APPENDIX N

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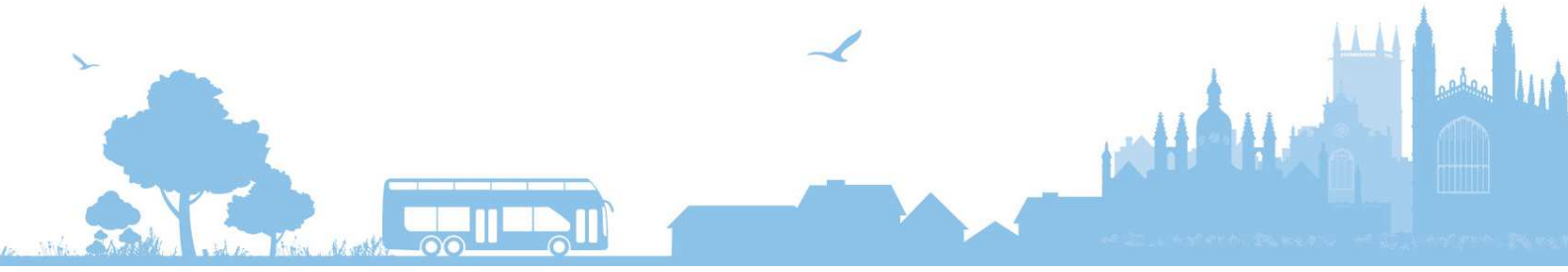
Cambourne to Cambridge Better Bus Journeys

Future Investment Programme – Option 3A Assessment Report

Greater Cambridge Partnership

August 2017



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Cambourne to Cambridge Better Bus Journeys

Future Investment Programme – Option 3A Assessment Report

Greater Cambridge Partnership

August 2017

This document has 98 pages.

This document and its contents have been prepared and are intended solely for Greater Cambridge Partnership's information and use in relation to the Cambourne to Cambridge Better Bus Journeys project.

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Table of contents

EXECUTIVE SUMMARY 7
1 PURPOSE 9
2 INTRODUCTION 10
3 APPROACH 12
4 CAMBOURNE TO CAMBRIDGE BETTER BUS JOURNEYS FUTURE INVESTMENT PROGRAMME ALIGNMENTS 13
4.1. GUIDED BUSWAY ARRANGEMENT 13
4.2. DESIGN METHODOLOGY 14
4.3. JUNCTION REVIEW 15
4.4. LINK REVIEW 15
5 BOURN ROUNDABOUT 16
5.1 Existing Arrangement 16
5.2 Existing constraints; 17
5.3 Bourn Roundabout Proposals 18
5.4 Bourn Roundabout Structures Proposals 26
5.5 Bourn Roundabout Initial Proposal Review Summary 32
6 BOURN JUNCTION PROPOSAL DEVELOPMENT 33
6.1 Proposal 1c - Priority busway through the centre of an enlarged Bourn Roundabout 34
6.2 Proposal 2. On carriageway bus provision with signalised bus gate 37
6.3 Proposal 3a. Signalised burst-through junction on St Neots Road 40
6.4 Proposal 3b. Construct a new underpass under St Neots Road adjacent to the existing A428 Childerley Overbridge 43
6.5 Bourn Roundabout Summary 46
7 BOURN TO HARDWICK JUNCTION LINK 47
7.1 Existing Arrangement 47
7.2 Existing constraints 48
7.3 Bourn to Hardwick Link Proposals 50
7.4 Proposal 2 – Busway adjacent to St Neots Road 53
7.5 Bourn to Hardwick Link Summary 56
8 HARDWICK JUNCTION 57
8.1 Existing Arrangement 57
8.2 Existing constraints; 58
8.3 Hardwick Junction Proposals 60
8.4 Bourn Roundabout Initial Proposal Summary 66
9 HARDWICK JUNCTION PROPOSAL DEVELOPMENT 67
9.1 Proposal 2. - Priority busway through the centre of an enlarged Bourn Roundabout 68
9.2 Proposal 3. - Provision of a burst-through bus junction on St Neots Road and reopen stopped-up St Neots Road with new junction 71

9.3 Proposal 6. - Provision of a burst-through bus junction on St Neots Road and reopen stopped-up St Neots Road with new junction 74
9.4 Hardwick Junction Summary 77
10 HARDWICK JUNCTION TO LONG ROAD 78
10.1 Existing Arrangement 78
10.2 Existing constraints 79
10.3 Hardwick Junction to Long Road Alignment Proposals 81
10.4 Proposal 2 – Two-way busway segregated from St Neots Road by a footway/cycleway 84
10.5 Proposal 3 – Two-way busway aligned adjacent to St Neots Road, upgraded footway/cycleway to the southern side of St Neots Road 87
10.6 Proposal 3b – Two-way busway aligned away from to St Neots Road, upgraded footway/cycleway to the southern side of St Neots Road 91
10.7 St Neots Road, Hardwick - Mitigation Measures 95
10.8 Hardwick Junction to Long Road Summary 97
11 CONCLUSIONS AND NEXT STEPS 98

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Executive summary

An assessment of proposed busway 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 the Future Investment Programme (Phase 2) , between Bourn Roundabout and the A1303 St Neots Road/Long Road junction. This assessment has determined that bus rapid transit within the 3A catchment area is feasible, therefore in line with the GCP Board decision of October 2016 the Option 3 catchment area has not been considered at this stage, pending further consideration. As such this engineering assessment forms only a part of the wider business case development process which is currently underway to identify the overall case for investment in both the Future Investment Programme of the Greater Cambridge Partnership and Phase 1 element of the scheme (from the A1303 St Neots Road/Long Road junction to Grange Road). No consultation on the Future Investment Programme (Phase 2) section of the corridor is proposed until after the Full Outline Business Case for the scheme has been completed. Only at that point will a determination be made by the GCP Executive Board in terms of whether there should be consultation on an alignment to the west of Madingley Mulch and if so whether Option 3 or 3A should be preferred or whether any off road intervention is required in this section of the corridor at all.

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 Bourn Roundabout, eight proposals to provide bus priority were considered. Four of these proposals were taken forward to be developed further and to undergo traffic modelling. Proposals 1c and 2 provide the busway through Bourn Roundabout and would require upgrading and enlargement of the existing roundabout. These proposals would have significant adverse impact on traffic flow, and would require land purchase from adjacent properties. Proposal 3 and 3b provide a busway to the west of Bourn Roundabout. Being remote of the roundabout reduces their impact on traffic. Proposal 3b is grade separated, and whilst improving footway/cycleway provision and bus journey time reliability, is more costly than at grade alternatives.

Between Bourn Roundabout and Hardwick, two proposals were considered to provide bus priority. Each proposal utilises land north of the existing St Neots Road. Proposal 1 provides a busway aligned along the northern side of the land area adjacent to the A428 Highway Boundary, allowing good connectivity with junction arrangements with which it would link. This additionally means it is less intrusive on land. Proposal 2 provides a busway and footway/cycleway adjacent to St Neots Road, thus giving good access to patrons, but would sever access between St Neots Road and land parcels to the north. Being aligned adjacent to St Neots Road would not provide good connectivity with Hardwick and Bourn junction proposals, and would require reduced bus speeds.

At Hardwick Junction, six proposals were considered to provide a priority busway, with three proposals being developed further with traffic modelling being undertaken. Proposal 2 has the busway aligned away from residential properties in St Neots Road, passing through the centre of the junction's southern roundabout. Traffic modelling of the proposal showed Proposal 2 would not perform well for future predicted traffic flows, but also identified the existing junction will be close to

capacity when modelled without any intervention and future traffic flows. Revising the roundabout to include the busway would provide an opportunity to improve the performance of the existing junction. Proposals 3 and 6 have a priority bus crossing of St Neots Road, west of the Hardwick Junction. Proposal 3 is an off line proposal, and Proposal 6 is an on-road alternative. Both would retain the existing roundabout and utilise the stopped-up section of the old St Neots Road. Whilst providing good busway alignment, Proposal 3 impacts on residential properties. Proposal 6 has slower bus journey times due to proposed give way arrangement at Hardwick Roundabout.

Between the Hardwick Junction and Long Road Junction it is feasible to provide a segregated busway utilising the area of land between St Neots Road and the A428. The following four possible proposals were considered. Busway proposals 1 and 2 provide segregated busways and footway/cycleways, but due to following the alignment of St Neots Road would have relatively low bus speeds. These proposals have considerable impact on existing vegetation with little opportunity to offer mitigation planting. Proposals 3 and 3b provide a busway to the northern side of St Neots Road and upgrade the existing footway to the southern side of St Neots Road. These proposals require less land, and allow scope for additional planting to mitigate loss from the busway. The narrower construction width of proposal 3b to the north of St Neots Road enables better alignment and maximum design speed.

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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 Future Investment Programme section between the Bourn Roundabout and the Long Road Junction, east of Hardwick village, 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.

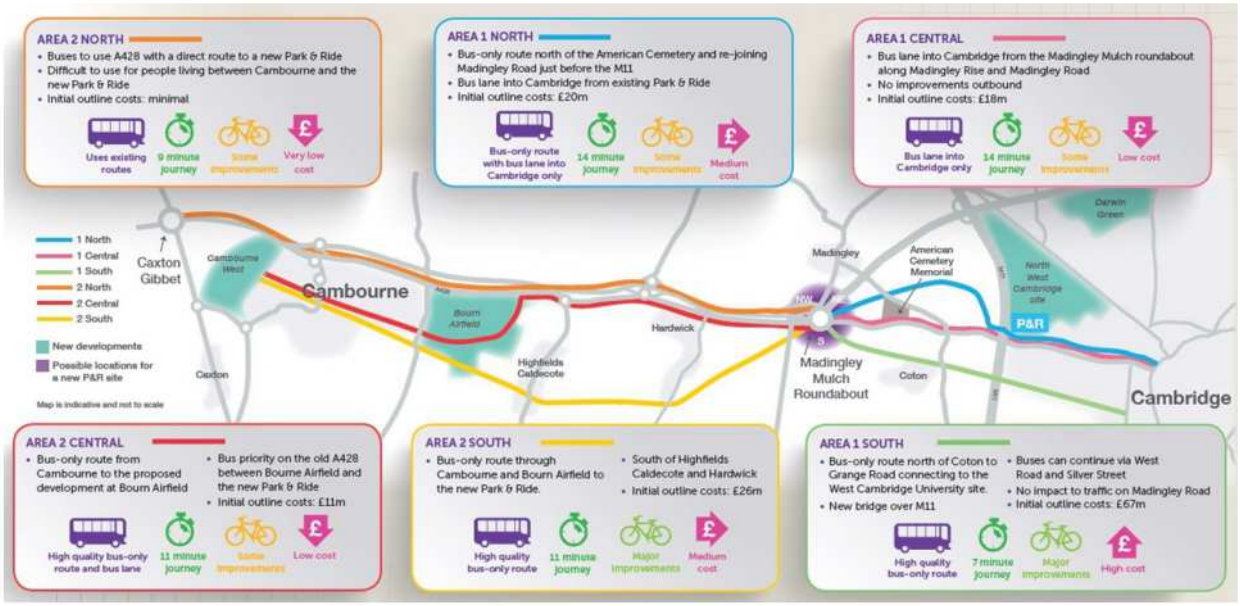


Figure 1. Options Published for Consultation

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. The Future Investment Programme discussed in this report is aligned to Area 2 between Bourn Airfield and Long Road west of Madingley Mulch Roundabout.

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.

Future Investment Programme junction proposals and busway alignment proposalss along the proposed corridor are described from west to east. These comprise of;

- Bourn Roundabout junction;
- Bourn Roundabout to Hardwick Junction;
- Hardwick Junction;
- Hardwick Junction to Long Road.

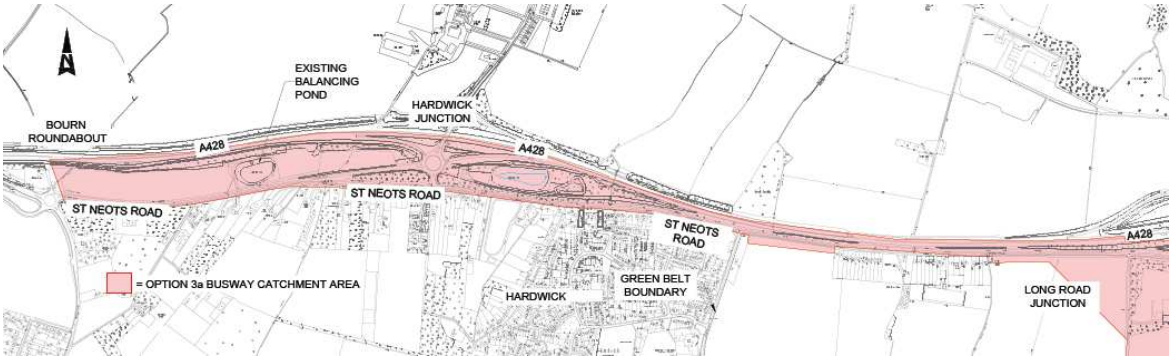


Figure 2. Busway Catchment Area Option 3A – Future Investment Programme Extents Bourn Roundabout to Long Road

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;-

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

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 busway 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 Future Investment Programme Alignments

The proposed Cambourne to Cambridge Future Investment Programme busway extends between the Bourn Roundabout at the junction of St Neots Road and Highfields Road to the west, through to the St Neots Road/Long Road Junction to the east.

The proposed route is within the preferred Option 3A corridor and is positioned north of the villages of Highfields Caldecote and Hardwick, parallel to the A428 trunk road, and following the alignment of the A1303 St Neots 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 to conform to bus rapid transit (BRT) requirements.

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

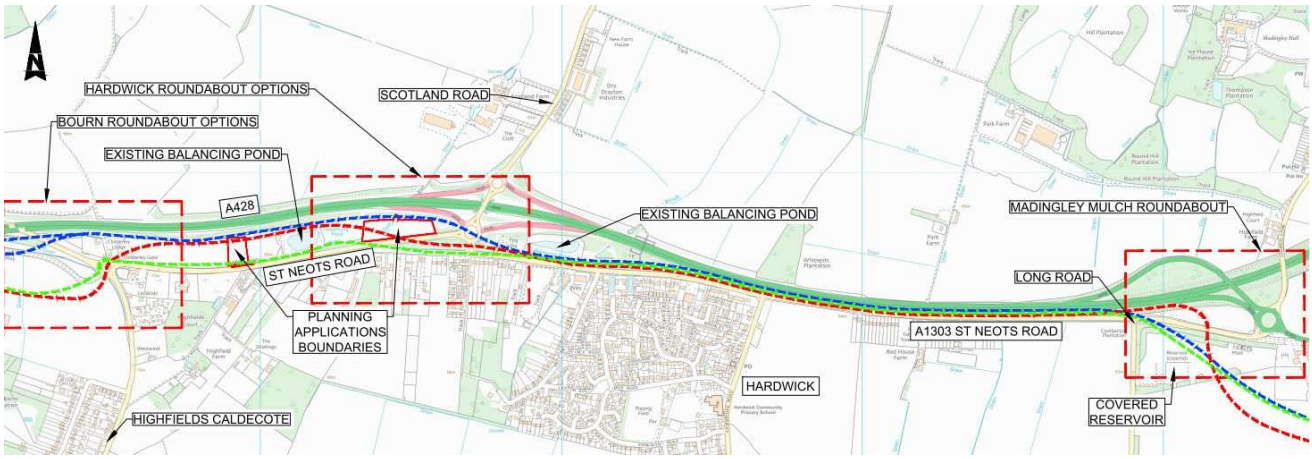


Figure 3. Proposed Future Investment Programme Busway Alignments within the Option 3A Corridor

4.1. Guided Busway Arrangement

The intention of the Cambourne to Cambridge busway is to replicate the success of the existing Cambridgeshire Guided Busway (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.

