck itself is ~8,900m². The approximate volume of fill required per embankment is 13,000m³ (i.e. 26,000m³ in total for both embankments).
The required earthworks required to align the busway over or under the structure and the impact on surrounding land and properties make the proposal unfavourable. Cambridge Road has low traffic flows and provision of a structure to carry the busway over the road is deemed to be excessive.
## Cambridge Road, Coton Initial Proposal Summary

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Description</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provision of a burst-through busway junction on Cambridge Road with curved entry and exit kerbing</td>
<td><strong>Proposal 1 taken forward for development and junction modelling analysis</strong></td>
</tr>
<tr>
<td>2</td>
<td>Provision of a burst-through busway crossing of Cambridge Road</td>
<td><strong>Proposal 2 not taken forward</strong></td>
</tr>
<tr>
<td>3</td>
<td>Provision of a burst-through busway crossing of Cambridge Road positioned 40m north of Coton village properties</td>
<td><strong>Proposal 3 not taken forward</strong></td>
</tr>
<tr>
<td>4</td>
<td>Provision of a Structure crossing Cambridge Road, Coton</td>
<td><strong>Proposal 4 not taken forward</strong></td>
</tr>
</tbody>
</table>
9 Cambridge Road, Coton Junction Proposal Development

The Cambourne to Cambridge busway junction proposals workshop held on 30th January 2017 identified a preferred proposal as outlined in sections 8.3 – 8.5 of this report. This proposal has been taken forward for development including amendments and alterations identified at the workshop.

Development of the junction arrangement at Cambridge Road, Coton, includes the following;

- Traffic modelling of each junction arrangement for am and pm peak periods to determine the capacity at which the junction would operate;
- Safety assessment of each proposal by a qualified Road Safety Engineer.
- Construction methodology.
- Strengths Weaknesses Opportunities Threats - SWOT analysis of each proposal;
9.1 Proposal 1. Provision of a burst-through junction on Cambridge Road with curved entry and exit kerbing

9.1.1 Junction Arrangement

- Proposal 1 is a burst-through junction on Cambridge Road to the north of the village of Coton.
- The proposed footway/cycleway would use a signalised crossing at the location of the burst-through. A further signalised crossing of the bus-link is provided for the footway alongside Cambridge Road.

9.1.2 Transport Modelling Assessment

Traffic modelling for Proposal 1 shows the junction to be operating at a 12.5% degree of saturation during am peak and 18% during pm peak. The junction arrangement is the only proposal selected for development for Cambridge Road and shows the arrangement to be operating below the maximum 80% saturation defined as being the upper limit. Cambridge Road is not a main transport link and has light traffic flows.

9.1.3 Safety Assessment

- Clear signing required to ensure road users do not enter the segregated busway in error, due to relaxed junction radii allowing buses to join from Cambridge Road.
9.1.4 Construction Methodology

Proposal 1 is constructed on the line of the existing Cambridge Road carriageway, and as a result would require traffic management and carriageway lane restrictions.

Construction activities are indicated below. The list is not exhaustive and subject to confirmation of details required from ground investigations that would be carried out during detailed design.

- Carry out site clearance of verge areas at the burst-through position.
- Expose and protect or divert statutory undertakers’ plant within the construction extents (preferably delivered pre works phase).
- Install and maintain traffic management.
- Excavate existing soft verge for burst-through alignment, break out and excavate existing footway on the western side of Cambridge Road.
- Excavate existing kerbing to Cambridge Road at the burst-through position.
- Construct carriageway drainage system alterations and install ducting for traffic signals.
- Excavate to formation level and lay sub-base.
- Install new kerbing.
- Construct tie-ins to carriageway and footway.
- Install traffic signal equipment
- Install traffic signs and road markings
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

9.1.5 Construction Risks

- Temporary traffic management comprising of carriageway closures and diversions would be required to construct the on-road sections of the crossing arrangement, with associated Temporary Traffic Regulation Orders.
- Temporary footway diversion would be required to manage pedestrian movements though the area of the site along Cambridge Road.
- Proximity of the arrangement to residential properties may require restricted working times to limit disturbance to residence.

9.1.6 Property and Environmental Impacts

Proposal 1 requires land acquisition from the areas east and west of Cambridge Road. West of Cambridge Road is agricultural farmland. The favourable alignment for the busway to prevent land segregation is a southern position which would align the busway alongside the most northern Coton residential property. To the east of Cambridge Road the favourable position of the busway in a southern alignment would reduce land segregation in the Coton Orchard. Again this would be in close proximity to the northern property in Cambridge Road to the east side.
9.1.7 Proposal 1 SWOT Assessment

Strengths
- The use of a ‘burst through’ type detail is simple and familiar arrangement utilised on other sections the existing CGB.
- The proposal provides kerb lines to allow buses to enter and exit the busway to and from Cambridge Road if required for increased flexibility;
- The busway is aligned to land boundaries, minimising land take to reduce severance of Coton orchard/nursery;

Weaknesses
- Junction is close to residential properties as a result of aligning the route to land boundaries.
- Queuing traffic on Cambridge Road may block residential property accesses for a short period whilst buses pass through the burst-through.

Opportunities
- Upgrading and improved connectivity of footway/cycleway provision from Cambridge Road, Coton.
- Greater flexibly for local bus services to be provided that can utilise the busway from Coton village.

Threats
- Objection from residence to the busway route to the proximity to Coton;
- Possible objection to land take from Coton Orchard.

Outcome
- Proposal 1 provides reduced impact of the busway on the public highways with greater flexibility.
- Junction modelling shows Proposal 1 to have minimal impact on traffic flow to Cambridge Road with a lower construction cost than the alternatives.
9.2 Cambridge Road, Coton Summary

Proposal 1 would provide a simple burst-through busway crossing with the flexibility of junction radius kerbs to enable buses to enter and exit the busway from Cambridge Road. The position of the crossing is aligned towards the properties within Coton village boundary to reduce land requirements and creation of land parcels either side of Cambridge Road, however the position of the arrangement can be amended to suit favourable busway alignments either side of the Cambridge Road.

In summary Proposal 1 would provide a simple junction arrangement with increased flexibility. The position of the junction crossing Cambridge Road could be altered to suit different link alignments.
10 Cambridge Road, Coton to M11 Link

10.1 Existing Arrangement
From Cambridge Road, Coton to the M11 the busway proposals pass through Coton Orchard following varying alignments. Coton Orchard was planted in the 1920’s and produce grown within the site is sold locally. To the south of Coton Orchard is Coton allotment gardens and rear garden boundaries of a number of properties in The Footpath, Coton. To the north east of the orchard is an open field/paddock to the rear of Rectory Farm. The link is 0.8km in length.

![Figure 46 - Cambridge Road, Coton to M11 Link](image)

There are a number of alignment proposals available between Cambridge Road and the M11. For each link proposal the junction proposals with which they align have been identified below.

10.2 Existing constraints

10.2.1 Carriageway alignment and land constraints

- The area of land is almost entirely made up of land that forms the Coton Orchard and is generally planted with a variety of fruit trees and bushes. To the south are allotment gardens within Coton village and further east of the allotments are the rear of residential property gardens. To the north are buildings associated with the Coton Orchard garden centre, including a post office and a number of retail outlets.

- A number of existing overhead low voltage power lines are located across the Coton Orchard and would be within the extent of the proposed busways. These services would need to be diverted or buried where they conflict with proposed busway alignments. Further detailed investigations on the height of the overhead lines and the extent of diversion works would need to be carried out during detailed designs stage.

10.2.2 Non motorised users
There are no public rights of way within the area of Coton Orchard that would be affected by the proposed busway alignments.
10.2.3 Environmental

There are no statutory environmental designations on the land area identified for the busways. To the south is the Coton village conservation area, all busways proposals would be north of this area.

10.2.4 Link alignment development

Early stage busway alignments identified for the section between Cambridge Road, Coton and the M11 crossing provided three alternative busway alignments, two positioned centrally to the Coton Orchard site and one positioned to the south, close to the northern extent of Coton village and the Coton allotments.

To provide connectivity between busway alignments from the west across Cambridge Road to the M11 crossing, with a reduced impact on Coton village and less severance of the Coton Orchard site, a further proposal was identified positioning the busway to the north of the Coton Orchard site.

Four potential busway proposals have been identified and are discussed in this report based on potential design speed and land/environmental impacts.
10.3 Cambridge Road, Coton to M11 Link - Alignment Proposals

Proposal 1 – Busway aligned to the north to connect to the West Cambridge development

- The proposal would provide a busway from Cambridge Road to the M11 through the Coton Orchard providing smooth alignment and link with an M11 crossing structure for direct alignment into the University of Cambridge West Cambridge development.
- The position of the alignment impacts on the Coton Orchards the greatest amount of the four proposals. The alignment cuts through the middle of the field/pasture area south of Rectory Farm.
- The proposed footway/cycleway would follow adjacent to the busway the full length of the busway link.

![Figure 47 - Cambridge Road, Coton to M11 Link -- Proposal 1 Alignment](image)

10.3.1 Link Alignment

The alignment of the Proposal 1 (Green) link has been designed to achieve the maximum design speed whilst being positioned to the north to align with an M11 crossing which links directly with the West Cambridge development. The alignment provides a minimum radius of 2500m giving a 120kph design speed based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. To provide the required alignment and maintain design speed the link utilises a large area of Coton Orchards and passes centrally through the field/pasture south of Rectory Farm, resulting in greater land severance than other proposals. The alignment is away from boundaries of properties in Coton, reducing the proximity of the busway to local residents.

![Figure 48 Proposal 1 Busway Section](image)
10.3.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

10.3.3 Construction Risks
- Land acquisition required from the privately owned Coton Orchard site and pasture south of Rectory Farm.
- Diversionary works may be required to overhead power lines across Coton Orchard.

10.3.4 Property and Environmental impacts
A search of environmental designations for the proposed Proposal 1 alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 1 busway is aligned. The busway would pass centrally through the orchard and through the area of pasture east of the Coton Orchard, adjacent to the M11.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction proposals compatible</td>
</tr>
<tr>
<td>* Cambridge Road – Northern junction positions</td>
</tr>
<tr>
<td>o M11 Crossing – A</td>
</tr>
<tr>
<td>Junction proposals not compatible</td>
</tr>
<tr>
<td>* Cambridge Road – Southern junction positions</td>
</tr>
<tr>
<td>M11 Crossing – B and C</td>
</tr>
</tbody>
</table>
10.3.5 Proposal 1 SWOT Assessment

**Strengths**
- Good alignment providing 120kph + design speeds for the majority of the route between junction proposals.
- Positioned away from properties that bound Coton Orchard.

**Weaknesses**
- Large area of land take required from Coton Orchard.
- Divides the pasture south of Rectory Farm into two.

**Opportunities**
- Provision of landscaping and screening along the busway corridor to enhance the environment and separate the busway from properties and allotment gardens.

**Threats**
- Land purchase required from the Coton Orchard.

**Outcome**
- Proposal 1 provides smooth alignment and reduced visual impact on Coton village.
- The proposal segregates land with a less favourable position within the Coton Orchard site.
10.4 Proposal 2 – Busway aligned to Coton Orchard Southern Boundary

- The proposal would provide a busway from Cambridge Road to the M11 aligned to the southern boundary of the Coton Orchard to reduce land take within the Orchard site.
- The proposal would provide a link to a potential M11 crossing proposal into the west Cambridge development.
- The proposed footway/cycleway would follow adjacent to the busway the full length.

10.4.1 Link Alignment

The alignment of the Proposal 2 (Blue) link has been designed to reduce the land required from the Coton Orchard by aligning the busway close to the southern boundary of the orchard adjacent to the allotment gardens and residential garden boundaries. To achieve this alignment the design speed has been reduced to enable the link to follow the boundary line. The alignment utilises radii between 1200 and 1500m, providing a design speed 85 -100kph along the link based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. The busway would be aligned at the eastern end with a favourable M11 crossing positioned aligned with the Data Centre within the west Cambridge development. The alignment follows the route of an existing overhead power line positioned east-west through the Coton Orchard, crossing the M11 at the point Proposal 2 aligns across the M11, and into west Cambridge. This overhead power line would need to be diverted to enable Proposal 2 to be constructed.
10.4.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

10.4.3 Construction Risks
- Land acquisition required from the privately owned Coton Orchard site.
- Diversionary works may be required to overhead power lines across Coton Orchard.

10.4.4 Property and Environmental impacts
A search of environmental designations for the proposed Proposal 2 (Blue) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 2 busway is aligned.

The busway alignment would be positioned close to residential properties in Cambridge Road and be aligned with the rear boundaries of properties in The Footpath, Coton potentially having a greater impact on these properties than other proposals that are positioned further to the north.

### Junction Proposals Compatible

| Junction proposals compatible | o Cambridge Road – Southern junction positions  
|                             | o M11 Crossing – B |

| Junction proposals not compatible | o Cambridge Road – Northern junction positions  
|                                 | M11 Crossing – A and C |
10.4.5 Proposal 2 SWOT Assessment

**Strengths**
- Reduced area of land take required from Coton Orchard compared with other proposals
- Southern alignment avoids the pasture south of Rectory Farm.

**Weaknesses**
- Design speed reduced to provide alignment along the orchard boundary.
- Busway positioned adjacent to properties that bound Coton Orchard, reducing the potential for introducing landscaping and screening along the boundary line.

**Opportunities**
- Provision of landscaping and screening along the bus corridor to separate the busway from the Coton Orchard nurseries.

**Threats**
- Land purchase required from the Coton Orchard.
- Objection to the close proximity to the orchard boundary line.

**Outcome**
- Proposal 2 provides smooth alignment and reduced land segregation aligned with an M11 crossing position to the east into West Cambridge.
- The alignment provides lower design speed to align with
10.5 Proposal 3 – Busway aligned to Coton Orchard Southern Boundary

- The proposal would provide a busway from a Cambridge Road crossing positioned away from Coton properties, linking to an M11 cross aligned to the south close to the existing M11 footbridge crossing, to align south of the west Cambridge development.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 51 - Cambridge Road, Coton to M11 Link -- Proposal 3 Alignment](image)

10.5.1 Link Alignment

The alignment of the Proposal 3 (Red) link has been designed to provide a connection with a southern link over the M11, which would run south of the West Cambridge development. The alignment provides a minimum radius of 1600m giving a 100kph design speed based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. To align with a structure over the M11 the curvature reduces to a 1020m radius providing an 85 kph design speed. To provide the required alignment and maintain design speed the link utilises a larger area of Coton Orchards being positioned away from the southern orchard boundary, resulting in greater land severance.

![Figure 52 Proposal 3 Busway Section](image)
### 10.5.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

### 10.5.3 Construction Risks
- Land acquisition required from the privately owned Coton Orchard site.
- Diversionary works may be required to overhead power lines across Coton Orchard.

### 10.5.4 Property and Environmental Impacts
A search of environmental designations for the proposed Proposal 3 (Red) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 3 busway is aligned.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
<th>Cambridge Road – Northern junction positions.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M11 Crossing – C</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Junction proposals not compatible</th>
<th>Cambridge Road – Southern junction positions.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M11 Crossing – A and B</td>
</tr>
</tbody>
</table>
10.5.5 Proposal 3 SWOT Assessment

**Strengths**
- Good alignment providing 100kph + design speeds for the majority of the route between junction proposals.
- Aligned to be positioned away from properties that bound Coton Orchard.
- The alignment does not impact on pasture south of Rectory Farm.

**Weaknesses**
- Design speed reduced below maximum permitted to move the alignment away from Coton residential properties.
- Large area of land take required from Coton Orchard.

**Opportunities**
- Provision of landscaping and screening along the bus corridor to separate the busway from the Coton Orchard nurseries.

**Threats**
- Land purchase required from the Coton Orchard.

**Outcome**
- Proposal 3 provides smooth alignment linked to a southern M11 crossing position.
- The proposal segregates land with a less favourable position within the Coton Orchard site.
10.6 Proposal 4 – Busway aligned to the north of Coton Orchard

- The proposal would provide a busway from a Cambridge Road crossing positioned away from Coton properties linking to an M11 crossing aligned to the north for direct alignment into the University of Cambridge West Cambridge development.
- The northern position of the alignment may impact on the Coton Orchards being positioned close to the garden centre and through a storage area, but reduces severance of the orchards. The alignment cuts through the middle of the field/pasture area south of Rectory Farm.
- The proposed footway/cycleway follows adjacent to the busway the full length.

10.6.1 Link Alignment

The alignment of the Proposal 4 (Pink) link has been designed to provide a connection with a north link over the M11 into the West Cambridge development. The alignment provides a minimum radius of 720m giving a design speed of 70kph at the western end aligning the busway past the garden centre, then into a 1440m radius giving a design speed of 100kph across the M11 based on a guideway constructed with a 2.5% superelevation as detailed in section 2. The alignment follows to the south of the garden centre buildings, reducing segregation of the orchard, but impacting to a greater extent on the garden centre than other proposals.
10.6.2 Safety Assessment
   - Fully segregated busway and footway/cycleway. No safety related concerns.

10.6.3 Construction Risks
   - Land acquisition required from the privately owned Coton Orchard site and pasture south of Rectory Farm.
   - Diversionary works may be required to overhead power lines across Coton Orchard.

10.6.4 Property and Environmental impacts
A search of environmental designations for the proposed Proposal 4 (Pink) alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 4 busway is aligned.
The proposed alignment would impact on the Coton Orchard garden centre and businesses on the site being in close proximity to the busway. This could result visual or noise disturbance to the site and removal of the storage area may affect the operation of the site.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction proposals compatible</td>
</tr>
<tr>
<td>- Cambridge Road – Northern junction positions.</td>
</tr>
<tr>
<td>- M11 Crossing – C</td>
</tr>
<tr>
<td>Junction proposals not compatible</td>
</tr>
<tr>
<td>- Cambridge Road – Southern junction positions.</td>
</tr>
<tr>
<td>- M11 Crossing – A and B</td>
</tr>
</tbody>
</table>
10.6.5 Proposal 4 SWOT Assessment

**Strengths**
- Good alignment providing 100kph + design speeds for the majority of the route between junction proposals.
- Reduced area of land take required from Coton Orchard compared with other proposals.

**Weaknesses**
- Design speed reduced to provide alignment along the orchard boundary.
- Busway positioned adjacent to Coton Orchard garden centre, reducing the potential for introducing landscaping and screening along the boundary line as well as potentially affecting the operation of the site.
- Divides the pasture south of Rectory Farm into two.

**Opportunities**
- Provision of landscaping and screening along the bus corridor to separate the busway from the Coton Orchard nurseries.

**Threats**
- Land purchase required from the Coton Orchard.
- Objection to the close proximity to the orchard boundary line.

**Outcome**
- Proposal 4 provides smooth alignment and reduced visual impact on Coton village.
- The alignment provides lower design speeds to align with property boundaries and impacts on the garden centre.
10.7 Cambridge Road, Coton to M11 Link Summary

Proposal 1 (green) would provide a link through the centre of the Coton Orchard site to connect a southern busway crossing of Cambridge Road with a northern M11 crossing position. The alignment would provide maximum design speed but would pass directly through the centre of the orchard site.

Proposal 2 (blue) would provide a busway aligned to the southern boundary of the Coton Orchard site linking a southern busway crossing of Cambridge Road with a centrally positioned crossing of the M11. The alignment would have a reduced impact on Coton Orchard but provide a lower design speed alignment. The proposal would position the busway close to residential properties in Coton village.

Proposal 3 (red) would connect a central Cambridge Road crossing position with a southern M11 crossing, requiring severance of the southern extent of Coton Orchard. The alignment provides a curve in the alignment to position the busway further away from Coton residential property boundaries and in doing so the design speed would be reduced.

Proposal 4 (pink) would connect a northern busway crossing of Cambridge Road with a northern crossing of the M11. The busway would be close to the Coton Orchard garden centre and therefore reduces severance of the Coton Orchard but has a greater impact on the garden centre with an alignment design speed below the maximum permitted.

In summary both Proposals 1 and 4 are positioned close to the edges of the Coton Orchard site reducing severance but within closer proximity to residential and commercial properties. Proposal 2 and 3 provide good alignments away from properties but sever the orchard site.
11 M11 Crossing Proposals

11.1 Initial Considerations

The provision of a bridge crossing of the M11 motorway south of Junction 13 would be required to provide continuation of the busway between Coton Orchard and west Cambridge. Various suitable crossing positions have been considered and structural forms reviewed for a bridge over the M11.

Existing constraints have been highlighted including, severance of access, public footpaths, wildlife corridors and land acquisition. Potential proposals for the bridge have been investigated for a selection of structural forms, outlining the advantages and disadvantages associated with each giving consideration to the overall scheme and budgetary constraints.

11.2 Route Proposals

Three route proposals (A, B and C) have been identified for the M11 crossing; refer to Figure 55 below for location plan. These link with the busway alignments to the east and west.

![Figure 55 - Proposals for the M11 crossing](image-url)
11.3 Preliminary Design Considerations

The following design considerations relate to the various structure proposals:

- Bridge aspect – the span arrangement of the proposed crossing including:
  - Closed bridge aspect (single span, integral bridge);
  - Open bridge aspect (three spans continuous structure);
- Bridge form (see section 11.6 of this Report);
- A span to depth ratio of 20-30 is used for estimating the thickness of the deck.
- Continuity of the deck over the supports is to be used where possible as it:
  - Reduces the number of expansion joints;
  - Reduces the bending moment effects, hence the required thickness of deck and the material needed;
- The use of prefabricated units which reduce construction time, although transportation could be an issue (special permissions required for beams longer than 27.5m on public roads).
- Length of the structure as a single bridge would increase the overall depth of the deck and would subsequently determine the height and length of the embankment approaches.

The foundation requirement would depend largely on the underlying ground conditions and its associated bearing capacity. The foundations are very likely to be reinforced concrete supported on bored, cast-in-situ piles. This would need to be confirmed following geotechnical ground investigations during detailed design.

11.4 Span Length and carriageway geometry

The following span lengths have been considered at each of the crossing positions

11.4.1 Span Length & Skew

<table>
<thead>
<tr>
<th>Bridge Aspect</th>
<th>Proposal A (Skew 0°)</th>
<th>Proposal B (Skew 7°)</th>
<th>Proposal C (Skew 26°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Bridge Aspect (1 span)</td>
<td>34m</td>
<td>30m</td>
<td>30.5m</td>
</tr>
<tr>
<td>Open Bridge Aspect (3 spans)</td>
<td>35m,39m,35m</td>
<td>32m,35m,32m</td>
<td>32.5m,35.5m,32.5m</td>
</tr>
</tbody>
</table>

Table 6 Span lengths & structure dimensions

Note 1: The dimension for a closed bridge aspect gives the minimum span length, and provides the minimum 0.6m set-back and working width. The set-back must be sufficiently far back to ensure that collision loading is not a factor.