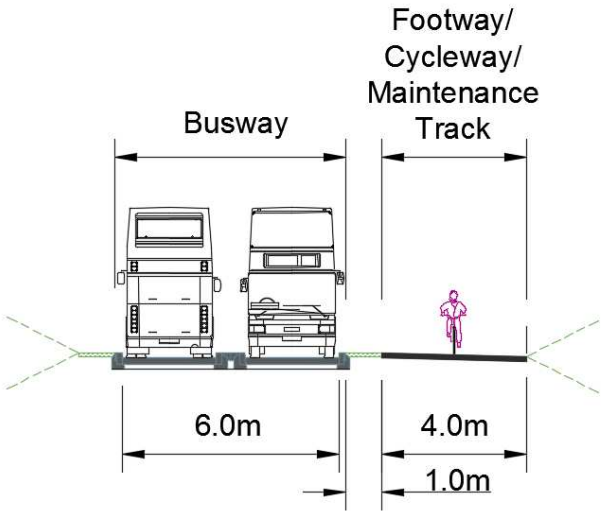


Figure 4 – Guided Busway and Maintenance Track Arrangement

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 could 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 could 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. Within this report the positive and negative factors of each busway alignment will be reviewed as well as identifying which junction arrangements the link would provide connectivity to.

A comparison of the developed alignment proposals has been carried out within this report reviewing the SWOT of each junction arrangement.

5 Bourn Roundabout

5.1 Existing Arrangement

Bourn Roundabout is an existing five arm roundabout at the junction between A1303 St Neots Road and Highfields Road at Childerley Gate, positioned at the western extent of the proposed Future Investment Programme busway. Access is provided to three private residential properties to the north and the Wellington Way private access to Bourn Airfield to the south west. The Bourn Airfield site is currently subject to planning approval for a large scale residential and employment development area which is proposed to include a busway serving the new development with continuation of the busway to the west through the Bourn site linking with Cambourne and beyond.

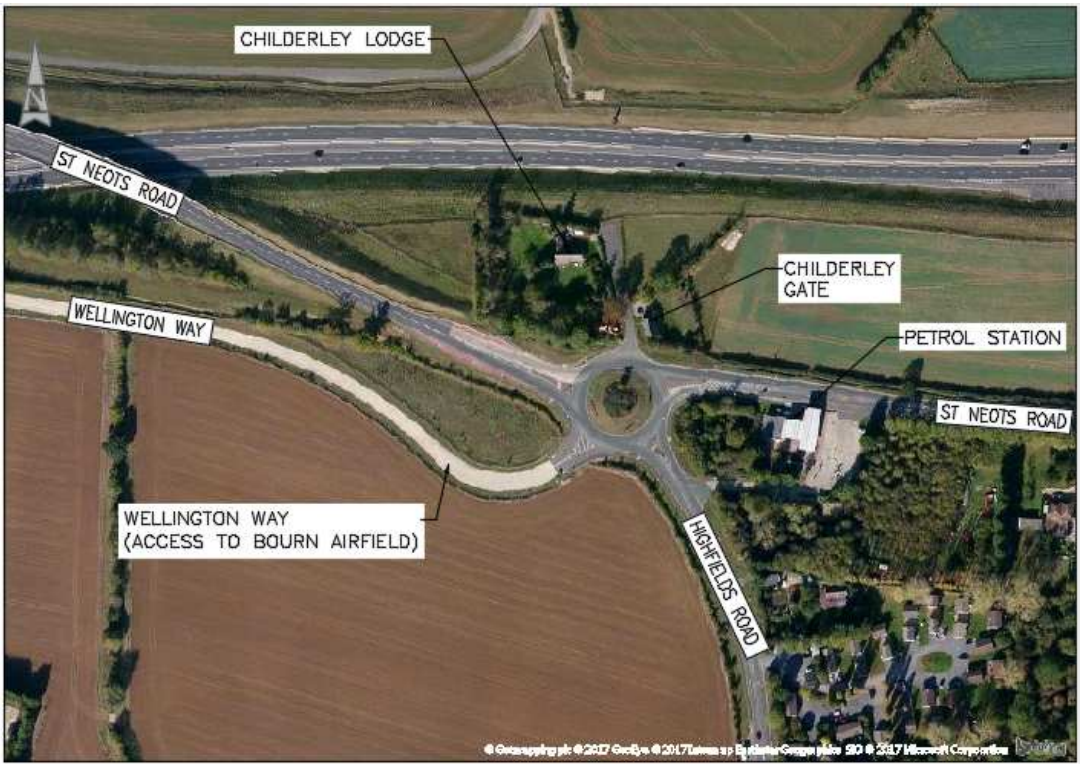


Figure 5 Bourn Roundabout

The connecting roads are single carriageway and subject to national speed limit on the immediate approaches to and exits from the roundabout. The roundabout and immediate approaches are lit by column mounted street lighting. Narrow footways allow pedestrians to walk around the roundabout with connections to all arms of the roundabout.

There are two existing bus stop lay-bys located on St Neots Road approximately 40m to the west of the roundabout. A petrol station is located to the east of the roundabout, which can be accessed via St Neots Road and Highfields Road.

Figure 6 Bourn Roundabout

5.2 Existing constraints;

5.2.1 Carriageway alignment and land constraints

To the north of the existing roundabout are three residential properties of Childerley Gate, including a converted Chapel (Chapel Gate). None of the properties are registered as listed buildings;

To the east of the roundabout is a petrol station and surrounding privately owned land. The petrol station main entrance and exit are located on St Neots Road east of Bourn Roundabout, with a further access onto Highfields Road;

The existing 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 site along the St Neots Road corridor. These comprise of National Grid medium pressure gas mains, Cambridge Water large bore asbestos cement water mains, and telecommunications services. 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 determined during detailed design stage to provide the appropriate mitigation works.

5.2.2 Non-motorised users

An existing footway is provided along the south side of St Neots Road and is aligned to the south of the roundabout crossing Highfields Road and the Bourn Airfield entrance (Wellington Way). This footway connects with a footway located to the western side of Highfields Road running south to the village of Highfields Caldecote. Footway provision is to be retained and where possible enhanced by any alterations required by each junction proposal.

5.2.3 Environmental

An area of protected trees (South Cambs Tree Preservation Orders) are registered along the boundary between St Neots Road and the Bourn Airfield site. The area follows the old St Neots Road/A428 highway boundary prior to construction of the roundabout. There is little evidence of the trees on the existing site, which have likely been removed previously for the construction of the roundabout.

5.3 Bourn Roundabout Proposals

5.3.1 Proposal 1a – Priority busway through the centre of the existing Bourn Roundabout

The proposal would provide a busway intersecting the existing roundabout circulatory with a signalised 'hamburger' style arrangement. Traffic signals provided on the roundabout circulatory and the Bourn approach to the roundabout, hold traffic whilst the bus passes through the junction as a priority manoeuvre. Footway/cycleway provision would be via an un-signalised crossing facility of the western St Neots Road arm of the roundabout.

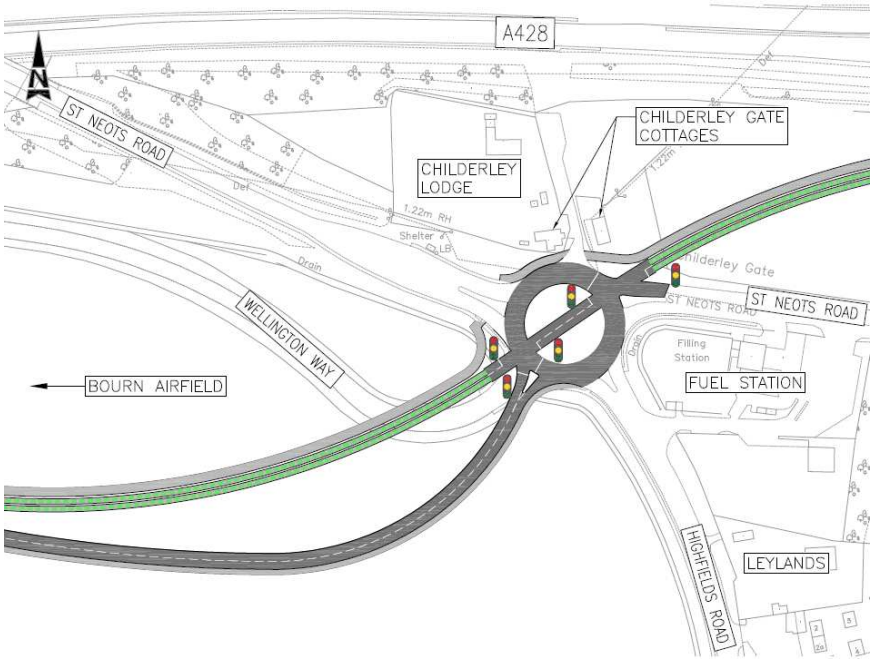


Figure 7 – Bourn Roundabout Proposal 1a

ADVANTAGES	DISADVANTAGES
Bus priority through the junction would provide bus rapid transit.	Existing roundabout would be unlikely to cope with the increased traffic requirements from the future Bourn development.
Proposal retains existing infrastructure minimising construction disruption and would provide a lower cost of the hamburger style arrangement junction proposals.	Footway/cycleway crossing would be uncontrolled and may cause difficulty and safety concerns for users.
Un-signalised footway/cycleway does not disrupt traffic flow on the roundabout.	Encroaches on Childerley Gate residential property boundary.
Proposal would provide the ability to facilitate a Bus Hub near to Highfields village.	'Hamburger' style roundabout would be an unfamiliar arrangement for road users particularly in a rural location.

Outcome

Proposal 1a not taken forward for development. The arrangement would not be future proof and would be unlikely to accommodate the increased traffic flow from the proposed Bourn Airfield development.

5.3.2 Proposal 1b - Priority busway through the centre of an enlarged Bourn Roundabout with aligned footway/cycleway

The proposal would provide a busway intersecting the Bourn Roundabout with a signalised 'hamburger' style arrangement; the roundabout circulatory is enlarged to provide extra capacity. Traffic signals would be provided on the roundabout circulatory and the Bourn approach to the roundabout to hold traffic whilst the bus passes through the junction as a priority manoeuvre. Footway/cycleway provision would follow the busway alignment with signalised crossings provided through the centre of the roundabout.

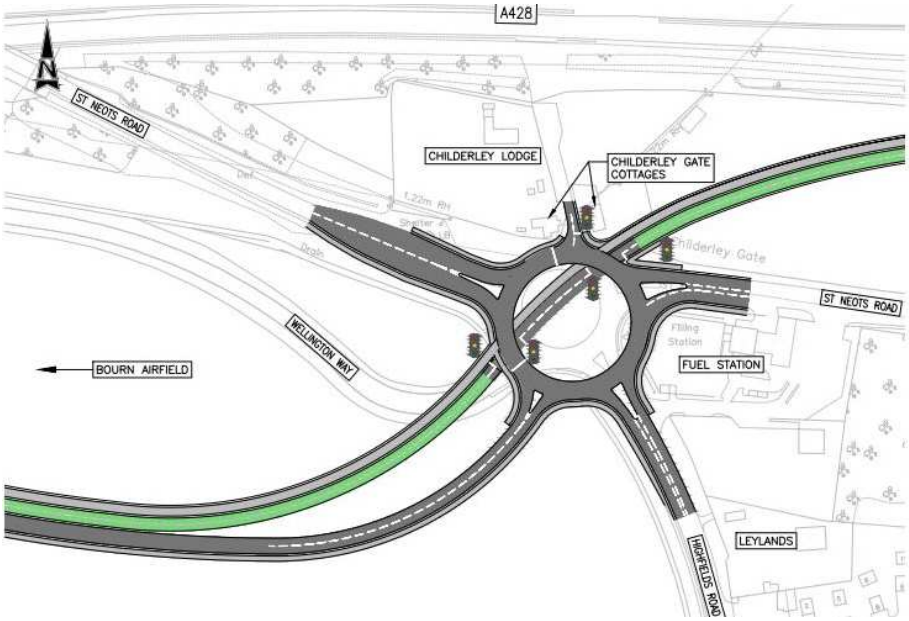


Figure 8 – Bourn Roundabout Proposal 1b

ADVANTAGES	DISADVANTAGES
Bus priority through the junction would provide bus rapid transit.	Additional land would be required to provide the enlarged roundabout circulatory
Proposal would provide the ability to facilitate a Bus Hub near to Highfields village.	Potential negative impact of the signalised footway/cycleway arrangement on traffic flow through the junction.
Larger circulatory would provide a greater ability to cope with the anticipated increased traffic flows from the proposed Bourn development.	Encroaches on Childerley Gate residential property boundary
Footway/cycleway crossing via the signalised junction would provide improved safety for users.	Higher construction costs than some other proposals.
	'Hamburger' style roundabout would be an unfamiliar arrangement for road users particularly in a rural location.

Outcome

Proposal 1b not taken forward for development. The impact of having the signalised footway/cycleway through the roundabout would potentially have a significant adverse effect on the traffic flows at the junction.

5.3.3 Proposal 1c - Priority busway through the centre of an enlarged Bourn Roundabout

The proposal would provide a busway intersecting the Bourn roundabout with a signalised 'hamburger' style arrangement, the roundabout circulatory would be enlarged to provide extra capacity. Traffic signals would be provided on the roundabout circulatory and the Bourn approach to the roundabout to hold traffic whilst buses pass through the junction as a priority manoeuvre. Footway/cycleway provision would be via an un-signalised crossing facility of the west St Neots road arm of the roundabout.

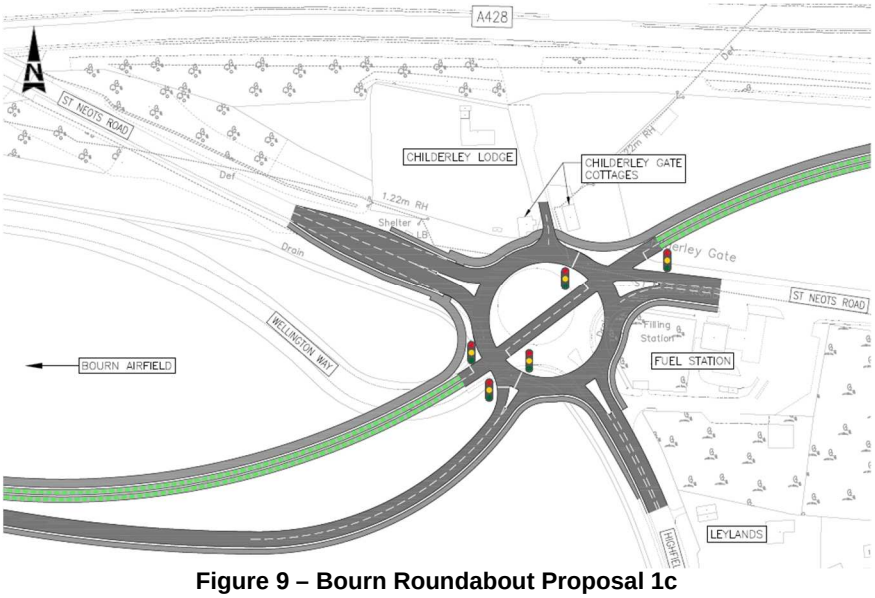


Figure 9 – Bourn Roundabout Proposal 1c

ADVANTAGES	DISADVANTAGES
Bus priority through the junction would provide bus rapid transit.	Additional land would be required to provide the enlarged roundabout circulatory
Un-signalised footway/cycleway does not disrupt traffic flow on the roundabout.	Encroaches on Childerley Gate residential property boundary.
Proposal would provide the ability to facilitate a Bus Hub near to Highfields village.	Higher construction costs than some other proposals.
Larger circulatory would provide a greater ability to cope with the anticipated increased traffic flows from the proposed Bourn development.	'Hamburger' style roundabout would be an unfamiliar arrangement for road users particularly in a rural location.
	Footway/cycleway crossing would be uncontrolled and may cause difficulty and safety concerns for users.