Note 2: The dimensions for an open bridge aspect have been selected considering a set-back of 4.5m and a working width of 1.8m.
11.4.2 Carriageway Width

The cross section of the bridge has been considered the same width for all the deck proposals. The cross section of the carriageway can be seen in Figure 56 below and for simplicity is assumed to be 17m wide, comprising 15.7m deck plus two 0.65m parapet plinths.

11.5 Feasibility of crossing routes

The advantages and disadvantages for each route proposal are listed below.

**M11 Crossing - Proposal A and B**

Existing site constraints comprising of buildings on the east side of the M11 are present close to the alignment of Proposals A and B.

Based on the topography of the surrounding area, the calculated length of the structures and the approaches would be approximately 386m long for **Proposal A** and 382m for **Proposal B**.

Proposal A crossing the M11 further to the north would cross at the beginning of the M11 Junction 13 slip roads and therefore would require a longer span than proposals further south of the junction.

The footprint of an embankment slope on the eastern approach to the structure, using the recommended gradients of 4%, would fall within the area of existing buildings. An alternative to the embankments would be to incorporate retaining walls into the design of the approaches so that the land take would be minimised, or to extend the length of the structure up to a point where the new road level meets the existing ground level. These two proposals, would significantly increase construction and maintenance costs although the amount of soil required to be imported for the fill would be reduced.

An adverse factor to these proposals would be the height of the road as it passes the buildings which may significantly affect the aspect from the building and generate opposition from the owners to the arrangement. It may also be likely that access between the buildings would be severed, and would have to be reinstated, possibly in the form of an underpass or ramped access and crossing at the new road level.

In summary Proposals A & B are expected to have higher costs of construction for a crossing at these two route locations.

**M11 Crossing - Proposal C**

The location of the site is not constrained by buildings compared to Proposals A or B.
The disadvantage of Proposal C when comparing to the other locations is that the structure would require greater skew angle to align the busway over the M11.

### 11.6 Bridge Forms Considered

There are numerous bridge forms which could be used in order to provide a structural solution for a span range between 30-40m, these proposals are listed below.

The purpose of this section is to highlight the advantages and disadvantages of each one of the proposals based on the different factors/constraints described above.

A summary of the bridge proposals considered at this feasibility stage are:

- Multi-Girder Composite Bridge Deck
- Ladder Bridge Deck
- Open-Topped Trapezoidal Girders.
- Pre-stressed pre-tensioned SY beams with in-situ slab.

**Multi-Girder Composite Bridge Deck**

This proposal would have a number of similar sized longitudinal plate girders arranged at uniform spacing across the width of the bridge deck which would be connected to a concrete deck slab. The composite action between the reinforced concrete deck slab and the longitudinal steel girder would be achieved by means of shear connectors welded on the top flanges of the steel girders. The deck slab would span transversely between the longitudinal girders and cantilevers transversely outside the outer girders. The girders would be braced together at supports and at intermediate positions (triangulated frame between adjacent girders).

The following tables highlight the advantages and disadvantages of the multi-girder composite bridge deck:

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness - particularly effective where construction depth is limited, cost-effective solution</td>
<td>Materials - increased amount of steel required, relative to the other proposals</td>
</tr>
<tr>
<td>Ease – relatively easy to manufacture, transport to site and lift in place</td>
<td>Cost - steel girders are costly</td>
</tr>
<tr>
<td>Time – short installation duration, minimising impact on local community</td>
<td>Construction - problems during erection for the stability of the compression flanges</td>
</tr>
<tr>
<td></td>
<td>Maintenance - higher maintenance cost than pre-stressed concrete bridges or steel box girders.</td>
</tr>
</tbody>
</table>
Ladder Bridge Deck

This proposal would have two pairs of longitudinal girders with a reinforced concrete slab continuous across all four main girders. The deck slab is supported on cross girders that span transversely between the main girders. The cross girder would be connected to the transverse web stiffeners on the main girders. The cross girder over intermediate supports would be deeper than the intermediate cross girder in order to provide a stiffer pier diaphragm.

The following table highlights the advantages and disadvantages of the ladder bridge deck:

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials - Reduced amount of steel required compared to the multi-girder proposal</td>
<td>Material cost - Fabrication cost per tonne may be higher (compared to the multi-girder proposal)</td>
</tr>
<tr>
<td>Less labour - Use of permanent formwork reducing the reliance on labour for in-situ work (i.e. formwork construction)</td>
<td>Size - Larger steel girder sections required in comparison with the multi-girder proposal</td>
</tr>
<tr>
<td>Construction - Reduced need to support points compared to the multi-girder proposals</td>
<td>Construction - Problems during erection for the stability of the compression flanges</td>
</tr>
<tr>
<td>Time - Short installation duration, minimising impact on local community</td>
<td>Maintenance - Higher maintenance cost than prestressed concrete bridges or steel box girders</td>
</tr>
<tr>
<td>Effectiveness - Cost-effective solution.</td>
<td>Additional design - May require steel cantilevers which would have cost implications during design and construction</td>
</tr>
</tbody>
</table>

Open-Topped Trapezoidal Girders

This proposal would consist of two trapezoidal girders, each comprising a bottom flange, inclined steel webs and a narrow steel flange on top of each web. The closed cell would be formed by the reinforced concrete slab deck.

The following table highlights the advantages and disadvantages of the open-topped trapezoidal girders bridge deck:

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation - excellent high torsional stiffness, therefore stable during erection and service compared to the multi-girder proposal</td>
<td>Cost - more expensive to fabricate and requires more time to design compared to plate girder</td>
</tr>
<tr>
<td>Aesthetics - excellence appearance and durability</td>
<td>Stability - provisions are needed to preserve stability during erection</td>
</tr>
<tr>
<td>Construction - reduced need to support points compared to the multi-girder proposals</td>
<td>Increased fabrication cost - greater fabrication costs on account of the reduced scope for automated fabrication and greater difficulty of handling and rotating during fabrication and coating</td>
</tr>
<tr>
<td>Durability - improved durability and reduced maintenance of protective coatings (less exposed surface, fewer edges, avoidance of exposed horizontal surfaces, no exposed bracing and stiffeners)</td>
<td>Risk - risk associated with working in confined spaces</td>
</tr>
</tbody>
</table>
**Pre-stressed Pre-Tensioned SY Beams with in-situ concrete**

This proposal would have a number of similar sized longitudinal pre-stressed pre-tensioned SY beams arranged at uniform spacing across the width of the bridge deck with the voids between the beams filled with in-situ concrete thus forming a solid deck. The SY beams were selected as they can span up to 40m.

The following table highlights the advantages and disadvantages of the Pre-stressed Pre-Tensioned SY Beams with in-situ concrete bridge deck:

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetics - clean and aesthetic lines</td>
<td>Construction - needs special equipment for lifting of the pre-cast units</td>
</tr>
<tr>
<td>Cost - cost efficiency</td>
<td>Supervision - strict Supervision required</td>
</tr>
<tr>
<td>Maintenance - improved durability and reduced</td>
<td>Transport - special arrangement required for transportation by road of pre-</td>
</tr>
<tr>
<td>maintenance (i.e. no painting needed when</td>
<td>cast units longer than 27.5m</td>
</tr>
<tr>
<td>compared to steel bridges)</td>
<td></td>
</tr>
<tr>
<td>Time - efficient construction and better</td>
<td></td>
</tr>
<tr>
<td>quality control (i.e. Pre-cast units)</td>
<td></td>
</tr>
</tbody>
</table>

### 11.7 Discounted Proposals

In addition to the above, the following bridge forms were initially considered but were discounted for the reasons listed below:

<table>
<thead>
<tr>
<th>Form of Bridge</th>
<th>Reasons for Rejection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Truss (half-through girders)</td>
<td>This are not recommended for Highways Bridges because of the risk of collapse due to</td>
</tr>
<tr>
<td></td>
<td>traffic collision with the main girder. Aesthetically unappealing. Regular maintenance</td>
</tr>
<tr>
<td></td>
<td>required to the exposed steel.</td>
</tr>
<tr>
<td>Steel Arch Bridge</td>
<td>Increased construction cost and maintenance cost.</td>
</tr>
<tr>
<td>Pre-Stressed Post-Tensioned Beams with in-situ</td>
<td>Difficult to construct due to the site constraints.</td>
</tr>
<tr>
<td>slab</td>
<td></td>
</tr>
</tbody>
</table>

### 11.8 Bridge Forms Summary

Based on indicative land take calculations a Multi-Girder Composite Bridge Deck is considered the most favourable arrangement for a crossing over the M11. In this case both bridge aspects (open and closed) have been considered. The example below is based on crossing Proposal C, Proposals A and B would be similar as discussed in Section 10.5.
• **Closed Bridge Aspect**

This proposal would consist of an integral bridge with a minimum span length of 28.5m providing a full height (5.3m) frame integral abutment with the supported structure founded well below the girders on bored piles. The integral bridge would need an approach embankment made of imported fill of approximately 172m (either side of the integral bridge) with a vertical gradient of 4% (i.e. 1 in 25) in the longitudinal direction and a vertical gradient of 50% (i.e. 1 in 2) in the transverse direction. Therefore the total length equates to 172+28.5+172=372.5m.

The following table summarises the area of land taken, and the volume of imported fill to create the embankment approaches:

<table>
<thead>
<tr>
<th>Land taken (m²)</th>
<th>Fill required (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12800</td>
<td>44800</td>
</tr>
</tbody>
</table>

The bridge form selected would consist on 6No. plate longitudinal girders of 1m height arranged at 3m intervals across the width of the deck connected to a 250mm reinforced concrete slab. A cross section of the proposed bridge deck is shown in Figure 57.

---

• **Open Bridge Aspect**

This solution would consist of a three span continuous structure with a main span of 33.5m and two side spans of 27m length. The bridge form would be the same as described above for the closed bridge aspect (i.e. 6No. plate longitudinal girders arranged at 3m intervals across the width of the deck connected to a 250mm reinforced concrete slab). The girder would be supported on a cantilever abutment wall with horizontal cantilever wing walls.

This solution provides a longer structure, however would reduce the amount of imported fill required for the embankment approaches. The embankment approach made of imported fill would have a length of approximately 148m (either side of the continuous structure). In this case the total length equates to 148+31+33.5+31+148=391.5m.

The following table summarises the area of land taken, and the volume of imported fill to create the embankment approaches:

<table>
<thead>
<tr>
<th>Land taken (m²)</th>
<th>Fill required (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13700</td>
<td>31200</td>
</tr>
</tbody>
</table>
11.8.1 Construction Methodology

The general sequence of construction for an overbridge is presented below. Specific sequencing would be dependent on the bridge form selected:

- Carry out site clearance & set up site compound
- Implementation of Traffic Management
- Earthworks, ground stabilisation (load transfer platform) and embankment construction
- Installation of subsurface elements; foundations
- Preparatory / enabling works (formwork/falsework)
- Cast abutments / supporting members of substructure
- Deck construction
- Application waterproofing to deck
- Lay pavement construction on road (busway)
- Install parapets, suitable edge protection and associated vehicle restraint system & transitions
- Install structure protection (VRS) below
- Remove / dismantle temporary works
- Demobilise from site, reinstate to agreed condition and open new overbridge

11.8.2 Construction Risks

Traffic Management would be required on M11 during installation of the new bridge. Lane closures may be required during the initial earthworks stage (construction of the embankments). A full carriageway closure, with implementation of a suitable diversion route, would be required for installation of beams and formwork/falsework. The arrangement would also be required when the substructure and superstructure are cast. Specific requirements would be dependent on the bridge form selected.

Access would be required across land either side of the structures position during the construction phase to construct approach structures and supports.