Outcome

Proposal 1c would provide a future proof junction arrangement with segregated and prioritised transit for buses. Un-signalised cycleway crossings reduce the impact on traffic flow; Proposal 1c taken forward for further development and junction modelling analysis.

5.3.4 Proposal 2. - On carriageway bus provision with signalised bus gate.

The proposal would provide bus lanes on-road around the Bourn Roundabout circulatory with a signalised bus transition gate on the St Neots Road east of the roundabout. Footway/cycleway provision would be via an un-signalised crossing facility, west of the St Neots Road arm of the roundabout.

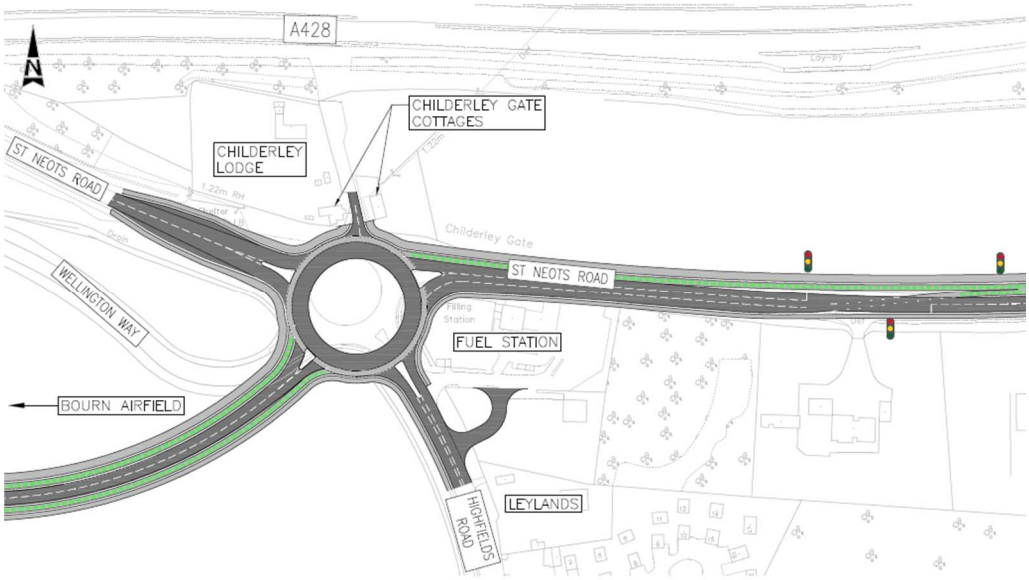


Figure 10 – Bourn Roundabout Proposal 2

ADVANTAGES	DISADVANTAGES
Signalised bus gates would be provided to hold traffic to provide priority access for buses into the junction.	Additional land would be required to provide the enlarged roundabout circulatory
Greater ability to cope with the anticipated increased traffic flows from the proposed Bourn development.	Slower bus transit as buses would be required to give way to vehicles at the roundabout and would be delayed by congestion at the junction.
Enlarged roundabout would function as a priority junction rather being signalised, reducing the impact on traffic flow around the roundabout;	Cycleway construction would require land from residential properties north of the roundabout or the cycleway to be narrowed.
	Footway/cycleway crossing would be uncontrolled and may cause difficulty and safety concerns for users.

Outcome

Proposal 2 would provide a future proof junction arrangement with reduced construction costs. Increased bus journey times due to the junction arrangement make it less favourable.
Proposal 2 taken forward for further development and junction modelling analysis with an amendment to include a bus gate on the Bourn Airfield approach road to give buses priority.

5.3.5 Proposal 3a. - Signalised burst-through junction on St Neots Road

The proposal would provide a signalised burst-through junction on the western section of St Neots Road, west of Bourn Roundabout, with the busway aligned north of the Childerley Lodge property. Footway/cycleway provision follows the busway alignment with a signalised crossing of St Neots Road.

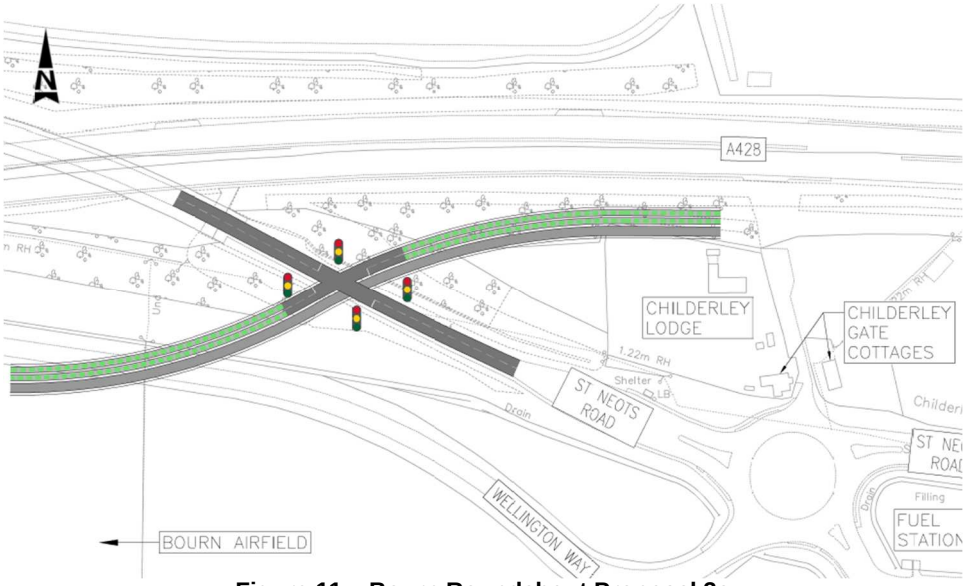


Figure 11 – Bourn Roundabout Proposal 3a

ADVANTAGES	DISADVANTAGES
Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.	Route continues east close to residential properties – Childerley Lodge.
Bourn Roundabout would be unaffected by the busway, leaving the Bourn airfield developer to provide a junction suitable for the development. This would be more cost effective for the project.	The busway cuts across mature trees/vegetated land along St Neots Road.
Would provide flexibility on the position of the crossing point to suit the Bourn development master plan.	Alignment would be close to A428 westbound carriageway which may result in further mitigation measures (i.e. screening)
Footway/cycleway crossing via a signalised crossing would provide improved safety for users.	Would provide less visual presence of the bus way to motorists on St Neots Road/Bourn roundabout.

Outcome

Proposal 3a would result in a reduced impact of the busway on the public highway with a junction arrangement compliant with a bus rapid transit system.

The proposal would not provide an upgrade or amendment to the existing Bourn Roundabout at a cost to the Better Bus Journeys project, instead leaving the Bourn Airfield developer to deliver any junction works identified through the planning process. Proposal 3a taken forward for development and junction modelling analysis.

5.3.6 Proposal 3b. Construct a new underpass under St. Neots Road adjacent to the existing A428 Childerley Overbridge

The proposal would provide a grade-separated crossing under St. Neots Road, west of Bourn Roundabout, with the busway aligned north of the Childerley Lodge property. Footway/cycleway provision follows the busway alignment.

The route would cross under St Neots Road at a location immediately south of the point at which the A428 is crossed by A428 Childerley overbridge. At this location, St Neots Road is a single carriageway road with a footway running adjacent to the northbound side. The combined width of the carriageway and footway is 9m.

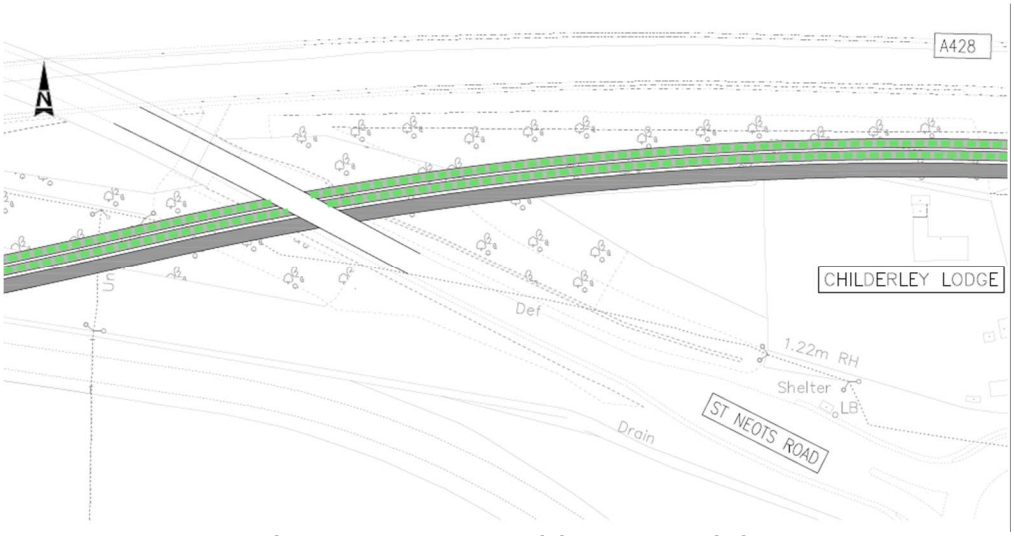


Figure 12 – Bourn Roundabout Proposal 3b

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 Bourn Roundabout Structure Proposals.

ADVANTAGES	DISADVANTAGES
Segregation of busway from St Neots Road traffic.	Technically challenging – construction of a new crossing adjacent at the eastern abutment of the existing A428 overbridge.
Reduced impact on traffic flow along St Neots Road and provide a safer route for pedestrians and cyclists	High costs from construction of new structure under St Neots Road.
Smooth busway alignment achieving maximum design speed (120kph)	Route continues east close to residential properties – Childerley Lodge.
Bourn Roundabout would be unaffected by the busway, leaving the Bourn airfield developer to provide a junction suitable for the development	Lack of flexibility for buses, pedestrians and cyclists to enter/exit the busway from St Neots Road.

Outcome
Proposal 3b would provide complete segregation between the busway, footway/cycleway and the carriageway.
Proposal 3b taken forward for development and junction modelling analysis.

5.3.7 Proposal 4 - Dedicated bus lane around the roundabout circulatory

The proposal would provide a dedicated bus lane around the existing Bourn roundabout circulatory with a signalised bus transition gate to the east of the roundabout allowing the buses to enter/exit a segregated busway to the north of St Neots Road. Buses remain on-carriageway into the Bourn development. Footway/cycleway provision would be via an un-signalised crossing facility of the west St Neots Road arm of the roundabout.

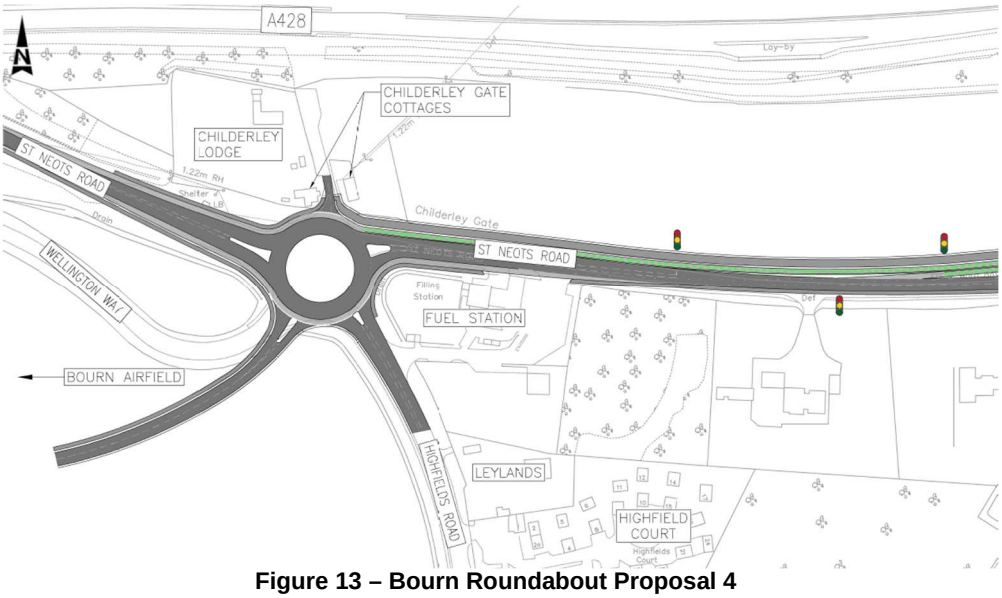


Figure 13 – Bourn Roundabout Proposal 4

ADVANTAGES	DISADVANTAGES
Low cost proposal would not require enlarging the roundabout or significant alteration existing infrastructure.	The existing roundabout would be unlikely to cope with the increased traffic requirements from the future Bourn development.
The roundabout operates as a priority junction as existing.	Potential delays for buses due to being on-road at the roundabout.
Single signalised transition gate to the east, away from the roundabout reducing the impact on traffic flow.	No provision of busway west of the roundabout or into the Bourn development.
	Bus lane around the outer circulatory would be an unusual arrangement, could be confusing and cause conflict with other road users.
	Footway/cycleway crossing would be uncontrolled, may cause difficulty and safety concerns for users.

Outcome

Proposal 4 not taken forward for development. It would not provide a segregated busway west of Bourn Roundabout, the online bus lanes around the roundabout may be potentially confusing for road users. Reliance on on-carriageway bus transit may result in user delays.

5.3.8 Proposal 5 – Replacement of the existing roundabout with a main through road

The proposal would comprise of removal of the existing Bourn roundabout, replaced by a realigned through road linking the eastern section of St Neots Road to the Bourn Airfield development. Priority junctions connect with the realigned western section of St Neots Road and Highfields Road; a small access road would be added to connect to Childerley Gate properties. The busway would cross the western section of St Neots Road with a burst-through junction. Footway/cycleway provision would follow the busway alignment with a signalised crossing provided adjacent to the busway.

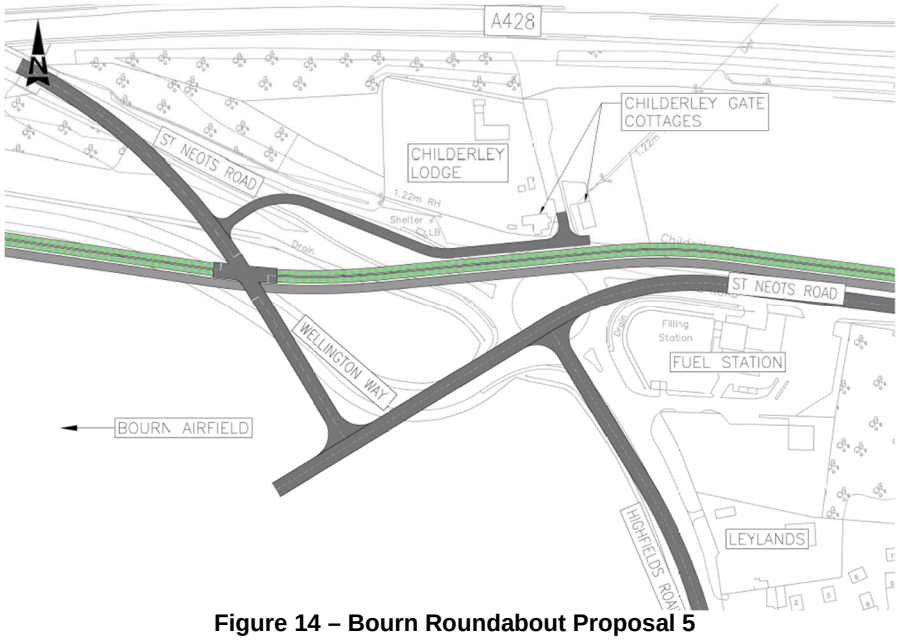


Figure 14 – Bourn Roundabout Proposal 5

ADVANTAGES	DISADVANTAGES
Burst-through type detail is a simple and familiar arrangement utilised on the CGB.	Multiple priority T junctions replacing an existing Bourn roundabout requiring right turn manoeuvres across opposing traffic for road users.
Land would be required from Bourn Airfield development site with less objection likely than other proposals (Childerley Gate and the petrol station left un-affected).	The arrangement would provide improved access to the development of Bourn Airfield for road users, which is not within the scope of the busway project.
Would provide flexibility on the position of the busway to suit the Bourn development master plan.	Potential to cause major delays and disruption with queueing traffic at T junctions.