11.8.3 Property and Environmental Impacts

Crossing point Proposals A and B have open land of the Coton Orchard, and pasture land to the west side of the M11 giving suitable access to construct approach slopes to a bridge, subject to acquisition of land. To the east, both proposals enter the West Cambridge development, Proposal A aligning with Charles Babbage Road and Proposal B aligning with the maintenance/cycle track through West Cambridge. Both Proposals A and B impact on properties within the West Cambridge development and available space for approaches to the structure would be limited, requiring the use of retaining structures to support the approach gradient to reduce the footprint of the earthworks. Proposal C has open land to both the east and west of the M11 and would not impact on any properties, requiring only land to be acquired.

Proposal A is the furthest north of the three crossing positions and would pass through an area of environmental designation categorised as a City Wildlife Site (CiWS) and Protected Open Space located to the east of the M11. A public right of way runs through this area of land from the existing footbridge over the M11 north to the A1303 Madingley Road. Consent would be required to construct a busway through this area of land.
Proposal B would pass to the southern extent of the CiWS adjacent to an artificial badger sett located in this area. Mitigation measures may require a licence to close the sett and re-locate the badgers to another location in the vicinity.
11.9 M11 Crossing, Summary

Proposal A would provide a crossing of the M11 the furthest north of the three proposals close to Junction 13. To the west is open land suitable for an approach to the structure. To the east is a developed area of the West Cambridge development. The approach earthworks may impact on an existing property to the north and may require earth retaining structures to reduce the area required for the approach earthworks. The position of the structure close to Junction 13 would require a slightly longer structure length than other proposals.

Proposal B would provide a central crossing position of the three proposals considered. To the west is a vegetated area of semi mature woodland. To the east is the Data Centre building; the approach earthworks may impact on existing property and may require earth retaining structures to reduce the area required for the approach earthworks.

Proposal C – would provide a southern crossing of the three proposals. The position aligns to semi mature woodland either side of the M11 and isn’t restricted by existing properties being south of the West Cambridge development. The southern position would require the structure to be skewed to align with the proposed busway alignments to maintain design speeds.

In summary Proposals A and B would have greatest impact on the West Cambridge development providing direct links into the development but impacting on properties. Proposal C would align south of the West Cambridge development, providing ease of construction but with an alignment away from the employment area.
12 M11 Crossing – Green Bridge Assessment

12.1 Green Bridge Assessment Scope

Consideration has given to the provision of a ‘green bridge’ over the M11. A ‘green’ bridge is defined as an artificial structure which is either vegetated or provides a wildlife function to provide a habitat corridor. For the M11 crossing the green bridge would provide both a transport link (paved busway and footway/cycleways) and vegetation (hedgerows and grassed areas) over the M11 motorway. Comparisons have been made between different structural requirements for the provision of a ‘green bridge’ and a ‘grey bridge’ (standard bridge with only paved surfaces and no vegetation).

The route proposals are presented in Figure 58.

![Figure 58. Overview sketch of the three proposed crossing points over the M11](image)

12.2 Bridge Geometry

12.2.1 Anticipated Layout and Carriageway Geometry:

The required cross section width of the structure would be determined by the type of vegetation required which in turn would dictate the depth of fill. The carriageway width for provision of a two-way busway varies depending on the type of bus guidance system used; 6m for a kerbed system with 1m separation width (total 7m) or 7.3m for a road with an alternative bus guidance system. For the purpose of this section of the report a 6m wide guided busway section has been assumed, along with a 4m wide cycleway and 1m verge would be used for both the green and grey bridge proposals. Depth of construction of the bridge deck for the busway, footway/cycleway and verge would be assumed to be 0.2m.

The provision of a vegetation belt over the structure would be in the form of a hedgerow with two grassed areas either side. Minimum depths of soil required for vegetation to be planted are 0.3m of soil for grass, 0.6m for shrubs and 1.5m for trees. For the green bridge proposal it is assumed that a 2m wide hedge would be used requiring a soil depth of 0.6m. The grassed verges are assumed to have a varying depth between 0.2m and 0.6m.
The width is 17m for the grey bridge (Figure 56) and 22.3m (Figure 59) for the green bridge. A cross section for the ‘green’ bridge is shown in Figures 59.

Land either side of the M11 is at a similar level to the carriageway so a structure would need to be elevated to around 6m above the carriageway with suitable ramped approaches which would also require appropriate planting where possible.

The capacity and cross section of the bridge decks would be dictated by the expected traffic loads and so for the purpose of this assessment the ‘green bridge’ and ‘grey bridge’ proposals are expected to have the same depth of construction for both proposals across the full width of the bridges. This is also the case for the span length, abutment height and foundation depth so that the only variant between the two bridges is the width of the bridge deck. The structures would have a single span of 40m in length with either a composite deck (steel beams with a concrete top slab) or full concrete (pre-cast concrete beams with an in-situ top slab) structural form. The abutments would be full height with solid side spans/wingwalls supported by strip foundations although this would be dependent on the ground conditions.

12.3 Environmental Considerations

12.3.1 Crossing Proposal A

The installation of a ‘green bridge’ at this crossing point would have direct impacts on the City Wildlife Site (CiWS) east of the M11, and may result in significant habitat loss within the boundary of the CiWS. Impacts could be reduced by minimising loss of mature vegetation and maintaining strong habitat linkages. This route is unlikely to provide a significant corridor of habitat further into West Cambridge due to the development in the area.

12.3.2 Crossing Proposal B

The installation of a ‘green bridge’ at this crossing point may cause temporary or permanent habitat loss at the southern extent of the CiWS. The artificial badger sett located at the southern extent of the CiWS would be affected by this proposal.

This crossing point does however have a number of advantages - It adjoins the CiWS at the southern end and could be used to link the CiWS with the wider environment west of the M11. The eastern approach to the crossing point could be designed to link into either ‘Coton Path Hedgerow’ County Wildlife Site (CWS) and/or ‘Hedgerows East of M11’ CWS, creating a significant habitat corridor to provide connectivity into the west of Cambridge. The proposal follows the path of existing overhead power lines, for which vegetation has been kept clear beneath the lines west of the M11, reducing vegetation loss resulting from construction of the crossing.
12.3.3 Crossing Proposal C

This crossing would be to the south of the existing M11 footbridge crossing and is unlikely to have a significant negative impact on the CWS or CiWS. The proposal could be used to create a link with ‘Coton Path Hedgerow’ CWS & ‘Hedgerows East of M11’ CWS, providing a significant habitat corridor into the west of Cambridge.

12.3.4 Additional Information

There is a Special Area of Conservation (SAC) at Wimpole, which falls within 30 km of the proposed scheme. Design Manual for Roads & Bridges (DMRB) guidance states that this would require a screening exercise to determine if a Habitat Regulations Appropriate Assessment is required for the proposed works.

Previous bat activity survey results (2015) from the West Cambridge development identified a barbastelle bat (a rare species) flying along the ‘Coton Path Hedgerow’ CWS. Therefore, it was recommended that the West Cambridge development retained the ‘Coton Path Hedgerow’ as a ‘dark corridor’ as this species of bat is particularly sensitive to light. Barbastelle are associated with woodland habitats and minimising mature vegetation removal should be a priority around the proposed crossing point.
### Ecological Benefits Summary:

<table>
<thead>
<tr>
<th>Route Proposal</th>
<th>Crossing point habitat</th>
<th>Designated sites</th>
<th>Wider connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposal A</strong></td>
<td>The crossing point would impact on the smallest footprint area of mature vegetation, compared with the other crossing point proposals, particularly on the west side of the M11.</td>
<td>The bridge would directly link the CiWS with the wider landscape to the west.</td>
<td>Retains a large area of vegetation to the south of the crossing point, both sides of the M11. Limited potential for a significant wildlife corridor.</td>
</tr>
<tr>
<td><strong>Proposal B</strong></td>
<td>The crossing point follows a clearing through the area of mature vegetation provided for existing overhead power lines, reducing the amount of mature vegetation clearance required to provide the alignment.</td>
<td>Runs along CiWS southern boundary, providing linkage across M11.</td>
<td>Provides potential for a significant wildlife corridor linking into multiple CWSs and CiWSs.</td>
</tr>
<tr>
<td><strong>Proposal C</strong></td>
<td>The crossing point is aligned with a large area of mature vegetation to the west of the M11 north of the Coton footpath.</td>
<td>Does not directly impact any designated sites</td>
<td>Provides potential for a significant wildlife corridor linking into multiple CWSs and CiWSs.</td>
</tr>
</tbody>
</table>
## Ecological Constraints Summary:

<table>
<thead>
<tr>
<th>Route Proposal</th>
<th>Crossing point habitat</th>
<th>Designated sites</th>
<th>Wider connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposal A</strong></td>
<td>Potential loss of dense mature vegetation and segregation of a designated environmental area (CiWS)</td>
<td>Work would be required within a CiWS.</td>
<td>The eastern approach to this crossing point is from within the West Cambridge development with limited width to provide a significant long term wildlife corridor. Severance of mature vegetation strips along M11.</td>
</tr>
<tr>
<td><strong>Proposal B</strong></td>
<td>Evidence of an active, artificial badger sett present which may require closure and impact on the southern extent of the CiWS</td>
<td>May result in small amounts of temporary and/or permanent vegetation loss within CiWS.</td>
<td>The eastern approach to this crossing point is from the southern extent of the West Cambridge development reducing the potential to provide a significant long term wildlife corridor. Severance of mature vegetation strips along M11.</td>
</tr>
<tr>
<td><strong>Proposal C</strong></td>
<td>May result in significant amounts of vegetation loss, including mature vegetation.</td>
<td>May indirectly impact bat species along the Coton Footpath corridor</td>
<td>Cuts a large area of mature vegetation to the west of the M11 in two. Severance of mature vegetation strips along M11.</td>
</tr>
</tbody>
</table>

### 12.3.6 Green Bridge Summary

Provision of a ‘green’ bridge over the M11 at any of the identified crossing points would provide a habitat corridor between the east and west of the M11 where a suitable link currently doesn’t exist. The bridge would have benefits on the wider environment and could mitigate some of the potential habitat loss that the busway crossing may cause passing through the area.
13 M11 Crossing to Grange Road Link

13.1 Existing Arrangement

The M11 crossing to Grange Road busway proposals would pass through or to the south of the West Cambridge development, across the northern extent of the west fields area and link to Grange Road via one of four potential routes.

Northern alignment proposals pass through the West Cambridge development area, a research park being developed by the University of Cambridge and a developing major employment area. An existing segregated footway/cycleway runs through the development linking west Cambridge with Coton to the west, crossing the M11 via an existing footbridge, this route forms part of the Harcamlow Way long distance walk route. Charles Babbage Road runs east-west through the development area. The roads within the site are owned by Cambridge University and are subject to a 20mph speed restriction.

To the south are the west-fields, an area of open agricultural land between Cambridge and the M11. The Bin brook water course runs to the eastern extent of the area, with southern route proposals requiring a crossing facility to be provided over the watercourse.

At the eastern extent the busways would utilise alignments along Adams Road, Herschel Road, the Rifle Range access track and Cranmer Road to link to Grange Road.

The link is 1.5km in length.

Figure 60 – M11 Crossing to Grange Road link
13.2 Existing constraints

13.2.1 Carriageway alignment and land constraints

- West Cambridge Lake and Canal is located to the south of Charles Babbage Road. The maintenance road/cycle path running east to west though the site crosses the northern extent of the lake with a bridge structure. A canal runs adjacent to the maintenance track along the southern side linking with the lake. To the east of the lake is the University Sports Centre.

- There are multiple buildings located along Charles Babbage Road. These include the University Department of Science and Metallurgy, Chemical Engineering and Biotechnology, the University Sports Centre, The Institute for Manufacturing, West Cambridge Residences, Hauser Forum, visitors parking and Entrepreneurship Centre. These facilities are major employers and whilst they need to remain unaffected by the busway alignments they should be served by bus services using the busway.

- Existing buried statutory undertakers’ services are located along the Charles Babbage Road corridor both within and adjacent to the highway running longitudinal to the carriageway. These include BT, Virgin Media, Cambridge Water, UKPN and National Grid.

- Existing buried statutory undertakers’ services including Fulcrum Gas, Virgin Media, Cambridge Water and UKPN are present along the Philippa Fawcett Drive corridor both within and adjacent to the Highway Boundary running longitudinal to the carriageway.

- Existing buried statutory undertakers’ services including Virgin Media, Fulcrum Gas and Cambridge Water are present along the Cambridge University cycle path, for a short length, to the east of the M11.

13.2.2 Non motorised users

- An existing footway/cycleway between Coton and Cambridge runs south of the West Cambridge development site. This crosses the M11 via an existing footbridge running through open land east of the M11, then turns north towards West Cambridge before turning east to link with Adams Road and routes into Cambridge. This is part of a national trail, the Harcamlow Way and is a busy route for cyclists.

- An existing segregated footway/cycleway runs through the West Cambridge development east to west. Linking with the Coton to Cambridge cycle route to the east.

- Footway cycleways are present within the West Cambridge site along Charles Babbage Way.

13.2.3 Environmental

- The west fields area to the south comprises of arable farmland with fields bounded by mature hedgerows. A number of these hedgerows have County Wildlife Site designation and are required to be retained. A 2015 survey confirmed the presence of bats with the Wildlife Sites.
13.2.4 Link alignment development

Early stage busway alignments identified for the section between the M11 Crossing and Grange Road considered three route proposals; A northern proposal following on-road through West Cambridge via Charles Babbage Road through to Adams Road, a centrally positioned proposal following the Coton to Cambridge Public Right of Way through to Herschel Road or Cranmer Road, and a southern proposal following land boundaries to the south of the West Cambridge development linking to the old Rifle Range access track.

Further development of the proposals was carried out in spring 2017 and considered a further fully segregated busway aligned through the West Cambridge development cutting across the West Cambridge Lake.

To provide greater flexibility of the busways, further proposals have been developed to provide interlinking routes connecting between the three M11 crossing proposals and the four identified routes to Grange Road, these being Adams Road, Herschel Road, the Rifle Range access track and Cranmer Road.

Route alignments have been developed to provide smooth potential busway alignments to maximise design speeds to provide bus rapid transit.

Seven potential busway proposals have been identified and are discussed in this report based on potential design speed and land/environmental impacts.
13.3 M11 Crossing to West Cambridge Link

Proposal 1 - Busway positioned north from proposed M11 crossing Proposal A through the West Cambridge development to Adams Road

- The proposal would provide a busway from a northern positioned M11 crossing (A) through to Adams Road at its junction with Wilberforce Road. From here the busway would continue to Grange Road along Adams Road.
- The proposal utilises the existing Charles Babbage Road from the west, turning to align south around the Forster Court buildings. It then follows the alignment of existing shared-use footway/cycleway route along the north side of the University Sports Ground through to Wilberforce Road/Adams Road.
- The proposed footway/cycleway would separate from the busway from the western end and follow the existing footway/cycleway alignment through West Cambridge to the Cavendish Laboratory, where the alignment of the busway would realign with the footway/cycleway through to Adams Road.

![Figure 61 - Busway from Proposal A M11 Crossing to Grange Road via Adams Road - Proposal 1 Alignment](image)

13.3.1 Link Alignment

The alignment of the Proposal 1 (green) link has been designed to utilise existing carriageway within the West Cambridge development, following a northern alignment position to allow buses to serve the West Cambridge development and to have a minimal impact on the land in West Cambridge. The alignment along Charles Babbage Road would be governed by the existing road alignment and the speed limit of the road. The alignment includes multiple junction points and 90 degree turns requiring the bus to come to a stop and make slow speed manoeuvres. The segregated section of busway to the east alongside the University sports ground has a 270m bend to align to Adams Road which provides a 20mph design speed. This alignment is largely affected by the existing road.
network and the shared-use pedestrian/cyclist facility alignments as well as the positioning of local private properties.

13.3.2 Safety Assessment

- The link would follow along Charles Babbage Road through the West Cambridge development. The road has footway/cycleways either side and numerous junctions and accesses along its length. The risk of conflict between pedestrian, cyclists and motorists would be increased by utilising an unsegregated section of busway along the existing road in a built-up area.
- The busway east of the West Cambridge development would follow the existing footway/cycleway to Adams Road. This has accesses to Stacey Lane, Clerk Maxwell Road, and Cavendish Laboratories for pedestrian and cyclists along its length. Provision of a segregated busway along this established pedestrian and cycle facility could lead to conflict between buses and pedestrians/cyclists that are familiar with the existing arrangement.

13.3.3 Construction Risks

- Temporary traffic management would be required to construct the busway with Charles Babbage Road comprising of temporary traffic signals and carriageway lane closures.
- Pedestrian/cyclist management would be required to construct the busway comprising of footway/cycleway closures and diversions.
- To the west the busway would require construction close to existing properties to align with a northern M11 crossing point (A).
- Land acquisition/alteration of existing road and footway/cycleways would be required in privately owned land areas.

13.3.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 1 (Green) alignment land area has been carried out. Existing hedgerows alongside the footway/cycleway south of the Cavendish Laboratories are designated as Wildlife Sites. Land either side of the existing footway/cycleway comprising of the University sports ground to the south and the Emmanuel College sports ground are designated open spaces. To widen the existing footway/cycleway through this section to provide a busway would require land acquisition along this section.

The route would pass though the car park access of the Forster Court building south of Charles Babbage Road. Private residential properties are located in Perry Court off Clerk Maxwell Road which back onto the existing footway/cycleway, along which the busway would pass, placing the properties in close proximity to the busway.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>M11 Crossing proposals compatible</td>
</tr>
<tr>
<td>Grange Road link compatible</td>
</tr>
<tr>
<td>M11 Crossing proposals not compatible</td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
</tr>
</tbody>
</table>
13.3.5 Proposal 1 SWOT Assessment

**Strengths**
- Minimal impact on surrounding properties.
- Would utilise the existing road network and shared-use pedestrian facility corridor through to Adams Road.
- Links directly with the West Cambridge employment area.

**Weaknesses**
- The achievable design speed is low due to tight corner radii and multiple junction points.
- Part of link subject to Charles Babbage Road speed limit (20mph).
- Existing shared-use pedestrian/cyclist facility would be replaced by busway and new footway/cycleway.
- Risk of delays to journey times using on-road busways.

**Opportunities**
- Greater flexibility for local bus services to be provided that can utilise the busway from Adams Road to Charles Babbage Road.

**Outcomes**
- Proposal 1 has minimal impact on adjacent properties and utilises the existing road network.
- The proposal has a low design speed due to tight radii and junction points.

**Threats**
- Land required from the Forster Court for carpark cut-through – potential objection from land owners.
13.4 Proposal 2a - Busway from the proposed M11 Proposal B central crossing to Grange Road via the Rifle Range access track reducing land take.

- The proposal would provide a busway from the M11 crossing Proposal B to Grange Road via West Cambridge to the old Rifle Range access track, following existing land boundaries.
- The proposal would provide a segregated busway within the West Cambridge development, turning south around the University sports ground to connect with a route via the old Rifle Range access track to Grange Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 63 - Busway from Proposal B M11 Crossing to Grange Road via Rifle Range access - Proposal 2a Alignment](image)

13.4.1 Link Alignment

The alignment of Proposal 2a (blue) has been designed to provide a segregated busway positioned to provide good access to the West Cambridge development with reduced impact on the adjacent road network through the development. The proposal would be positioned to align with an M11 crossing position (B) which links directly with the West Cambridge development, crossing the West Cambridge Lake via a new structure and following a route south of the canal. To the east the busway is aligned to the south to link with the Rifle Range access track to provide a fully segregated busway through the section to Grange Road. To achieve this alignment the design speed has been reduced along the eastern section to enable the link to follow land boundary lines, following the western boundary of the University sports ground. A 90 degree turn would require the bus to come to a stop and make the slow speed manoeuvre to the south, which would not be possible with a guided busway system. The alignment south of the University sports ground has a maximum radii of 160m, providing a design speed of 30kph based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. To the east the link would require a new crossing of the Bin Brook watercourse to link with the Rifle Range access track.

![Figure 64 Proposal 2a Busway Section](image)
13.4.2 Safety Assessment
- The link through West Cambridge would require a number of crossing points for pedestrians, increasing the risk of conflict between pedestrians and buses along this section of the busway.

13.4.3 Construction Risks
- Temporary traffic management would be required to construct the busway at the western end of the link to cross Ada Lovelace Road, comprising of temporary traffic signals and carriageway lane closures.
- Land acquisition would be required from private owned land areas and agreement to construct the link through the West Cambridge development with the University of Cambridge.
- To the west the busway would require construction close to existing properties to align with a central M11 crossing point (B).

13.4.4 Property and Environmental Impacts
A search of environmental designations for the proposed Proposal 2a (blue) alignment land area has been carried out. Existing hedgerows alongside the footway/cycleway south of the Cavendish Laboratories through which the proposed busway would pass are designated as Wildlife Sites. The University sports ground along which the busway would pass to the west is designated open spaces.

The route would pass through a paved area north of the University sports centre entrance, requiring alteration of the paved area and cycle parking facilities.

### Junction Proposals Compatible

<table>
<thead>
<tr>
<th>M11 Crossing proposals compatible</th>
<th>o Proposal B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grange Road link compatible</td>
<td>o Rifle Range Access</td>
</tr>
<tr>
<td>M11 Crossing proposals not compatible</td>
<td>o Proposal A and Proposal C</td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
<td>o Adams Road, Herschel Road and Cranmer Road</td>
</tr>
</tbody>
</table>
13.4.5 Proposal 2a SWOT Assessment

**Strengths**
- Provides a direct and well aligned link into West Cambridge.
- Links directly with the West Cambridge employment area.
- Minimal impact on the surrounding road network through West Cambridge.
- Would not be affected by existing speed restrictions on the road network.

**Weaknesses**
- The achievable design speed is low due to tight corner radii to the eastern section of the link.
- A new structure crossing of the West Cambridge Lake would be required.
- A new structure would be required to cross the Bin Brook watercourse at the eastern end of the link.

**Opportunities**
- Greater flexibility for local bus services to be provided that can utilise the busway from Grange Road through to the West Cambridge development.

**Threats**
- Land required from the University of Cambridge and adjacent landowners to connect through to the Rifle-Range access track.