Outcome

Proposal 5 not taken forward for development. The effect of replacing the roundabout with T junctions would cause delays to the traffic flow and would have a negative impact on road user safety.

5.4 Bourn Roundabout Structures Proposals

5.4.1 Proposal 3b – Construct a new underpass under St Neots Road adjacent to the existing A428 Childerley Overbridge

Initial Considerations

The proposed crossing of St Neots Road is anticipated to be a grade-separated underpass under the A1303 St Neots Road.

An overbridge proposal over St Neots Road has not been considered due to the road already being elevated on an existing embankment on approach and departure to the A428 Childerley overbridge. An elevated overbridge crossing would be visually imposing due to its required height. An overbridge proposal has therefore not been further considered due to cost, complexity and visual appearance. Consequently, the grade-separated proposal is restricted to consideration of an underpass only.

Grade–separated crossing of St Neots Road – Underpass Structure

The proposed busway would cross St Neots Road at OS Grid Ref. (535264, 259790). The width of the carriageway and footway measured perpendicular to the verge is 9m at this location. The alignment of the crossing with a skew (60°) and a 1 in 3 slope at the edge of carriageway each side, would require the overall length of the structure to be 30m (assuming 1m cover). The span of the underpass would be defined by the section of the busway, taken to be 15.7m based on a guided busway as shown in Figure 15.

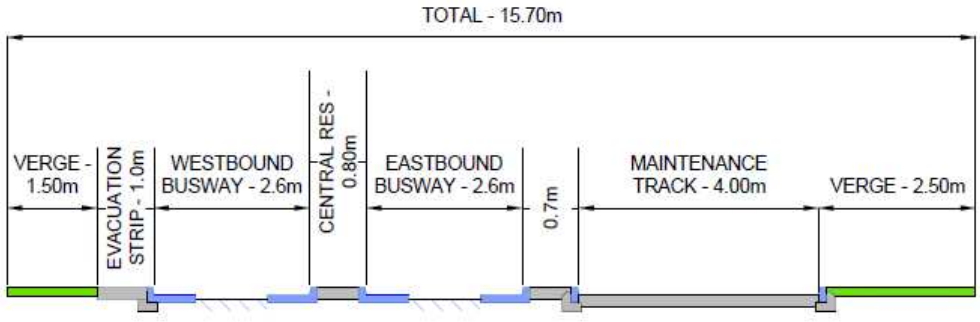


Figure 15 – Typical Section through proposed underpass

Span Length and Structure Dimensions

The approximate span lengths and geometry for the underbridge crossing is detailed in Table 1.

	Underpass Proposal
Width of carriageway and footway crossed (m)	9m
Min set-back (each side) (m)	3m
Length[†] (underpass) (m)	30m
Span (underpass) (m)	15.7m
Skew Angle (º)	60°

Table 1- Span lengths & structure dimensions

[†] The envisaged length (under) allows for 60° skew, set-back from edge of carriageway / footway and construction / groundworks activities.

Bridge Form – Proposals Considered

Due to the relatively short span required to cross under St Neots Road and the adjoining footway a single span structure beneath St Neots Road is deemed suitable with no requirement for intermediate supports.

The foundation requirements would depend largely on the underlying ground conditions and bearing capacity, which would need to be confirmed at detailed design stage. It is anticipated that an underpass would be supported on integral shallow spread foundations. The spread foundations would be bedded either on a layer of ST1 levelling concrete or suitable compacted granular fill. The same bedding arrangement would be used for the wing walls. For poor soil conditions, consideration may need to be given to a piled solution with associated capping slab to adequately disperse loads.

In accordance with DMRB TD27/05 (Cross-sections and Headrooms), the headroom†† requirements for new construction highway bridges is 5.30m (plus sag curve compensation, allowing for deflection of the structure under load).

†† Defined as the minimum distance between the surface of the highway cross-section and the deflected structure (including any temporary or permanent attachments) measured at right angles to the surface of the cross-section.

A number of crossing solutions of the structural forms are available for an underpass. For the purpose of this Report the following bridge forms have been considered:

- 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

The following tables summarise the advantages and disadvantages of the bridge forms considered.

- **In-Situ Reinforced Concrete Slab**

ADVANTAGES	DISADVANTAGES
Ease of design & detailing. Relatively straightforward and well established design.	Requires a temporary formwork support (in-situ construction). Increased construction time in comparison to a pre-cast beam construction.
Ideal for small crossing. Unobtrusive, relatively slender detail.	Limited span length (conventionally RC slab suitable up to 15m). Additional reinforcement required for longer spans.
	Construction time & TM - long construction duration and additional traffic management (closure of road above) in comparison to pre-cast portal frame form.

- **Pre-cast Concrete Rectangular Beam**

ADVANTAGES	DISADVANTAGES
Reduced construction time in comparison to a cast in-situ form. Less duration for temporary works (earthwork support & temporary propping).	Geometry – not ideally suited for challenging geometries.
	Additional time required to tie into in-situ cast abutment/end supports.
	Large number of short transverse beams required to suit the underpass length.
	Construction time & TM - long construction duration and additional traffic management (closure of road above) in comparison to pre-cast portal frame form.

- **Pre-stressed Concrete I-Beam**

ADVANTAGES	DISADVANTAGES
Durability and maintenance - relatively low maintenance solution.	Materials & Dimensions - deeper beams required
Standardised detail - beam detail would be straightforward for given span.	Large number of short transverse beams required to suit the underpass length.
Economical design - economical solutions for spans between 15m-50m.	Logistics – potential constraints on use of longer beams due to transport/logistics and accessibility.
Geometry – adaptable to suit challenging geometries.	Construction time & TM - long construction duration and additional traffic management (closure of road above) in comparison to pre-cast portal frame form.

- **Steel Structure**

ADVANTAGES	DISADVANTAGES
Material properties – lighter material in comparison to a concrete construction form.	Cost – higher cost than other proposals
	Materials – likely to require more steel members (connections and bracings) owing to additional dead load (soil cover & earth pressures)
	Suitability – steel structure not typically used for “buried” type solution. Issues with moisture/corrosion.
	Aesthetics – may be considered visually obtrusive (e.g. weathering steel may not be seen as appealing).
	Additional maintenance cost – regular/routine maintenance. Regular painting (if weathering steel Is not used).
	Construction time & TM - long construction duration and additional traffic management (closure of road above) in comparison to pre-cast portal frame form.

- **Post-tensioned Slab**

ADVANTAGES	DISADVANTAGES
Reduced cost – economical solution. Post-tensioned slab has proven to be a good solution to provide stronger structures at affordable cost.	Maintenance – Tendons require special inspection and maintenance for corrosion issues.
Design flexibility – slender slab profile when compared to similar conventional reinforced or voided slab.	Accessibility of the tendons - in the case of buried structure/underpass with cover accessibility to the tendons (for inspection purposes) may be difficult.
	Design complexity – more onerous to design and install.
	Construction time & TM - long construction duration and additional traffic management (closure of road above) in comparison to pre-cast portal frame form.

- **Pre-cast Reinforced Concrete Portal Frame**

ADVANTAGES	DISADVANTAGES
Speed of installation & buildability – pre-cast structure can be installed relatively easily and quickly in comparison to in-situ construction forms	Aesthetics – Functional, but not always considered visually attractive in certain settings.
Labour requirement less intensive compared to alternative construction forms	Section dimension / materials – deeper section required than for overbridge of same form owing to additional loads (cover and soil pressures).
High quality control – pre-fabricated structures are cast under quality controlled factory conditions.	Deep excavation – a deep excavation is required compared with overbridge proposal (which is set on embankments).
Programme - Prefabricated off-site, less dependent on weather and labour skills.	Construction – may require fill to distribute loads.
Wide availability – numerous companies can provide “off the shelf” pre-cast units (reducing design costs).	
Installation – can be ‘dropped in’ from above or moved into position from below (e.g. via self-propelled modular transporter).	
Reduced maintenance activity - no articulation, no transverse movement joints or bearings to inspect, refurbish or replace	

5.4.2 Bridge Form – Discounted Proposals

An alternative solution to the underpass could be an extension of the existing Highways England A428 Childerley overbridge north of the location of the proposed underpass. If the structure were extended at the southern end it could potentially span the proposed busway. This proposal has been discounted owing to the envisaged cost of the extension works compared to the installation of a new underpass. An additional factor is the traffic management required on the A428 & St Neots Road for the duration of the scheme.

5.4.3 Bridge Forms – Summary

Given the relatively short span but significant 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) busway vertical gradient criteria outlined in the Britpave Guided Busway Design Handbook on the profile of the approach and departure to the bridge would require a minimum of 175m length of transition either side of the underpass based on a cutting depth of 7m below existing carriageway level. This would maintain the level of the existing St Neots Road carriageway.

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.

The approximate area of each cutting footprint is estimated as 5400m^2. The total plan area of the footprint for two embankments (east & west side of St Neots Road) plus the bridge deck itself is 11,300m^2. The approximate volume of fill required, accounting for 4m level difference between start of incline and existing carriageway level of St Neots Road (based on topographical survey and 1 in 2 embankment slopes), per cutting is 8,100m^3 (i.e. 16,300m^3 in total for both cuttings). The excavation for the underpass is 3600m^3. Therefore total volume of excavation 19,800m^3.

To reduce the impact on St Neots Road and the surrounding highway infrastructure and keep restrictions to an absolute minimum, an appropriate proposal is a pre-cast structure such as a pre-cast reinforced concrete portal frame. With this proposal the approach cutting could be constructed with minimal traffic management (lane closures or partial restrictions may be required as works approach the highway boundary, for the purposes of access etc.). The full closure of St Neots Road would be reduced in duration using precast units rather than adopting a cast ‘in-situ’ construction proposal.

5.5 Bourn Roundabout Initial Proposal Review Summary

Proposal	Description	Outcome	
1a	Priority busway through the centre of the existing Bourn Roundabout	Proposal 1a not taken forward	
1b	Priority busway through the centre of an enlarged Bourn Roundabout with aligned footway/cycleway	Proposal 1b not taken forward	
1c	Priority busway through the centre of an enlarged Bourn Roundabout	**Proposal 1c taken forward for further development and junction modelling analysis.**	
2	On carriageway bus provision with signalised bus gate.	**Proposal 2 taken forward for further development and junction modelling analysis.**	
3a	Signalised burst-through junction on St Neots Road	**Proposal 3a taken forward for development and junction modelling analysis.**	
3b	Construct a new underpass under St Neots Road adjacent to the existing A428 Childerley Overbridge	**Proposal 3b taken forward for development and junction modelling analysis.**	
4	Dedicated bus lane around the roundabout circulatory	Proposal 4 not taken forward	
5	Replacement of the existing roundabout with a main through road	Proposal 5 not taken forward	

6 Bourn 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 section 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 arrangements at the Bourn Roundabout junction 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 1c - Priority busway through the centre of an enlarged Bourn Roundabout

6.1.1 Junction Arrangement

- Proposal 1c would provide an unguided busway intersecting the Bourn 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 traffic capacity and to assist with providing capacity required for the bus 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;
- A proposed footway/cycleway crossing would be provided by an un-signalised crossing west of the St Neots Road arm, reducing the potential impact of the crossing on traffic flow. The footway/cycleway encroaches into Childerley Gate residential property boundary.

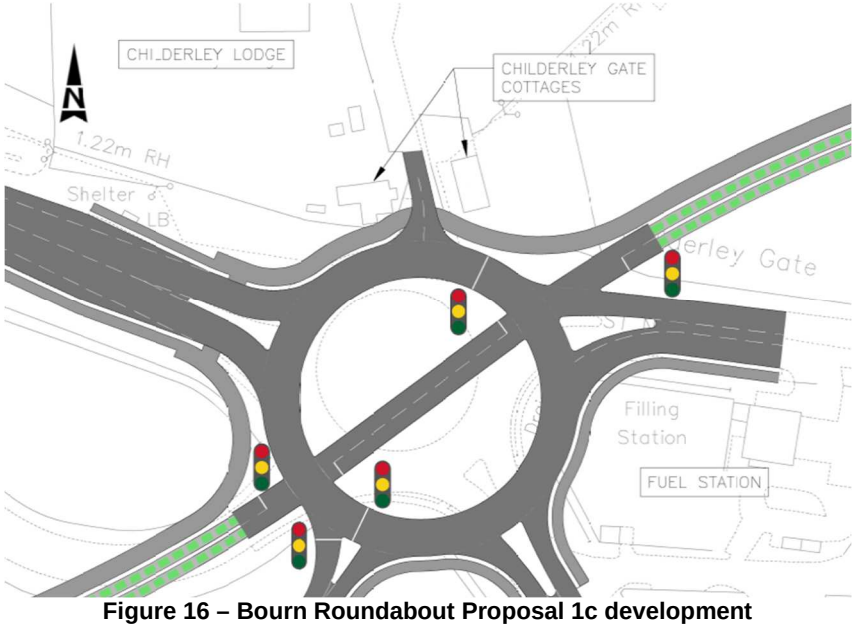


Figure 16 – Bourn Roundabout Proposal 1c development

6.1.2 Transport Modelling Assessment

Traffic modelling for Proposal 1c 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 three developed proposals identified for Bourn Roundabout (Proposal 3b segregated busway excluded) Proposal 1c shows a 30% degree of saturation during am peak which is the middle of the three Bourn proposals modelled. This 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 would be from the south and west approaches. During pm peak where traffic flows would be predominantly from the east St Neots Road approach. Traffic modelling data shows a 6% degree of saturation which is the lowest of the three proposals and indicates the arrangement would be operating well within capacity.

6.1.3 Safety Assessment

- Uncontrolled cycle crossing on the western arm may not be suitable depending on predicted pedestrian, cycle and vehicle flows. Provision of an uncontrolled or signal controlled crossing would be identified through the NMU Audit process.
- Eastbound exit – clear signing and possible alignment change required so that road users do not enter the segregated busway in error.
- Risk of vehicles blocking exits from the roundabout due to partial signalisation.

6.1.4 Construction Methodology

Proposal 1c would be predominantly constructed on the line of the existing A1303 St Neots Road carriageway, and as a result would require traffic management and carriageway lane restrictions to construct the enlarged roundabout and associated infrastructure.

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 widening/realignment areas.
- 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 carriageway realignment and break out and excavate existing carriageway in phased approach to allow traffic routes to be maintained.
- Construct proposed carriageway drainage system, and ducting for street lighting and traffic signals.
- Excavate to formation level and lay carriageway sub-base.
- Install kerbing, construct bound carriageway layers and footpath layers.
- Construct tie-ins to adjacent carriageway sections and bus guideway sections
- Install street lighting, and 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 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.
- Noise mitigation measures would be required due to the close proximity of residential properties north of the roundabout.
- Land acquisition would be required within land areas to the south and east of Bourn Roundabout to allow construction of the enlarged circulatory and the busway either side
- The roundabout alignment would be amended with widening into the verges of the existing roundabout, impacting of buried services within the verges, requiring diversion or protection.

6.1.6 Property and Environmental Impacts

Proposal 1c requires land take from the area to the south and east of the existing roundabout, comprising of highway verge and agricultural farmland to the south, and highway verge and trees/scrub area to the east of the roundabout within the area of the petrol station. To the north the proposed footway/cycleway alignment encroaches into the southern garden boundary of the Chapel Gate residential property.

6.1.7 Proposal 1c SWOT Assessment

6.2 Proposal 2. On carriageway bus provision with signalised bus gate

6.2.1 Junction Arrangement

- Proposal 2 would provide an on carriageway bus route around the roundabout with signalised priority bus transition gate either side of the roundabout allowing buses to join the carriageway either side of the junction;
- The roundabout circulatory would be enlarged to provide extra capacity;
- The proposed footway/cycleway crossing would be provided by an un-signalised crossing on the western St Neots Road arm, reducing the potential impact of the crossing on traffic flow at the junction.