**Outcome**
- Proposal 2a provides a fully segregated busway to serve directly the West Cambridge development.
- The proposal has a low design speed due to tight radii and requires new structures increasing costs.
13.5 Proposal 2b - Busway from the proposed M11 Proposal B central crossing to Grange Road via the Rifle Range access track

- The proposal would provide a busway from the M11 crossing Proposal B to Grange Road via West Cambridge to the old Rifle Range access track.
- The proposal would provide a segregated busway within the West Cambridge development, passing the University sports centre, east of which the link would cross farmland in a south-easterly direction to connect with a route via the old Rifle Range access track to Grange Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 65 - Busway from Proposal B M11 Crossing to Grange Road via Rifle Range access - Proposal 2b Alignment](image)

### 13.5.1 Link Alignment

The alignment of Proposal 2b (blue) has been designed to provide a segregated busway positioned to provide good access to the West Cambridge development with reduced impact on the adjacent road network through the development, and to achieve a higher design speed than Proposal 2a. The proposal would be positioned to align with an M11 crossing position (B) which links directly with the West Cambridge development, crossing the West Cambridge Lake via a new structure and following a route south of the canal. East of the University sports centre the alignment would follow to the south across open farm land with a maximum radii of 360m, providing a design speed of 50kph along the link based on a guideway constructed with a 2.5% supererelevation as detailed in section 2 of this Report. The alignment would pass south of the University sports ground to link with the old Rifle Range access track. The link would require a new crossing of the Bin Brook watercourse to link with the Rifle Range access track.
13.5.2 Safety Assessment
- The link through West Cambridge would require a number of crossing points for pedestrians, increasing the risk of conflict between pedestrians and buses along this section of the busway.

13.5.3 Construction Risks
- Temporary traffic management would be required to construct the busway at the western end of the link to cross Ada Lovelace Road, comprising of temporary traffic signals and carriageway lane closures.
- Land acquisition would be required from private owned land areas and agreement to construct the link through the West Cambridge development with the University of Cambridge.
- Construction of crossings of the West Cambridge Lake and Bin Brook require working near open water. Protection of the workforce and pollution control measures would be required.
- To the west the busway would require construction close to existing properties to align with a central M11 crossing point (B).

13.5.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 2b (blue) alignment land area has been carried out. Existing hedgerows alongside the footway/cycleway south of the Cavendish Laboratories through which the proposed busway would pass are designated as Wildlife Sites. The University sports ground along which the busway would pass to the west is designated open spaces.

The route would pass through a paved area north of the University sports centre entrance, requiring alteration of the paved area and cycle parking facilities. To the east of the West Cambridge development the route would segregate farm land to align south to link with the Rifle Range access track, creating parcels of land.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
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</thead>
<tbody>
<tr>
<td>M11 Crossing proposals compatible</td>
</tr>
<tr>
<td>Grange Road link compatible</td>
</tr>
<tr>
<td>M11 Crossing proposals not compatible</td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
</tr>
</tbody>
</table>
13.5.5 Proposal 2b SWOT Assessment

**Strengths**
- Provides a direct and well aligned link into West Cambridge.
- Links directly with the West Cambridge employment area.
- Minimal impact on the surrounding road network through West Cambridge.
- Would not be affected by existing speed restrictions on the road network.

**Weaknesses**
- The achievable design speed (50kph) is lower than maximum permitted due to curves in the busway alignment.
- A new structure crossing of the West Cambridge Lake would be required.
- A new structure would be required to cross the Bin Brook watercourse at the eastern end of the link.
- Land parcels created due to cutting directly through farm land.

**Opportunities**
- Greater flexibly for local bus services to be provided that can utilise the busway from Grange Road through to the West Cambridge development.

**Threats**
- Land required from the University of Cambridge and adjacent land owners to connect through to the Rifle Range access track.

**Outcome**
- Proposal 2b provides a fully segregated busway to serve directly the West Cambridge development with greater design speed than Proposal 2a.
- The proposal segregates land and requires two new structures.
13.6 Proposal 3a - Busway from proposed M11 Proposal C southern crossing to Grange Road via Herschel Road

- The proposal would provide a busway from the southern M11 crossing Proposal C to Grange Road via Herschel Road.
- The proposal would follow the alignment of an existing Public Right of Way (Harcamlow Way) from the M11 footbridge, passing south of the West Cambridge development and cutting diagonally across farmland to link to Herschel Road through to Grange Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 67 - Busway from Proposal C M11 Crossing to Grange Road via Herschel Road – Proposal 3a Alignment](image)

13.6.1 Link Alignment

The alignment of the Proposal 3a (red) link has been designed to have a minimal impact on the adjacent land whilst being positioned to align with a southern M11 crossing position (C) which links south of the West Cambridge development. The link follows the line of the existing Public Right of Way from the west to reduce segregation of farmland. Where the path turns to the north midway along the link the busway would then cut across farmland with a linear alignment to reduce uneven segregation of land, aligning south of the University sports ground. The alignment has a maximum radius of 720m and no junction points giving a 70kph design speed based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. The busway would connect with the western end of Herschel Road which is privately owned by Clare Hall University.

![Figure 68 Proposal 3a Busway Section](image)
13.6.2 Safety Assessment

- Fully segregated busway and footway/cycleway. No safety related concerns.

13.6.3 Construction Risks

- Land acquisition would be required from private owned land areas and agreement to construct the link through Clare Hall University owned land.

13.6.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 3a (red) alignment land area has been carried out. Existing hedgerows alongside the Public Right of Way from the M11 east are designated Wildlife Sites alongside which the busway would be aligned. This area has been identified for bat potential during 2015 surveys and the hedgerows are to be retained. Any busway along this section would need to be positioned so as not to negatively impact on the Wildlife Site.

The route would pass open farm land following a linear alignment to reduce uneven segregation of land. To the east the link would pass through an area of trees at the western end of Herschel Road owned by Clare Hall University.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
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<tbody>
<tr>
<td>M11 Crossing proposals compatible</td>
</tr>
<tr>
<td>Grange Road link compatible</td>
</tr>
<tr>
<td>o Proposal C</td>
</tr>
<tr>
<td>o Herschel Road</td>
</tr>
<tr>
<td>M11 Crossing proposals not compatible</td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
</tr>
<tr>
<td>o Proposal A and Proposal B</td>
</tr>
<tr>
<td>o Adams Road, Rifle Range access track and Cranmer Road</td>
</tr>
</tbody>
</table>
13.6.5 Proposal 3a SWOT Assessment

**Strengths**
- Minimal impact on surrounding properties.
- Fully segregated busway and footway/cycleway away from public roads.
- Higher design speeds achievable than proposals which pass through West Cambridge.

**Weaknesses**
- Design speed does not achieve the maximum permitted as the alignment is designed to reduce uneven segregation of land.
- Land parcels created due to cutting directly through farm land.
- Busway does not directly enter West Cambridge development employment area.

**Opportunities**
- Potential environmental enhancements could be carried out within the area of the existing Wildlife Site corridor.

**Threats**
- Land purchase required across land south of West Cambridge and for the private section of Herehlel Road.

**Outcome**
- The Proposal 3a has a higher average design speed than some other proposals due to having no tight bends or junctions.
- The proposal does not directly serve the West Cambridge development.
13.7 Proposal 3b - Busway from proposed M11 Proposal C southern crossing to Grange Road via Cranmer road

- The proposal would provide a busway from the southern M11 crossing Proposal C to Grange Road via Cranmer Road.
- The proposal would follow the alignment of an existing Public Right of Way (Harcamlow Way) from the M11 footbridge, passing south of the West Cambridge development and cutting diagonally across farmland to link to Cranmer Road through to Grange Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

13.7.1 Link Alignment

The alignment of the Proposal 3b (purple) link has been designed to have a minimal impact on the adjacent land whilst being positioned to align with a southern M11 crossing position (C) which links south of the West Cambridge development. The link follows the line of the existing Public Right of Way from the west to reduce segregation of farmland. Where the path turns to the north midway along the link the busway would then cut across farmland with a curved alignment to reduce uneven segregation of land, aligning south to link with Cranmer Road. The alignment would provide a 720m radius linking into a 1600m radius to the east, providing a design speed of 720m to 100kph based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report.

At the eastern end toward Cranmer Road the busway would cross the Bin Brook watercourse requiring a new structure to be provided.
13.7.2 Safety Assessment
- Fully segregated busway and footway/cycleway. No safety related concerns.

13.7.3 Construction Risks
- Land acquisition would be required from private owned land areas.
- Construction of a crossing of Bin Brook would require working near open water. Protection of the workforce and pollution control measures would be required.

13.7.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 3b (pale pink) alignment land area has been carried out. Existing hedgerows alongside the Public Right of Way from the M11 east are designated Wildlife Sites alongside which the busway would be aligned. This area has been identified for bat potential during 2015 surveys and the hedgerows are to be retained. Any busway along this section would need to be positioned so as not to negatively impact on the Wildlife Site.

The route would pass open farm land following a linear alignment to reduce uneven segregation of land.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
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</thead>
<tbody>
<tr>
<td><strong>M11 Crossing proposals compatible</strong></td>
</tr>
<tr>
<td>Grange Road link compatible</td>
</tr>
<tr>
<td>o Proposal C</td>
</tr>
<tr>
<td>o Cranmer Road</td>
</tr>
<tr>
<td><strong>M11 Crossing proposals not compatible</strong></td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
</tr>
<tr>
<td>o Proposal A and Proposal B</td>
</tr>
<tr>
<td>o Adams Road, Herschel Road and the Rifle Range access track.</td>
</tr>
</tbody>
</table>
13.7.5 Proposal 3b SWOT Assessment

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Minimal impact on surrounding properties.</td>
<td>• Design speed does not achieve the maximum permitted as the alignment is designed to reduce uneven segregation of land.</td>
</tr>
<tr>
<td>• Fully segregated busway and footway/cycleway away from public roads.</td>
<td>• Land parcels created due to cutting directly through farm land.</td>
</tr>
<tr>
<td>• Higher design speeds achievable than proposals which pass through West Cambridge.</td>
<td>• Busway does not directly enter West Cambridge development employment area</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Potential environmental enhancements could be carried out within the area of the existing Wildlife Site corridor.</td>
<td>• Land purchase required across land south of West Cambridge</td>
</tr>
</tbody>
</table>

**Outcome**

- The Proposal 3b has a higher average design speed than some other proposals due to having no tight bends or junctions.
- The proposal does not directly serve the West Cambridge development.
13.8 Proposal 4 - Busway from the proposed M11 Proposal B central crossing aligned to the south to link with Grange Road via the Rifle Range access track

- The proposal would provide a busway from the central M11 crossing Proposal B to Grange Road via the old Rifle Range access track, with the route aligned south away from West Cambridge.
- The proposal would align south from the West Cambridge development along Ada Lovelace Road aligning east along existing land boundaries to link to the Rifle Range access track to Grange Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 71 Busway from M11 crossing to Grange Road via Rifle Range access track - Proposal 4 Alignment](image)

13.8.1 Link Alignment

The alignment of the Proposal 4 (pale blue) link has been designed to have a minimal impact on the adjacent land whilst being positioned to align with a central M11 crossing position (B). The busway would provide direct access to the West Cambridge development employment area to the western end, whilst providing a route to the east away from the development to avoid creating land parcels. From West Cambridge the link would be aligned on road along the Ada Lovelace Road (20mph speed limit) to the south, crossing the existing Public Right of Way (Harcamlow Way). The alignment curve to the east would have a maximum radius of 190m giving a slower 35kph design speed based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. The busway alignment would then be straight providing the maximum 120kph design speed, reducing to 50kph to the east to align with the Rifle Range access track.

The link would require a new crossing of the Bin Brook watercourse to link with the Rifle Range access track.

![Figure 72 Proposal 4 Busway Section](image)
13.8.2 Safety Assessment

- The link would follow along Ada Lovelace Road through the West Cambridge development. The road has footway/cycleways either side and numerous junctions and accesses along its length. The risk of conflict between pedestrian, cyclists and motorists would be increased by utilising an unsegregated section of busway.
- The route would cross the existing east–west footway/cycleway between Cambridge and Coton (Harcamlow Way) which is a well-used route. The crossing would need to be managed to prevent conflict between pedestrians/cyclists and buses.

13.8.3 Construction Risks

- Temporary traffic management would be required to construct the busway with Ada Lovelace Road comprising of temporary traffic signals and carriageway lane closures.
- Land acquisition would be required from private owned land areas and agreement to construct the link through the West Cambridge development with the University of Cambridge.
- Pedestrian/cyclist management would be required to construct the busway comprising of footway/cycleway closures and diversions.
- Construction of a crossing of Bin Brook would require working near open water. Protection of the workforce and pollution control measures would be required.

13.8.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 4 (pale blue) alignment land area has been carried out. Existing hedgerows alongside the western extent of the link south of West Cambridge designated Wildlife Sites alongside which the busway would be aligned. Any busway along this section would need to be positioned so as not to negatively impact on the Wildlife Site.

The route would pass open farm land following a linear alignment to reduce uneven segregation of land.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
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</thead>
<tbody>
<tr>
<td>M11 Crossing proposals compatible</td>
<td>o  Proposal B</td>
</tr>
<tr>
<td>Grange Road link compatible</td>
<td>o  Rifle Range Access</td>
</tr>
<tr>
<td>M11 Crossing proposals not compatible</td>
<td>o  Proposal A and Proposal C</td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
<td>o  Adams Road, Herschel Road and Cranmer Road</td>
</tr>
</tbody>
</table>
13.8.5 Proposal 4 SWOT Assessment

**Strengths**

- Provides a direct link into West Cambridge.
- Minimal impact on surrounding properties.
- Higher design speeds achievable than proposals which pass through West Cambridge.

**Weaknesses**

- On road section into West Cambridge would be subject to speeds limit (20mph) and potential delays.
- A new structure would be required to cross the Bin Brook watercourse at the eastern end of the link.
  - Route cuts across open farmland.

**Opportunities**

- Potential environmental enhancements could be carried out within the area of the existing Wildlife Site corridor.

**Threats**

- Land purchase required across land south of West Cambridge.

**Outcome**

- Proposal 4 provides a busway to serve West Cambridge development with greater design speeds along the segregated section and reduced creation of land parcels.
- The position is far south across open farmland.
13.9 Proposal 5 - Busway from the proposed M11 Proposal A northern crossing aligned to link with Grange Road via the Adams Road

- The proposal would provide a busway from a northern positioned M11 crossing (A) through to Adams Road at its junction with Wilberforce Road. From here the busway would continue to Grange Road along Adams Road.
- The proposal would align south from the West Cambridge development along Ada Lovelace Road aligning east to follow the alignment of the existing Public Right of Way (Harcamlow Way), passing south of the West Cambridge development. The route would then cut diagonally across farmland to follow the alignment of existing shared-use footway/cycleway route along the north side of the University Sports Ground through to Wilberforce Road/Adams Road.
- The proposed footway/cycleway follows adjacent to the busway the full length.

![Figure 73 Busway from M11 crossing to Grange Road via Adams Road - Proposal 5 Alignment](image)

13.9.1 Link Alignment

The alignment of the Proposal 5 (pink) link has been designed to provide a direct link from the western extent of the West Cambridge development whilst having a minimal impact on the adjacent land within West Cambridge. From West Cambridge the link would be aligned on road along the Ada Lovelace Road (20mph speed limit) to the south to align with a link east along the line of the existing Public Right of Way (Harcamlow Way). Where the path turns to the north midway along the link the busway would then cut across farmland with a diagonal alignment aligning north of the University sports ground. The alignment has a maximum radius of 510m giving a 60kph design speed based on a guideway constructed with a 2.5% superelevation as detailed in section 2 of this Report. The busway to the east would then align with the existing footway/cycleway alongside the northern side of the University sports ground with 270m bend to align to Adams Road, which provides a 20mph design speed.

![Figure 74 Proposal 5 Busway Section](image)
13.9.2 Safety Assessment

- The link would follow along Ada Lovelace Road through the West Cambridge development. The road has footway/cycleways either side and numerous junctions and accesses along its length. The risk of conflict between pedestrian, cyclists and motorists would be increased by utilising an unsegregated section of busway.
- The busway east of the West Cambridge development would follow the existing footway/cycleway to Adams Road. This has accesses to Stacey Lane, Clerk Maxwell Road, and Cavendish Laboratories for pedestrian and cyclists along its length. Provision of a segregated busway along this established pedestrian and cycle facility could lead to conflict between buses and pedestrians/cyclists that are familiar with the existing arrangement.

13.9.3 Construction Risks

- Temporary traffic management would be required to construct the busway with Ada Lovelace Road comprising of temporary traffic signals and carriageway lane closures.
- Pedestrian/cyclist management would be required to construct the busway comprising of footway/cycleway closures and diversions.
- Land acquisition/alteration of existing road and footway/cycleways would be required in privately owned land areas.

13.9.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 5 (pink) alignment land area has been carried out. Existing hedgerows alongside the Public Right of Way from the M11 east are designated Wildlife Sites alongside which the busway would be aligned. This area has been identified for bat potential during 2015 surveys and the hedgerows are to be retained. Any busway along this section would need to be positioned so as not to negatively impact on the Wildlife Site. Existing hedgerows alongside the footway/cycleway south of the Cavendish Laboratories are designated as Wildlife Sites.

Land either side of the existing footway/cycleway comprising of the University sports ground to the south and the Emmanuel College sports ground are designated open spaces. To widen the existing footway/cycleway through this section to provide a busway would require land acquisition along this section.

To the east of the existing Public Right of Way (Harcamlow Way) the busway would segregate farm land to align north to link with the existing footway/cycleway north of the University sports ground.

<table>
<thead>
<tr>
<th>Junction Proposals Compatible</th>
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<tbody>
<tr>
<td>M11 Crossing proposals compatible</td>
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<tr>
<td>Grange Road link compatible</td>
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<tr>
<td>M11 Crossing proposals not compatible</td>
</tr>
<tr>
<td>Grange Road link not compatible</td>
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</tbody>
</table>
13.9.5 Proposal 5 SWOT Assessment

**Weaknesses**
- Part of link subject to Ada Lovelace Road speed limit (20mph).
- The achievable design speed (60kph) is lower than maximum permitted due to curves in the busway alignment.
  - Land parcels created due to cutting directly through farm land.
  - Existing shared-use pedestrian/cyclist facility would be replaced by busway and new footway/cycleway.
  - Risk of delays to journey times using on-road busways.

**Strengths**
- Provides a direct link into West Cambridge.
- Minimal impact on surrounding properties.

**Opportunities**
- Greater flexibly for local bus services to be provided that can utilise the busway from Adams Road to Ada Lovelace Road.
- Potential environmental enhancements could be carried out within the area of the existing Wildlife Site corridor.

**Threats**
- Land purchase required across land south of West Cambridge.

**Outcome**
- Proposal 5 has minimal impact on adjacent properties provides a link into the West Cambridge development.
- The proposal aligns from the north to the south and then returns north increasing journey times.
13.10 M11 Crossing to West Cambridge Summary

Proposal 1 (green) would provide a busway through the West Cambridge development through to Adams Road. The busway would utilise an on-road section along Charles Babbage Road from the west, then be aligned along the existing footway/cycleway route link through to Adams Road. The alignment provides good connectivity with the West Cambridge development but would be susceptible to delays through the on-road section and the alignment would be restricted by properties providing low design speeds.

Proposal 2a (blue) would provide a segregated busway through the West Cambridge development aligned across the West Cambridge Lake and north of the University sports centre, providing good connectivity with the West Cambridge development. The busway is aligned with property boundaries to reduce the impact on land, linking through to the Rifle Range access track, resulting in low design speeds.

Proposal 2b (blue) would provide a segregated busway through the West Cambridge development aligned across the West Cambridge Lake and north of the University sports centre, providing good connectivity with the West Cambridge development. The busway would align south to link with the Rifle Range access track, segregating open farmland to provide an increased design speed compared to Proposal 2a.

Proposal 3a (red) would be aligned along the Coton to Cambridge Public Right of Way, following existing land boundaries to link to Herschel Road to the east. The busway provides a well aligned route with higher design speeds and would evenly divide land areas. The busway would be south, away from the West Cambridge development and therefore would not provide a direct connection to this employment area that proposals further north provide.

Proposal 3b (purple) would provide a busway aligned along the Coton to Cambridge Public Right of Way, connecting to Cranmer Road to the east. The busway provides a well aligned route with higher design speeds and would evenly divide land areas. The busway would be south, away from the West Cambridge development and therefore would not provide the direct connection to this employment area than proposals further north provide.

Proposal 4 (pale blue) busway connects the West Cambridge development with the Rifle Range access track. The busway utilises a slow speed on-road link along Ada Lovelace Road to align south to follow field boundaries to evenly divide land areas. The busway provides good connectivity to the West Cambridge development at the western end, but would be susceptible to delays. East of the Ada Lovelace Road section the alignment is straight, providing maximum design speeds through to the Rifle Range access track.

Proposal 5 (pink) provides a busway between the West Cambridge development and Adams Road via the Coton to Cambridge Public Right of Way. The busway utilises a slow speed on-road link along Ada Lovelace Road to align south to follow the Public Right of Way to the east. The busway then aligns north segregating open farmland. The alignment results in low design speeds.

In summary Proposals 1, 4 and 5 provide direct connection with the West Cambridge development but utilise on-road sections resulting in the potential for delays. Proposals 2a and 2b provide segregated routes through the West Cambridge development, with Proposal 2b having a smoother alignment but segregating open farmland as a result. Proposals 3a, 3b provide segregated busways to the south evenly dividing land areas.
14 Bin Brook Crossing Proposals

14.1 Bin Brook Crossing

Consideration has been given to structure proposals for crossing the Bin Brook watercourse in west Cambridge. Busway proposals connecting to Grange Road via Herschel Road, the Rifle Range access track and Cranmer Road will be required to cross Bin Brook. Bin Brook is designated as a Main River by the Department of Environment, Food and Rural affairs, and is a maintenance responsibility of the Environment Agency.

14.1.1 Route Proposals

Three of the four busway route proposals considered for connecting to Grange Road would be required to cross Bin Brook, with Adams Road being unaffected. Herschel Road has an existing structure over Bin Brook which for the purpose of this report is considered adequate for the busway. Busways connecting to the Rifle Range access track and Cranmer Road would require new structures over Bin Brook which are considered here.

Figure 75 below highlights points the busway will be required to cross Bin Brook indicated by red circles.

Figure 75 - Route proposals for the Bin Brook crossing
14.1.2 Span Lengths and carriageway geometry

The approximate span lengths for the various crossing points are detailed in the table below:

<table>
<thead>
<tr>
<th>ROUTE PROPOSAL</th>
<th>Rifle Range access track</th>
<th>Cranmer Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of watercourse (m)</td>
<td>2.75m</td>
<td>1.55m</td>
</tr>
<tr>
<td>Skew width (m)</td>
<td>2.78m</td>
<td>1.60m</td>
</tr>
<tr>
<td>Span† (m)</td>
<td>4m</td>
<td>3m</td>
</tr>
<tr>
<td>Skew Angle (°)</td>
<td>7°</td>
<td>14°</td>
</tr>
</tbody>
</table>

Table 7 - Span lengths required
† The envisaged span length allows for skew, scour protection and construction / groundworks in proximity to watercourse.

14.1.3 Carriageway Width

For the purpose of this document a typical section 17m width is considered for the proposed carriageway.