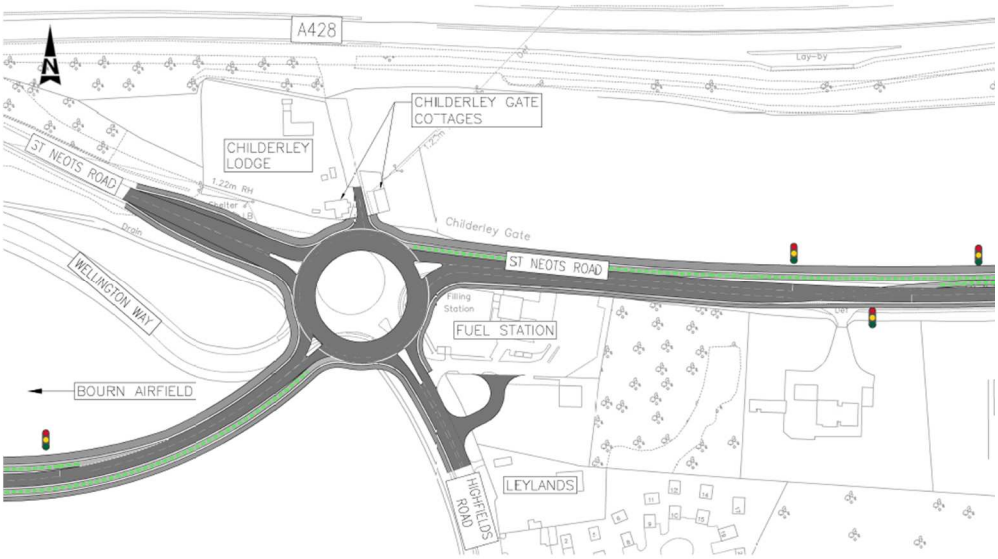


Figure 17 – Bourn Roundabout Proposal 2 development

6.2.2 Transport Modelling Assessment

Traffic modelling for Proposal 2 shows the junction to be operating at a 31.5% degree of saturation during am peak which is the greatest of the three modelled proposals for the junction by a small margin. The figure is below the maximum 80% saturation defined as being the upper limit, and therefore indicates the junction proposal is operating within capacity. As with Proposal 1c during am peak the majority of traffic flow is from the south and west approaches. During pm peak the junction is operating at 30.2% saturation, very similar to the am peak. This is the highest pm peak saturation value, but only marginally more than the second highest, Proposal 3a. For both am and pm peak the junction is operating well within capacity but not operating as efficiently as the other proposals modelled.

6.2.3 Safety Assessment

- Uncontrolled cycle crossing on the western arm may not be suitable depending on predicted pedestrian, cycle and vehicle flows. A signal controlled crossing may be required.
- To reduce risk of vehicles overshooting the signals at the transition gates, traffic islands should be provided to mount offside primary signal head. Alignment and entry into the busway should be reviewed during detailed design to discourage motorists from accidentally entering the segregated busways when exiting the roundabout.

6.2.4 Construction Methodology

Proposal 2 would be predominantly constructed on the line of the existing A1303 St Neots Road carriageway, and as a result would require traffic management and carriageway lane restrictions to construct the enlarged roundabout and associated infrastructure.

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 widening/realignment areas.
- 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 carriageway realignment and break out and excavate the existing carriageway in phased approach to allow traffic routes to be maintained
- 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.
- Construct tie-ins to adjacent carriageway sections and bus guideway sections
- Install street lighting, and traffic signal equipment on the Bourn approach and St Neots Road east of the roundabout.
- Install traffic signs and road markings
- 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.
- Noise mitigation measures would be required due to the close proximity of residential properties north of the roundabout.
- Land acquisition would be required within land areas to the south and east of Bourn Roundabout to allow construction of the enlarged circulatory and the busway either side.
- The roundabout alignment would be amended with widening into the verges of the existing roundabout, impacting of buried services within the verges, requiring diversion or protection.

6.2.6 Property and Environmental Impacts

Proposal 2 requires land take from the area to the south and east of the existing roundabout, comprising of highway verge and agricultural farmland to the south, and highway verge and trees/scrub area to the east of the roundabout within the area of the petrol station. To the north the proposed footway/cycleway alignment encroaches into the southern garden boundary of the Chapel Gate residential property.

6.2.7 Proposal 2 SWOT Assessment

6.3 Proposal 3a. Signalised burst-through junction on St Neots Road

6.3.1 Junction Arrangement

- Proposal 3a would be a burst-through junction on the west section of St Neots Road, with the busway aligned north of Childerley Lodge residential property;
- The Bourn 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.

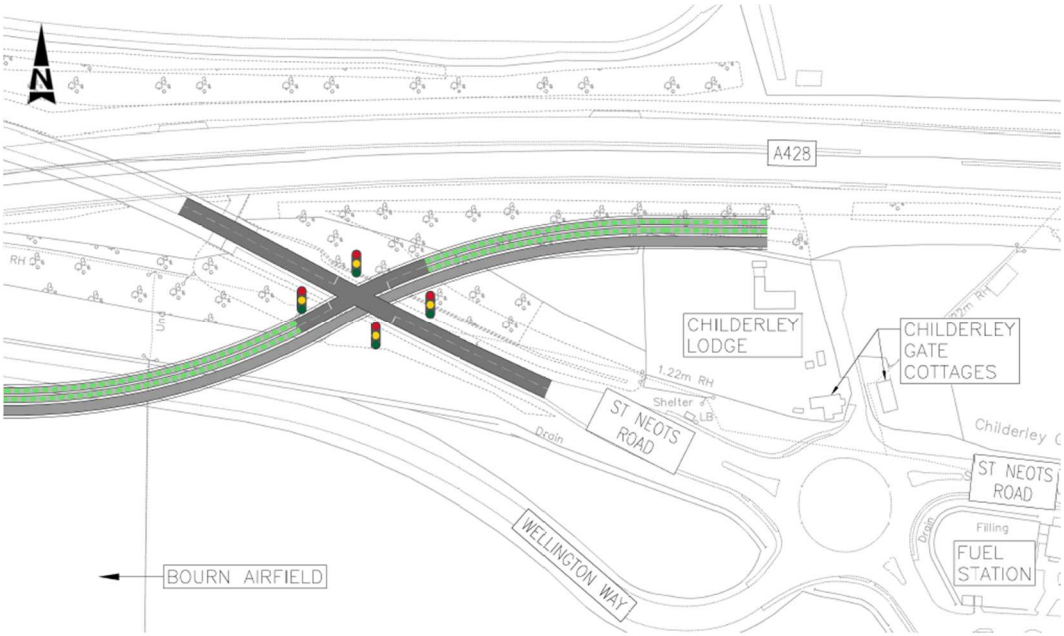


Figure 18 – Bourn Roundabout Proposal 3a development

6.3.2 Transport Modelling Assessment

Proposal 3a would be away from the Bourn Roundabout. Traffic modelling shows the junction to be operating at a 23.8% degree of saturation during am peak which is the lowest value of the three modelled proposals for the junction and below the maximum 80% saturation defined as being the upper limit. During am peak the majority of traffic flow would be from the west approach, the burst-through arrangement would not directly impact on expected traffic flows from the proposed Bourn development and the Highfields Caldecote approach to Bourn Roundabout. During pm peak the junction is operating at 29.1% saturation, slightly higher than am peak. This value is the middle of the three proposals but only marginally less than the highest, Proposal 2. During this period traffic flow would predominantly be in a westbound direction, and therefore the position of the burst-through may cause queuing vehicles back towards Bourn Roundabout, impacting on the junctions operation.

6.3.3 Safety Assessment

- No safety concerns for the junction arrangement.
- Potential risk if queues extend back to Bourn Roundabout resulting in queuing vehicles on the roundabout.

6.3.4 Construction Methodology

Proposal 3a would be constructed on the line of the existing A1303 St Neots 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.
- Site clearance of remaining vegetation/landscaping and vehicle restraint system to St Neots Road verges.
- Excavate existing soft verge for burst-through alignment break out and excavate existing footway on the westbound side of St Neots Road.
- Excavate existing kerbing to St Neots 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.

6.3.5 Construction Risks

- Temporary traffic management comprising of lane closures utilising two-way traffic signals would be required to tie the busway into the existing carriageway and install equipment
- Land acquisition would be required within land areas to the north and south of St Neots Road to construct the busway leading up to the burst-though crossing
- Construction works in the verges of St Neots Road would impact on buried services within the verges, requiring diversion or protection.

6.3.6 Property and Environmental Impacts

Proposal 3a requires land take from land to the north and south of the St Neots Road corridor. To the north is highway verge and a planted area of environmental landscaping provided when the A428 was constructed. To the south is highway verge and an area of grassland. The busway alignment to the east continues close the northern boundary of the Childerley Gate residential property.

6.3.7 Proposal 3a SWOT Assessment

6.4 Proposal 3b. Construct a new underpass under St Neots Road adjacent to the existing A428 Childerley Overbridge

6.4.1 Junction Arrangement

- Proposal 3b would provide of a fully segregated crossing of St Neots Road via an underbridge structure positioned alongside the existing A428 Childerley Overbridge;
- The Bourn Roundabout would be unaffected by the proposed junction arrangement;
- The proposed footway/cycleway alongside the busway underneath St Neots Road, providing a fully segregated footway/cycleway route for users, away from the public highway.

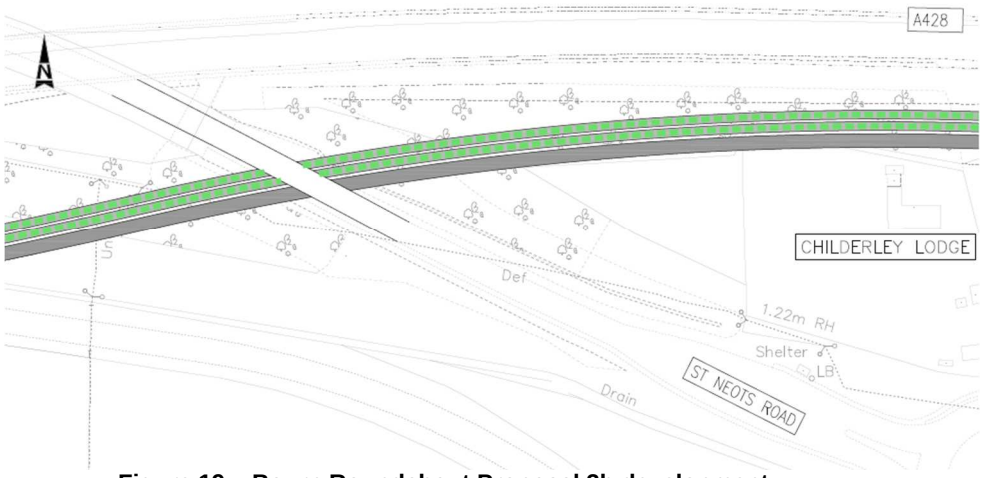


Figure 19 – Bourn Roundabout Proposal 3b development

6.4.2 Transport Modelling Assessment

Proposal 3b would provide an entirely segregated busway and footway/cycleway. As a result the arrangement would have no impact on the operation of the Bourn Roundabout Junction or St Neots Road from existing. Traffic modelling has therefore not been carried out for the proposal.

6.4.3 Safety Assessment

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

6.4.4 Construction Methodology

The general sequence of construction for an underbridge is anticipated to be as follows (example sequence for use of Self-Propelled Modular Transporter (SPMT) in the case of the favoured pre-cast proposal):

- Carry out site clearance & set up site compound and casting yard in adjacent land.
- Fabrication of main structural unit(s) – (in case of pre-cast solution).
- Site clearance of remaining vegetation/landscaping and vehicle restraint system to St Neots Road verges.
- Preparatory / enabling works (formwork/falsework).
- Cast the concrete for the underpass.
- Drainage & utility diversions & temporary access bridges.
- Apply waterproofing to outside of structural unit(s).
- Implement weekend full road closure with diversions as appropriate.
- Deep excavation through existing carriageway (St Neots Road).
- Preparation of foundations.
- Construction of underpass / transport structural units into position (in case pre-cast solution via Self Propelled Modular Transporters) complete headwalls/wingwalls, install drainage features and backfill.
- Reinstate services.
- Complete backfilling, install kerbs and reinstate carriageway and verges & edge protection (over).
- Complete pavement construction, VRS and landscaping leading to underpass.
- Demobilise from site, reinstate to agreed condition and open new underpass.

6.4.5 Construction Risks

- Temporary traffic management comprising of lane closures, carriageway closures and diversions would be required to construct the underbridge. Full weekend closure(s) would be required to construct the structure, with associated Temporary Traffic Regulation Orders.
- An additional land area would be required adjacent to the crossing for a compound to prepare structural elements and site any lifting equipment required.
- Land acquisition would be required within land areas to the north and south of St Neots Road to construct the busway leading up to the underbridge.
- Construction works would require temporary diversion of all utility services buried along St Neots Road to enable the structure to be constructed.

6.4.6 Property and Environmental Impacts

Proposal 3b requires land take from land to the north and south of the St Neots Road corridor. To the north is highway verge and a planted area of environmental landscaping provided when the A428 was constructed. To the south is highway verge and an area of grassland. The busway alignment to the east continues close the northern boundary of the Childerley Gate residential property.

6.4.7 Proposal 3b SWOT Assessment

6.5 Bourn Roundabout Summary

Proposal 1c would provide bus priority through Bourn roundabout with a separate footway/cycleway. The proposal would require Bourn roundabout to be enlarged and partially signalised. The footway/cycleway would be aligned around the roundabout with an un-signalised crossing of the western arm, presenting a greater risk to users.

Proposal 2 would provide an enlarged Bourn Roundabout with unsegregated buses on-road around the roundabout making buses susceptible to delay. The footway/cycleway would be aligned around the roundabout with an un-signalised crossing of the western arm, presenting a greater risk to users. Both Proposals 1c and 2 involve upgrading the Bourn Roundabout at a cost to the Cambourne to Cambridge project.

Proposal 3a would provide a burst-through junction on the St Neots Road west of the existing Bourn Roundabout. The proposal would minimise the impact on Bourn Roundabout by being positioned away from the junction, enabling junction alterations required for the Bourn Airfield development to be undertaken separately by the sites developer. The footway/cycleway would follow alongside the busway and cross St Neots Road via a signalised crossing.

Proposal 3b would provide a fully segregated busway and footway/cycleway from the highway network. The proposal would have greater risks associated due to being technically more challenging and being less versatile than other proposals.

In summary Proposals 1c and Proposals 3a and 3b would provide bus priority junctions, with Proposals 3a and 3b benefitting from being positioned away from Bourn Roundabout meaning the costs of upgrading it would be met by the Bourn Airfield developer. Proposal 2 would not provide bus priority through the junction making it susceptible to delay. Additional cost of upgrading the roundabout would be offset by improved capacity. Proposal 3b would provide a completely segregated busway and footway/cycleway, but with greater cost and reduced flexibility.

7 Bourn to Hardwick Junction Link

7.1 Existing Arrangement

The A1303 St Neots Road between Bourn Roundabout and Hardwick Junction is a single carriageway road 1.2km in length with a national speed limit throughout. The immediate approaches to Bourn Roundabout and Hardwick Junction are street lit; the interlinked section is unlit.

Access is provided to a number of private properties and businesses south of St Neots Road adjacent to the westbound carriageway, the majority are set back from the carriageway edge and screened from the road by mature hedges and walled or fenced boundaries. A number of the properties are provided with parking lay-bys alongside St Neots Road. A ditch runs parallel to the westbound carriageway for much of the length of the road. A narrow footway is present (approx. 1.5-2m width) running parallel to the westbound carriageway between Bourn Roundabout and Hardwick.