14.1.4 Busway proposals connecting to the Rifle Range access track

At the eastern end of the scheme the route would cross Bin Brook (Grid Ref. 543600, 258310). At this location Bin Brook is designated Main River and has associated Environment Agency flood zones which are approximately 30-40m wide at this location (1 in 100 (1%) annual probability event). The route crosses the watercourse where there appears to be a drain discharging into Bin Brook. The effective width of the watercourse, measured perpendicularly to the bank, is 2.75m. The indicative alignment of the crossing has minimal skew (7°). A conservative estimate for the span, allowing for skew, scour protection and cut back of the bank is therefore taken as 4m.
14.1.5 Busway proposals connecting to Cranmer Road

At the eastern end of the scheme the route would cross Bin Brook (Grid Ref. 543540, 258210), at this location the floodplain (1 in 100 (1%) annual probability event) is approximately 30-40m wide at this location. The effective width of the watercourse, measured perpendicularly to the bank, is 1.55m. The indicative alignment of the crossing exhibits moderate skew (14°). A conservative estimate for the span, allowing for skew, scour protection and cut back of the bank is therefore taken as 3m.

14.1.6 Structural considerations

Due to the relatively short spans required at the two crossing points, the structure proposals for both locations would be broadly similar. The span lengths range between 3m – 6m hence a single span structure would be sufficient with no requirement for intermediate support lines. The foundation requirements would depend largely on the underlying ground conditions and its associated bearing capacity. For good soil conditions, a mass concrete foundation may be suitable. For poor soil conditions, consideration may need to be given to a piled solution.

Flood events and anticipated water levels would need to be considered and mitigated at detailed design stage. Headroom requirements could be influenced by the volume of excavation within the stream bed.

A number of solutions exist in terms of carrying a highway over a small-span obstacle – a selection of these are discussed below:

14.1.7 Masonry / Brick Arch

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong> – A masonry arch bridge design is an incredibly strong structural form and is able to resist intense vertical loading.</td>
<td><strong>Construction</strong> – the arch is a highly specialised structure and, compared to other culverts and bridges, can take significantly longer to construct and would inevitably incur great labour costs – in particular for skew spans.</td>
</tr>
<tr>
<td><strong>Variety of Materials</strong> – Arch bridges can be constructed from numerous materials (e.g. bricks, naturally occurring stone). This means that the bridge can be designed aesthetically to suit a variety of settings.</td>
<td><strong>Future maintenance</strong> – due to the nature of arches, specialist contractors may be required to undertake regular routine maintenance. Maintenance activities for an arch are likely to take longer and cost more.</td>
</tr>
<tr>
<td><strong>Aesthetics</strong> – An arch bridge is generally considered to be a visually attractive feature.</td>
<td><strong>Soil conditions</strong> – an arch bridge typically requires more lateral support than alternative structural forms. The bearing strata at the abutments must be sound. May require additional earthworks and geotechnical input.</td>
</tr>
<tr>
<td><strong>Inspection access</strong> – small span arches, particularly those over water, can be very difficult to inspect due to restricted headroom.</td>
<td><strong>Scour action</strong> – brickwork arches spanning water may suffer significant degradation as a result of scour action and so require regular monitoring and maintenance.</td>
</tr>
</tbody>
</table>
### 14.1.8 Pre-cast Box Culvert

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong> – an inexpensive proposal compared to an arch bridge.</td>
<td><strong>Aesthetics</strong> – Functional, but not always considered visually attractive in certain settings (although can be faced with ornate brickwork to enhance appearance).</td>
</tr>
<tr>
<td><strong>Strength</strong> – pre-cast concrete box culverts are very strong</td>
<td></td>
</tr>
<tr>
<td><strong>Speed of installation</strong> – box culverts can be installed relatively easily and very quickly compared to other forms constructed in-situ (fabricated off-site, excavate &amp; install)</td>
<td></td>
</tr>
<tr>
<td><strong>Less labour</strong> – the labour requirements are less intensive compared to alternative forms</td>
<td></td>
</tr>
<tr>
<td><strong>Wide availability</strong> – Numerous companies can provide ‘off the shelf’ units (reducing design costs).</td>
<td></td>
</tr>
<tr>
<td><strong>Maintenance</strong> – easier and quicker to inspect than a masonry arch</td>
<td></td>
</tr>
<tr>
<td><strong>Articulation</strong> – No articulation, no transverse movement joints or bearings required.</td>
<td></td>
</tr>
<tr>
<td><strong>Additional ecological features</strong> – many pre-cast box culverts now come with incorporated features such as mammal ledges</td>
<td></td>
</tr>
<tr>
<td><strong>Apron / scour protection</strong> – pre-cast box units have ready-made aprons to suit a variety of flow conditions.</td>
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</tr>
</tbody>
</table>

### 14.1.9 Armco Culvert (single or twin)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong> – an inexpensive proposal compared to other culvert proposals</td>
<td><strong>Aesthetics</strong> – Functional, but not always considered visually attractive in certain settings (although can be made to look like an arch with headwall / spandrel feature).</td>
</tr>
<tr>
<td><strong>Strength</strong> – very strong</td>
<td><strong>Inspection &amp; Maintenance</strong> – requires painting and increased routine maintenance compared with box</td>
</tr>
<tr>
<td><strong>Articulation</strong> – No articulation, no transverse movement joints or bearings required</td>
<td></td>
</tr>
</tbody>
</table>
### 14.1.10 Concrete Beam & Slab

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong> – Straightforward to design and materials are readily available</td>
<td><strong>Strength</strong> – not as strong as an arch solution</td>
</tr>
<tr>
<td><strong>Articulation</strong> – may require expansion joints (e.g. asphaltic plug) – introducing a potential future failure mechanism or source of water ingress (formation of secondary defects). Expansion and contraction would need to be accommodated by joints and bearing system.</td>
<td></td>
</tr>
<tr>
<td><strong>Increased maintenance costs</strong> – associated with additional maintainable elements (expansion joints, bearings &amp; increased likelihood of substructure (concrete) defects)</td>
<td></td>
</tr>
<tr>
<td><strong>Transition</strong> – may require run-on slabs on approaches</td>
<td></td>
</tr>
<tr>
<td><strong>Increased complexity of construction</strong> – more onerous to build on site than modular precast box units or portal frame (due to bearings / articulation)</td>
<td></td>
</tr>
</tbody>
</table>

### 14.1.11 Portal Frame

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong> – an inexpensive proposal compared to an arch.</td>
<td><strong>Aesthetics</strong> – Functional, but not always considered visually attractive in certain settings</td>
</tr>
<tr>
<td><strong>Speed of installation</strong> – portal frame construction can be installed relatively quickly &amp; easily.</td>
<td><strong>Strength</strong> – Not as strong as an arch, box culvert or Armco culvert.</td>
</tr>
<tr>
<td><strong>Less labour</strong> – the labour requirements are less intensive compared to some alternative forms.</td>
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</tr>
</tbody>
</table>

### 14.1.12 Steel truss

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speed of installation</strong> – very quick &amp; easy to install (fabricated off-site and ‘drop-in’)</td>
<td><strong>Aesthetics</strong> – May be considered visually obtrusive</td>
</tr>
<tr>
<td></td>
<td><strong>Maintenance</strong> – requires painting</td>
</tr>
</tbody>
</table>
### Pipe Culvert

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong> – very inexpensive</td>
<td><strong>Aesthetics</strong> – Functional, but not always considered visually attractive in certain settings (although can be made to look like an arch with headwall / spandrel feature).</td>
</tr>
<tr>
<td><strong>Strength</strong> – circular section pipe can be very strong (depending on material/class, e.g. concrete)</td>
<td><strong>Maintenance</strong> – may require remote access to inspect (CCTV)</td>
</tr>
<tr>
<td><strong>Speed of installation</strong> – very quick &amp; easy to install</td>
<td><strong>Spans</strong> – may require more than one pipe depending on span / flow (i.e. twin arrangement)</td>
</tr>
<tr>
<td><strong>Less labour</strong> – the labour requirements are less intensive compared to alternative forms</td>
<td></td>
</tr>
<tr>
<td><strong>Numerous size proposals</strong> – diameter to suit span and flow</td>
<td></td>
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</tbody>
</table>

### Steel Arch

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong> – A steel arch bridge design is strong structural form</td>
<td><strong>Construction</strong> – The arch is a highly specialised structure and, compared to other culverts and bridges, can take significantly longer to construct and would, in all likelihood, incur great labour costs.</td>
</tr>
<tr>
<td><strong>Looks visually attractive</strong> – An arch bridge is generally considered to be a visually attractive feature</td>
<td><strong>Future maintenance</strong> – Due to the nature of the steel arch specialist contractors may be required to undertake regular routine maintenance (painting &amp; welding). Maintenance activities for an arch are likely to take longer and cost more.</td>
</tr>
<tr>
<td></td>
<td><strong>Inspection access</strong> – small span arches, particularly those over water, can be very difficult to inspect due to restricted headroom.</td>
</tr>
<tr>
<td></td>
<td><strong>Environment</strong> – damp / moist environment could lead to accelerated deterioration of steel members.</td>
</tr>
</tbody>
</table>
14.1.15 Proposals Overview
Based on size of the Bin Brook watercourse and the required span for a crossing a pre-cast concrete box culvert would be a suitable proposal providing a number of advantages in relation to other proposals considered.

Pre-cast units offer an economical proposal, structurally sound and have no specialist / bespoke maintenance costs. The feature would be straightforward to install and require minimal design effort compared to other structural forms.

The pre-cast reinforced concrete units could be sized such that minimal additional elevation (relative to existing ground/bank level) is required to cross the watercourse and any re-profiling would be based on the plan area of the culvert and 5m either side for any apron/run-on slabs.

14.1.16 Construction Method
The proposal for a single span, pre-cast concrete box culvert would be relatively straightforward to install. The modular box sections would be delivered to site and placed within the excavated ground on a suitable foundation base. A coffer dam arrangement or temporary diversion of the watercourse may be required in order to prepare the existing ground and foundations. Given the relatively small width of the watercourse the use of coffer dams and suitable pumping should be sufficient for the short duration of the installation works. The advantage the box culvert solution has is that the temporary / enabling works would be required for a shorter length of time owing to the relative speed of installation for the pre-cast modular box sections.

The general sequence of construction is anticipated to be:

- Installation of temporary enabling works (coffer dam / pumping arrangement or temporary diversion of watercourse)
- Excavation of bank and river bed
- Installation of subsurface elements; foundations (potentially piled)
- Drop in modular box sections from above and joint/seal adjacent sections
- Application of waterproofing to box structure
- Backfill sides of box and soil cover at top
- Lay pavement construction
- Install suitable parapets and suitable edge protection and associated vehicle restraint system & transitions
- Remove / dismantle temporary works.

14.1.17 Summary
Provision of a crossing over Bin Brook at either of the two identified positions is achievable with a short single span structure.
15 Conclusions and Next Steps

Phase 1 of the Cambourne to Cambridge Better Bus Journeys project, between the Long Road Junction/Madingley Mulch Roundabout and Grange Road has the ability to provide a segregated two-way busway and footway/cycleway along the length of the Option 3A corridor, with bus priority junction arrangements provided at Long Road/Madingley Mulch and Cambridge Road, Coton. Busway alignments and junction arrangements have been developed to provide bus rapid transit whilst aiming to minimise the impact on properties, designated sites and traffic flows along the length of the routes. A crossing of the M11 could be provided with a bridge over the motorway to provide a segregated busway with footway/cycleway provision, and the potential to provide a habitat corridor between east and west of the M11 with a ‘green bridge’ proposal.

Consultation with local stakeholders is encouraged to determine the impact the proposals would have and capture any specific requirements. Furthermore, this assessment is engineering based and does not consider the environmental and planning impact of the potential proposals. It is therefore recommended that environmental and planning assessments are undertaken prior to developing the proposals further.