To the north side of St Neots Road is a wide grass verge and mature hedgerow beyond which is an area of land between the St Neots Road and the A428 Trunk Road. A number of gated accesses are provided into this area of land from the northern side of St Neots Road. The land, which is separated into parcels owned both privately and by the Highway Authority, includes a balancing pond provided for drainage of the A428 bypass. An earthworks bund is in place between the land area and the A428 provided during the construction of the A428 Trunk Road; this has been landscaped with saplings the full length of the link.

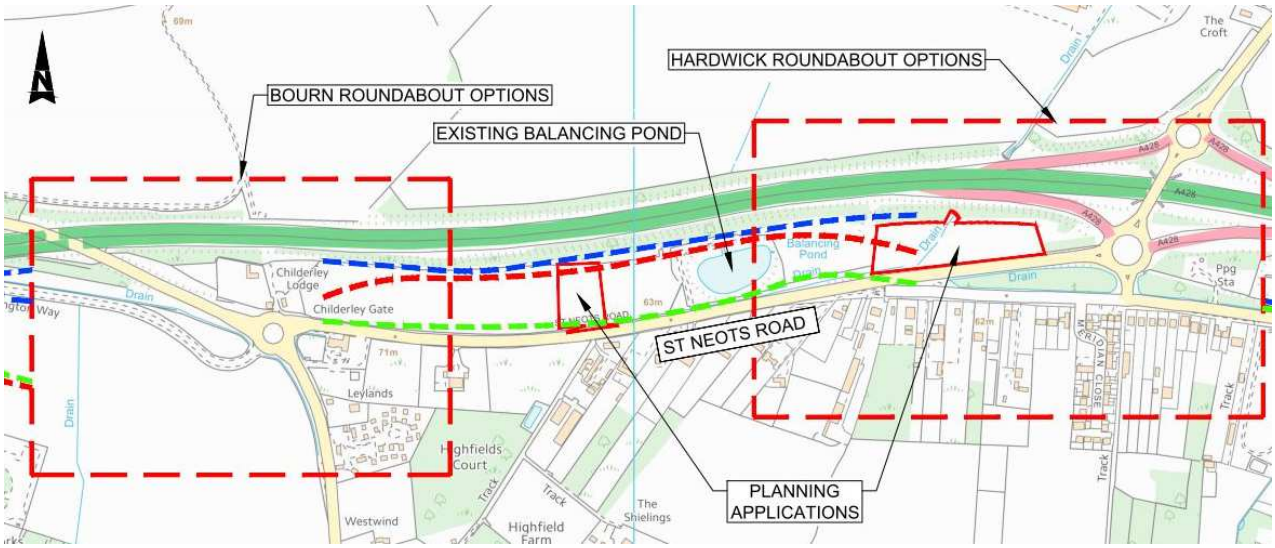


Figure 20 - Bourn Roundabout to Hardwick Junction link

The Cambourne to Cambridge Option 3A corridor looks to utilise busway alignments through this area of land between the St Neots Road and the A428. There are a considerable number of alignment proposals available between junctions through the land area, although not all link alignment proposals work with all junction proposals. 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 the edge of land area where possible, to reduce land-take requirements. For each link proposal the junction proposals with which they align have been identified.

Figure 21 - Bourn Roundabout to Hardwick Junction – looking North West

7.2 Existing constraints

7.2.1 Carriageway alignment and land constraints

The area of land to the north of the existing St Neots Road is split between private ownership and Highway Authority Ownership. Planning applications have been submitted for development of two of the privately owned parcels of land, refer to Figure 20. At the time of writing these applications are still subject to a planning decision.

A balancing pond serving the A428 carriageway is positioned centrally within the area of land with associated drainage infrastructure. This restricts alignment proposals for a busway through this area to avoid the need to provide a bridge over the balancing pond, which would result in additional costs.

Existing buried statutory undertakers' services are located along the St Neots Road corridor within the Highway Boundary running longitudinal to the existing carriageway. These comprise of National Grid medium pressure gas mains, Cambridge Water large bore asbestos cement water mains, BT telecommunications services. Gas and water mains also cross the site transversely in the north-south direction east of the balancing pond. Detailed investigations into the exact position and depth of the services would need to be determined during detailed design stage to provide the appropriate diversion or protection requirements for these services.

An existing watercourse crosses the land area to the eastern end between the A428 balancing pond and Hardwick Roundabout. The watercourse is culverted under the A428 at the northern side of the area of land. A further short span culvert is located in the middle of the site for access across the watercourse, the alignment and width of this culvert is unsuitable for use for a busway to cross. Any busway alignment through the land area would be required to cross the watercourse, either by provision of a new culvert, or extension of the existing culverts, dependent upon the busway alignment.

7.2.2 Non-motorised users

An existing footway is provided along the south side of St Neots Road which would be unaffected by any busway arrangement. There are no other non-motorised user routes within the area.

7.2.3 Environmental

There are no statutory environmental designations on the land area identified for the busway. The site has previously been used as the site compound during the construction of the A428 bypass, and has subsequently been returned to pasture.

7.3 Bourn to Hardwick Link Proposals

Proposal 1 – Busway adjacent to A428 boundary

- The proposal would provide a busway aligned along the northern side of the land area adjacent to the A428 Highway Boundary.
- The alignments are north of the A428 balancing pond, running alongside the earthworks bund that separates the land area from the A428 trunk road.
- The proposed footway/cycleway runs adjacent to the busway for the full length.

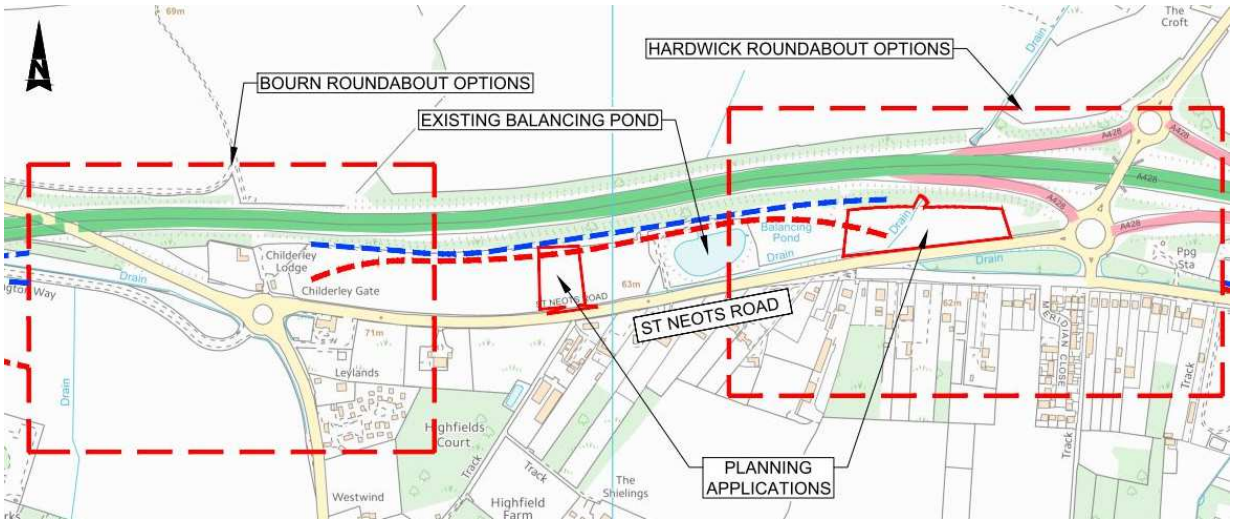
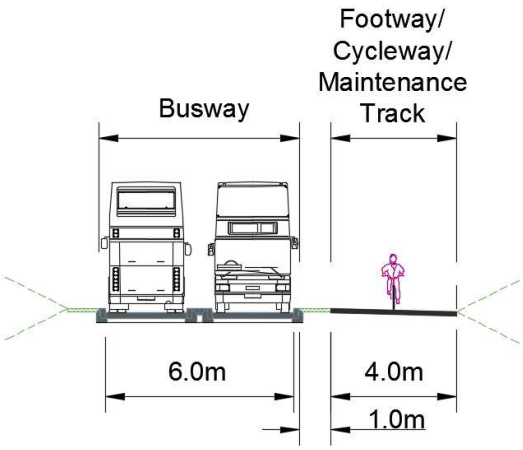


Figure 22 - Bourn to Hardwick Link - Proposal 1 Alignments

7.3.1 Link Alignments

Figure 23 Proposal 1 Busway Section



Two alternative variations of Proposal 1 have been identified as shown on Figure 22 indicated as blue and red lines. These provide connectivity with various junction proposals at Bourn Roundabout and Hardwick Roundabout.
The alignment of the Proposal 1 link has been designed to follow the southern side of the existing earthworks bund at the northern side of the land area, adjacent to the A428. The resulting alignment would provide a minimum busway radius of 1500m for the length of the link. Based on a guideway constructed with a 2.5% elevation as detailed in Section 4 of this Report, this gives a design speed of 100kph for the link alignment, below the maximum 120kph design speed. Additional earthworks excavation into the earthworks bund adjacent to the A428 to straighten the design alignment could be carried out to increase the alignment to the 2040m radii required to achieve a 120kph design speed with a 2.5% superelevation. This proposal would result in additional cost and potential mitigation works should the increased excavation reduce the effectiveness of the bund. Increasing the superelevation to the maximum design guidance value of 3.5% during detailed design would allow a 120kph design speed to be achieved.

7.3.2 Safety Assessment

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

7.3.3 Construction Risks

- Land acquisition required from private and highway authority owned land.
- Construction of a new culvert, or extension of the existing A428 culvert would be required over the watercourse at the eastern end of the proposed link.
- Aligning the busway and footway/cycleway along the southern side of the A428 earthworks bund could require earthworks reprofiling or earthworks support to enable the link to be constructed.

7.3.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 1 alignments 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 land area has previously been utilised for the site compound during the construction of the A428 and was subsequently returned to pasture.

The Proposal 1 link alignments would pass to the northern side of the planned development area to the west, reducing the impact on the parcel of land. The Proposal 1 blue alignment is aligned north of the eastern planned development area. The Proposal 1 red alignment would pass through the eastern development area and would have a significant impact on the proposed development of the site.

Junction Proposals Compatible	
Junction proposals compatible	o Bourn Roundabout – 1c, 3a & 3b o Hardwick Roundabout – 3 & 2
Junction proposals not compatible	o Bourn Roundabout – 2 o Hardwick Roundabout - 6

7.3.5 Proposal 1 SWOT Assessment

7.4 Proposal 2 – Busway adjacent to St Neots Road

- The proposal would provide a busway aligned along the southern side of the land area adjacent to the eastbound carriageway of St Neots Road.
- The alignment would be south of the A428 balancing pond.
- The proposed footway/cycleway runs adjacent to the busway for the full length.

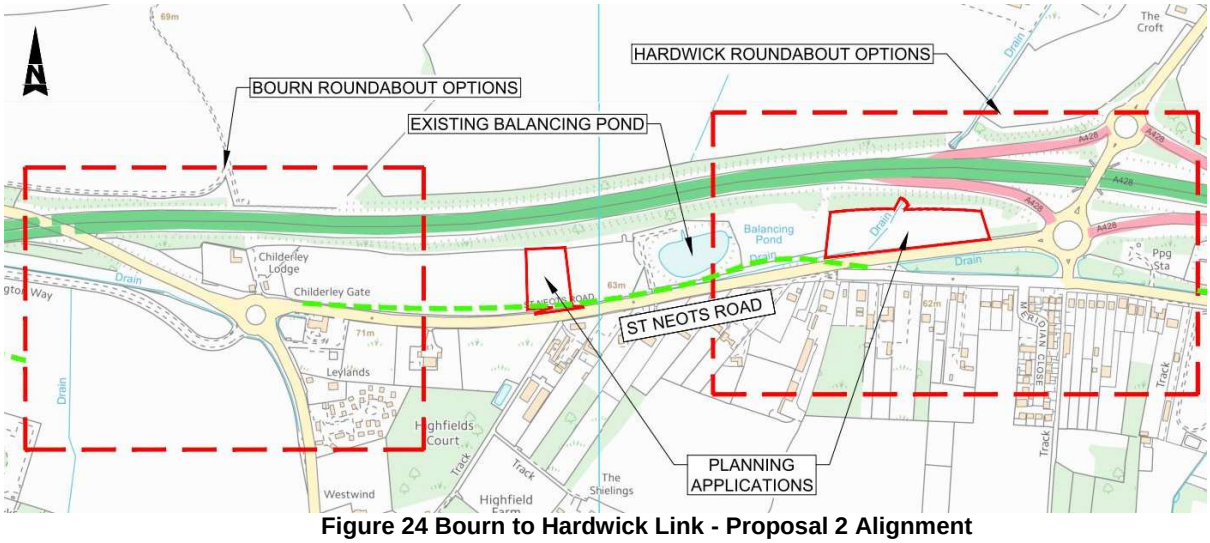
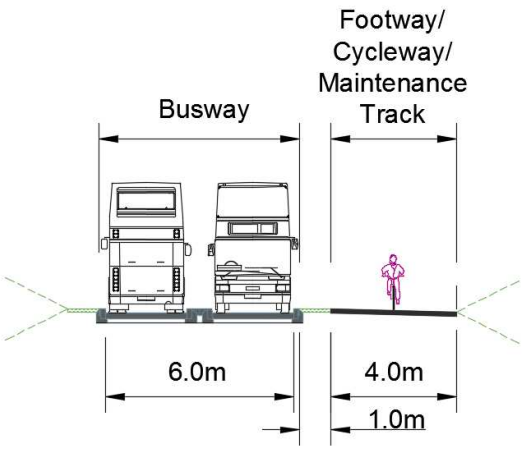


Figure 24 Bourn to Hardwick Link - Proposal 2 Alignment

7.4.1 Link Alignment

Figure 25 Proposal 2 Busway Section



The alignment of the Proposal 2 (green) link has been designed to follow the alignment of the A1303 St Neots Road Highway Boundary. The resulting alignment would provide a guideway radius of 2700m at the western end where there is a greater open area, providing a 120kph design speed with a 2.5% superelevation. The alignment, tightens to a 700m radius at the eastern end where available land area is restricted due to the position of the existing balancing pond and watercourse. The 700m radius would provide a design speed of 60kph. The alignment could be improved to provide a higher design speed by carrying out reconstruction of the southern side of the balancing pond, however the position of the reduced design speed section is on approach to Hardwick Junction, where bus speeds would be required to reduce on approach to the junction. Relaxation to provide a 3.5% superelevation during detailed design could provide an increased design speed of 70kph.

7.4.2 Safety Assessment

- The busway and footway/cycleway would cross land accesses and the balancing pond access which would need to be managed to prevent conflict between buses, pedestrians or cyclists and vehicles using the accesses.
- Positioning of the busway adjacent to St Neots Road could result in headlights dazzling eastbound traffic due to nearside opposing bus route. Provision of anti dazzle fencing could be required depending on the proximity of the busway to the public highway and loss of existing screening during construction works.

7.4.3 Construction Risks

- Temporary traffic management comprising of lane closures or temporary narrowing of the St Neots Road carriageway could be required to carry out works adjcent to the road and to construct accesses to land areas and the balancing pond.
- Land acquisition required from private and highway authority owned land areas.
- Piping of the existing ditch along the north side of St Neots Road would be required to construct the busway and footway/cycleway.
- Existing buried statutory undertakers' services along the northern side of St Neots Road corridor could be affected by the busway alignment and require lowering or diversion to enable the busway to be constructed.

7.4.4 Property and Environmental Impacts

A search of environmental designations for the proposed Proposal 2 alignment land area has been carried out. The search has found no statutory designations assigned to the area through which the Proposal 2 busway design is aligned. As with Proposal 1 the land area has previously been utilised for the site compound area during the construction of the A428, and was subsequently returned to pasture.

The alignment impacts on an existing ditch adjacent to St Neots Road which would require environmental assessment during detailed design to determine if diversion or piping of the ditch would impact on habitats and appropriate mitigation requirements.

The Proposal 2 alignment would pass to the southern extents of the western planned development area. This would have an impact on the proposed access point to the site from St Neots Road, and could lead to conflict between buses and vehicles accessing the site. The eastern development would be unaffected by the Proposal 2 alignment. Proposal 2 would also cross a number of other field accesses and the access track to the A428 balancing pond along its length.

Junction Proposals Compatible	
Junction proposals compatible	o Bourn Roundabout – 2 o Hardwick Roundabout – 6
Junction proposals not compatible	o Bourn Roundabout – 1c, 3a & 3b o Hardwick Roundabout – 3 & 2

7.4.5 Proposal 2 SWOT Assessment

7.5 Bourn to Hardwick Link Summary

Proposal 1 (Blue and Red) would provide a busway and footway/cycleway aligned to the A428 boundary, north of the area of land between St Neots Road and the A428. The proposal would be less intrusive on land areas than Proposal 2 and would provide good connectivity with junction arrangements at either end.

Proposal 2 (Green) provides a busway and footway/cycleway adjacent to St Neots Road. The position of the busway provides good access to patrons. However the busway does not provide good connectivity with Hardwick and Bourn junction proposals, without introducing tight curvature in the busway alignment requiring greatly reduced bus speeds. The proposal would segregate access from St Neots Road to land parcels to the north of the busway.

In summary both Proposals 1 and 2 would provide segregated busways between Bourn and Hardwick. Proposal 1 is less disruptive to land access and provides an alignment to meet the needs of bus rapid transit.

8 Hardwick Junction

8.1 Existing Arrangement

Hardwick Junction is a grade separated junction connecting St Neots Road and Scotland Road with the A428 Trunk Road dual carriageway. Local roads provide direct access to the villages of Hardwick, Highfields Caldecote and Dry Drayton.

The southern roundabout of the Hardwick Junction is a five arm roundabout. The northern arm of the roundabout links across the A428 overbridge to the A428 eastbound carriageway and Scotland Road. The southern arm links to St Neots Road which continues to the east to Hardwick village. Two arms are provided linking the entry and exit slip roads from the A428 westbound dual carriageway. The fifth arm to the west links to the continuation of St Neots Road towards Bourn.

Figure 26 - Hardwick Roundabout

The junction is subject to national speed limit with connecting roads being single carriageway or single lane slip roads. The southern arm to St Neots Road reduces to a 40mph speed limit just south of the roundabout at the gateway into Hardwick village. The junction and immediate approaches are lit by column mounted street lighting. A 2m wide footway is to the east of the junction connecting St Neots Road to the south, across the A428 entry slip road arm of the roundabout, and continues north over the A428 to Scotland Road. A footway of varying width is present to the southern side of St Neots Road running east-west following the old St Neots Road alignment towards Bourn, this footpath serves the numerous properties fronting the St Neots Road to the south.

Junction modelling carried out for the existing Hardwick Junction Roundabout show that with the expected increases in traffic flow from urban development in the area the junction will be operating close to capacity, with 61.9% degree of saturation during am peak and 53.7% during pm peak. 80% saturation being defined as being the upper limit for junction operation. As a result proposed alterations and signalisation of the roundabout to incorporate a busway through the junction are likely to push the junction close to, or in excess of capacity, and will require improvement works and mitigation measure to ensure the junction operates within its limits.

Figure 27 - Hardwick Junction South Roundabout

8.2 Existing constraints;

8.2.1 Carriageway alignment and land constraints

To the north of Hardwick Junction is the A428 dual carriageway Trunk Road with an overbridge to the A428 eastbound carriageway and Scotland Road.

To the east of the roundabout a westbound exit slip road connects from the A428. Adjacent to this is an area of vegetated land between the slip road and the eastern section of the A1303 St Neots Road. This area of land includes a balancing pond for drainage of the A428.

To the west of the roundabout a westbound entry slip road links to the A428, adjacent to this is an area of open land part under private ownership. A planning application for commercial property development has been submitted for part of this area at time of writing this Report, which has implications on busway alignments through the area, refer to Figure 23 and Section 7 of this Report. A fifth arm of the roundabout links to the western section of the A1303 St Neots Road towards Bourn Roundabout.

South of the roundabout links to A1303 St Neots Road running east-west at the northern extent of Hardwick village. The western section is an old alignment of St Neots Road which has been stopped up, now providing access to residential properties, with the western section of St Neots Road now connecting via Hardwick Roundabout as noted above.

The existing junction and approaches are street lit with verge mounted lighting columns. Buried supply cabling for the street lighting is present throughout the site.

Existing buried statutory undertakers' services are located throughout the site along the St Neots Road corridor. These comprise of National Grid medium pressure gas mains, Cambridge water mains, Anglian Water foul sewers, and BT, Virgin Media and Vodafone telecommunications. BT telecommunications are also located to the east side of the Hardwick Junction roundabout from St Neots Road north across the A428. 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 determined during detailed design stage to provide the appropriate mitigation works.

8.2.2 Non-motorised users

Existing footways are provided along the east side of Hardwick Roundabout from Hardwick to Scotland Road and to the southern side of St Neots Road Hardwick. Footway provision is to be retained and where possible enhanced by any alterations to the junction

8.2.3 Environmental

An area of protected trees (South Cambs Tree Preservation Orders) is registered along the east side of Hardwick Junction on the old alignment of Scotland Road. This area was cleared during the construction of the A428 bypass and now comprises the A428 junction and verge areas with no trees remaining.

8.3 Hardwick Junction Proposals

8.3.1 Proposal 1 – Provision of two burst-through busway junctions to St Neots Road

The proposal would use two burst-through busway junctions, one on western section of St Neots Road, west of the Hardwick Junction, and the other on the southern arm of Hardwick Roundabout on the eastern section of St Neots Road. The busway remains offline throughout within the parcel of land north of the stopped up section of St Neots Road. Footway/cycleway provision follows the busway alignment with signalised crossings provided at each burst-through crossing.

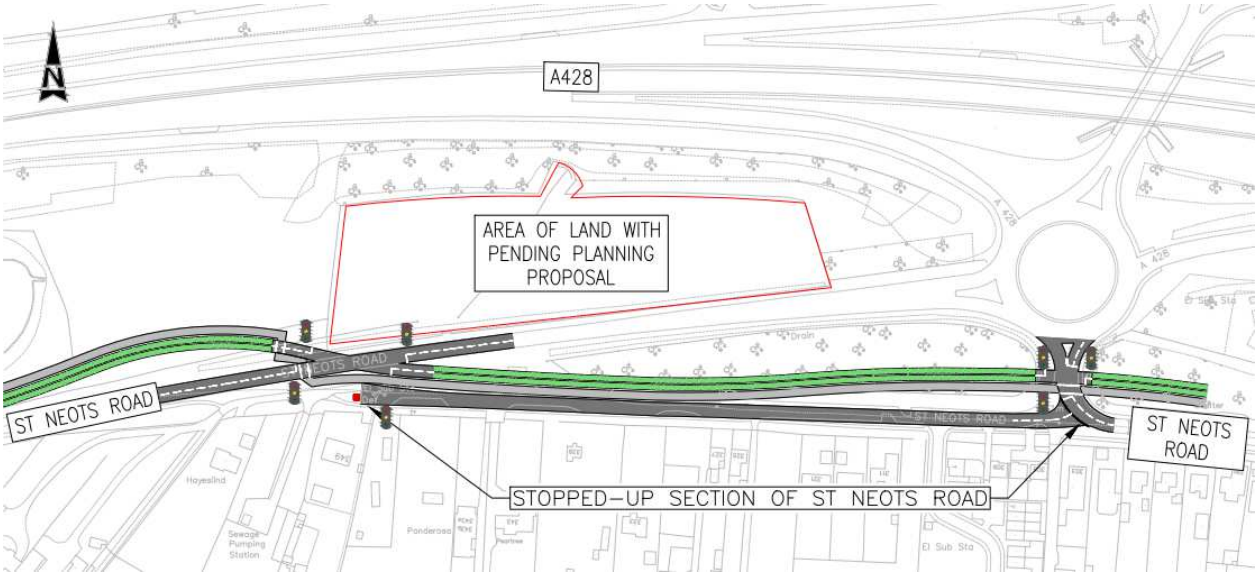


Figure 28 - Hardwick Junction Proposal 1

ADVANTAGES	DISADVANTAGES
Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.	The burst-through junction on the eastern section of St Neots Road would be extremely close to the roundabout, there is a risk that queues would block the roundabout.
Busway and footway/cycleway positioned away from property accesses.	Long length of burst-through junction arrangement due to the oblique angle of crossing of St Neots Road west of Hardwick Roundabout, increasing potential for traffic delays.
Stopped up section of St Neots Road remains unaffected by busway alignment.	Numerous statutory undertakers' plant in northern verge of St Neots Road requiring diversion or protection.
Busway alignment should not affect the privately owned area of land to the west of Hardwick Junction, currently subject to planning consent.	
Minimises land take providing the busway alignment adjacent to the existing St Neots Road.	

Outcome

Proposal 1 not taken forward for development. Concerns over queuing onto Hardwick Roundabout potentially causing congestion

8.3.2 Proposal 2 – Priority busway through the centre of Hardwick Junction Roundabout

The proposal would provide a busway intersecting the existing roundabout circulatory with a signalised 'hamburger' style arrangement. Traffic signals are provided on the roundabout circulatory and the St Neots Road eastbound approach to the roundabout to hold traffic whilst the bus passes through the junction as a priority manoeuvre.
To the west the busway is aligned towards the A428 boundary, to the north side of the land parcel between Hardwick Junction and Bourn Roundabout. Footway/cycleway provision follows the busway alignment with signalised crossings provided through the centre of the roundabout.

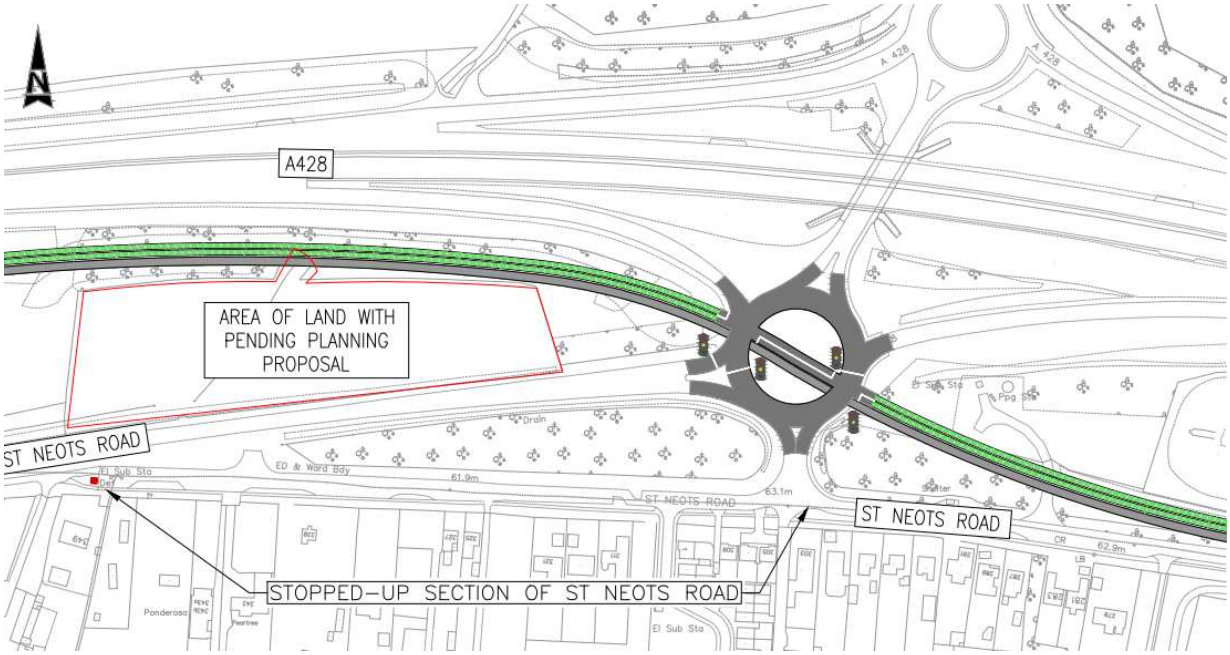


Figure 29 - Hardwick Junction Proposal 2

ADVANTAGES	DISADVANTAGES
Bus priority through the junction allows for bus rapid transit.	Potential negative impact of the signalised footway/cycleway arrangement on traffic flow through the junction.
Busway and footway/cycleway away from existing residential properties.	The route alignment follows close to the westbound carriageway of the A428 which would require liaison with Highways England and may result in further mitigation measures.
Proposal retains existing infrastructure minimising construction disruption.	Busway crossing existing watercourse under the A428 would require extension/alternation to the existing culvert structure.
Busway alignment adjacent to the A428 should not affect the privately owned area of land currently subject to planning consent.	
Footway/cycleway crossing via the signalised junction would provide improved safety for users.	

Outcome
Proposal 2 would provide a well aligned junction arrangement with minimal impact on residential and private properties. Proposal 2 taken forward for further development and junction modelling analysis.

8.3.3 Proposal 3 – Provision of a burst-through bus junction on St Neots Road and reopen stopped-up St Neots Road with new junction

The proposal would remove the southern arm of the roundabout linking to the eastern section of St Neots Road and reopen the old, currently stopped up section of St Neots Road. A new un-signalised T junction would be provided, joining to the western section of St Neots Road. A signalised burst-through junction would be provided between the new junction and roundabout with crossing provision for the footway/cycleway. St Neots Road west of the roundabout would be realigned to provide a shorter bus burst-through junction and a better alignment of the T junction.

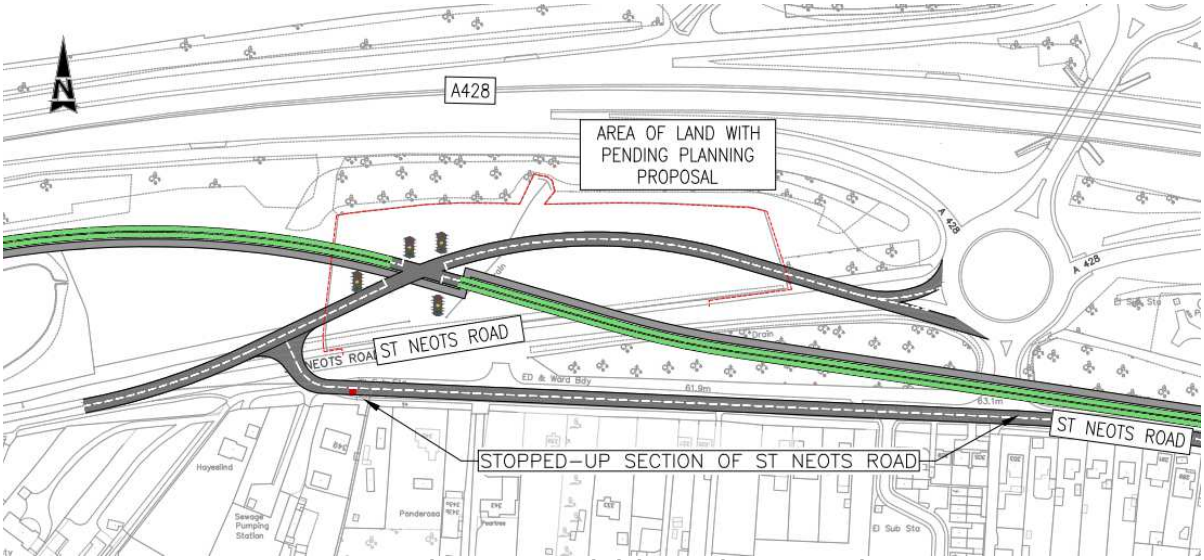


Figure 30 - Hardwick Junction Proposal 3

ADVANTAGES	DISADVANTAGES
Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.	Requires land purchase in the area of privately owned land west of Hardwick Junction currently subject to planning consent for development.
Busway remains offline with single priority burst-through;	The proposal requires considerable alteration to the existing highway infrastructure.
Busway and footway/cycleway away from existing residential properties.	Reopening the stopped-up section of St Neots Road currently closed to through traffic would impact on residential properties.
Footway/cycleway crossing via the signalised junction would provide improved safety for users.	Burst-though arrangement in close proximity to the junction impacting on traffic flow;
	T Junction is a lower standard of junction than the existing roundabout.

Outcome

Proposal 3 requires considerable alteration to the highway to provide a well aligned busway route; Proposal 3 taken forward for further development and junction modelling analysis with amendment to include signals at the new junction.

8.3.4 Proposal 4 - Provision of a burst-through bus junction on St Neots Road combined with a new junction with reopened stopped-up St Neots Road

The proposal would remove the southern arm of the roundabout linking to the eastern section of St Neots Road and reopens the old, currently stopped up section of St Neots Road. A new signalised junction would be provided, joining to the western section of St Neots Road. St Neots Road west of the roundabout would be realigned to provide a shorter burst-through junction which would be combined with the signalised junction arrangement. A signalised burst-through junction would be provided between the new junction and roundabout with crossing provision for the footway/cycleway.

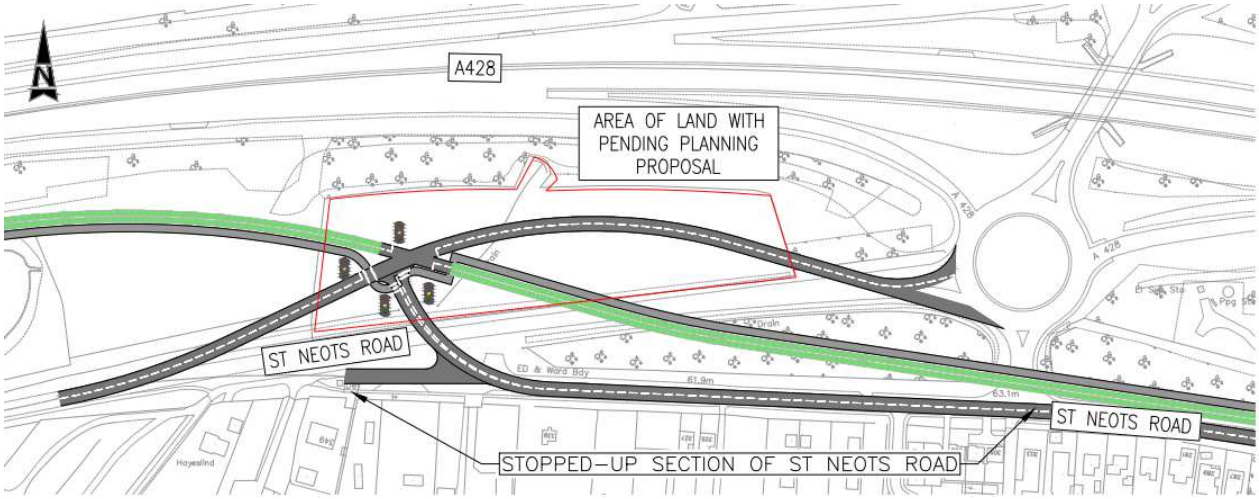


Figure 31 - Hardwick Junction Proposal 4

ADVANTAGES	DISADVANTAGES
Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.	Requires land purchase in the area of privately owned land west of Hardwick Roundabout currently subject to planning consent for development.
Busway remains offline with single Priority burst-through;	The proposal requires considerable alteration to the existing highway infrastructure.
Busway and footway/cycleway away from existing residential properties.	Reopening the stopped-up section of St Neots Road currently closed to through traffic would impact on residential properties;
Footway/cycleway crossing via the signalised junction would provide improved safety for users.	Signalised burst-through and junction arrangement with footway/cycleway crossing would be complicated and likely to cause significant delays

Outcome

Proposal 4 not taken forward for development. Concerns over queuing caused by complicated signalised junction arrangement.

8.3.5 Proposal 5 – Provision of a burst-through on St Neots Road, busway either side of stopped up section of St Neots Road

The proposal would provide a burst-through on the west section of St Neots Road joining on to busways either side of the currently stopped up section of St Neots Road. A signalised junction would be provided on the southern arm of the roundabout replacing the existing give way arrangement, allowing for buses to pass through the junction with priority. The busway on the east section of St Neots Road would have a transition gate in the westbound direction to join the carriageway. Footway/cycleway provision would be aligned to the north with signalised crossings at both burst-through's.

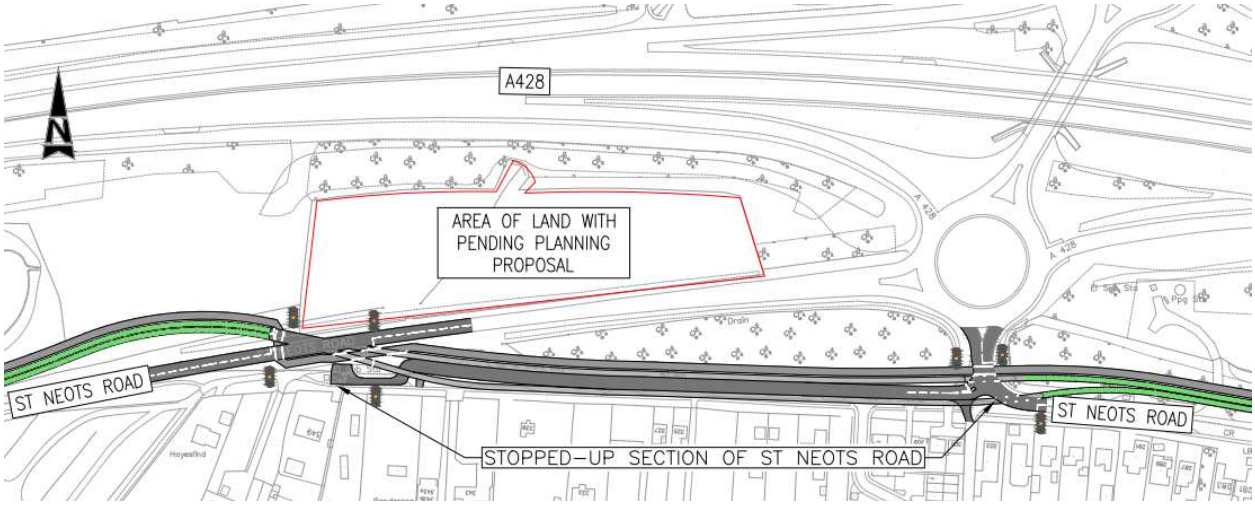


Figure 32 - Hardwick Junction Proposal 5

ADVANTAGES	DISADVANTAGES
Hardwick Roundabout unaffected by the busway, utilising existing assets.	Long length of burst-through junction arrangement due to the oblique angle of crossing of St Neots Road west of Hardwick Roundabout increasing potential for traffic delays.
Burst-through type detail is a simple and familiar arrangement utilised on the existing CBG.	Unsegregated bus lanes on the stopped up section of St Neots Road.
Busway alignment should not affect the privately owned area of land to the west of Hardwick Junction, currently subject to planning consent.	Westbound busway cuts across numerous property accesses.
Minimises land take providing the busway alignment adjacent to the existing St Neots Road corridor.	Signalised junction south of the roundabout would be in close proximity to the roundabout affecting traffic flows.

Outcome

Proposal 5 not taken forward for development. Concerns over queuing and impact on residential property accesses on south side of St Neots Road.

8.3.6 Proposal 6 - Provision of a burst-through on St Neots Road with bus lanes along stopped up section of St Neots Road

The proposal would provide a burst-through on the western section of St Neots Road joining on to the currently stopped up section of St Neots Road. Bus lanes would be provided through this section with a give way arrangement at the southern arm of Hardwick Roundabout similar to the existing junction arrangement. Eastbound buses join an offline busway at this point. The eastern section of St Neots Road would have a transition gate for westbound buses. Footway/cycleway provision would be aligned to the south with a signalised crossing at the burst-through.

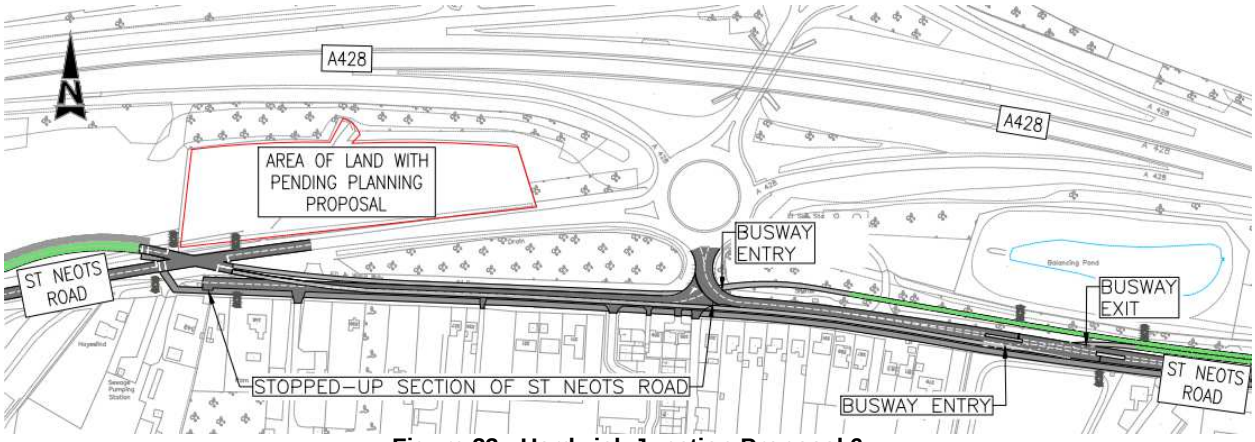


Figure 33 - Hardwick Junction Proposal 6

ADVANTAGES	DISADVANTAGES
Hardwick Roundabout unaffected by the busway, utilising existing assets.	Long length of burst-through junction arrangement due to the oblique angle of crossing of St Neots Road west of Hardwick Roundabout increasing potential for traffic delays.
Burst-through type detail is a simple and familiar arrangement utilised on the existing CGB.	Buses utilising the stopped up section of St Neots Road.
Busway alignment should not affect the privately owned area of land to the west of Hardwick Junction, currently subject to planning consent;	Give way arrangement for eastbound buses, increasing journey times.
Minimises land take providing the busway alignment adjacent to the existing St Neots Road corridor.	Footway/cycleway to cross multiple junctions and property accesses increasing the potential for conflict with motorists.
Footway/cycleway would provide connectivity with the village of Hardwick.	

Outcome

Proposal 6 gives busway provision without significant alteration to existing highway infrastructure, and utilising existing assets where possible minimise costs. Proposal 6 taken forward for further development and junction modelling analysis with amendment to run buses on St Neots Road rather than to provide bus lanes.

8.4 Bourn Roundabout Initial Proposal Summary

Proposal	Description	Outcome	
1	Provision of two burst-through busway junctions to St Neots Road	Proposal 1 not taken forward	
2	Priority busway through the centre of Hardwick Junction Roundabout	**Proposal 2 taken forward for development and junction modelling analysis.**	
3	Provision of a burst-through bus junction on St Neots Road and reopen stopped-up St Neots Road with new junction	**Proposal 3 taken forward for development and junction modelling analysis.**	
4	Provision of a burst-through bus junction on St Neots Road combined with a new junction with reopened stopped-up St Neots Road	Proposal 4 not taken forward	
5	Provision of a burst-through on St Neots Road, busway either side of stopped up section of St Neots Road	Proposal 5 not taken forward	
6	Provision of a burst-through on St Neots Road with bus lanes along stopped up section of St Neots Road	**Proposal 6 taken forward for development and junction modelling analysis.**	

9 Hardwick Junction Proposal Development

The Cambourne to Cambridge busway junction proposals workshop held on 30th January 2017 identified a number of preferred proposals as identified in sections 8.3 and 8.4 of this Report. These proposals have been taken forward for development following amendments and alterations identified at the workshop.

Development of each preferred proposal identifies the most suitable junction arrangement at the Bourn Roundabout junction 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;

9.1 Proposal 2. - Priority busway through the centre of an enlarged Bourn Roundabout

9.1.1 Junction Arrangement

- Proposal 2 would provide an unguided section of busway intersecting the Hardwick roundabout with a signalised hamburger style arrangement to allow buses to pass through the junction unobstructed;
- The roundabout circulatory would be retained in its current form with the addition of stop lines positioned on the roundabout circulatory to hold traffic and allow priority for buses passing through the interchange without the need for signalising each arm individually, allowing the roundabout to operate as a priority junction;
- The proposed footway/cycleway crossing would be aligned through the centre of the roundabout circulatory alongside the busway.

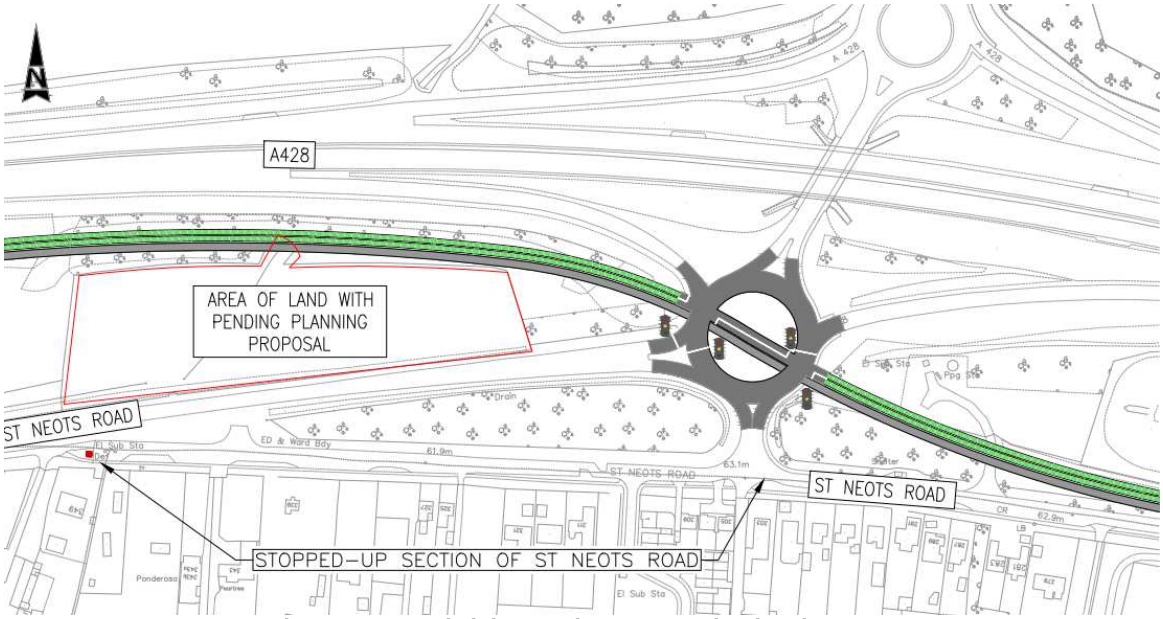


Figure 34 - Hardwick Junction Proposal 2 development

9.1.2 Transport Assessment

Traffic modelling for Proposal 2 has been carried out for peak am and pm traffic flow periods to determine the impact the proposed busway would have of the operation of the proposed junction arrangement.

Proposal 2 shows an 82.7% degree of saturation during am peak which is the highest figure of the three proposals modelled at the junction. This is above the maximum 80% saturation defined as being the upper limit and therefore indicates the proposal would not perform adequately. During pm peak traffic modelling data shows a 73% degree of saturation which is the middle of the three proposals modelled, and although lower than the 80% limit it is close to it and therefore the arrangement would likely perform poorly in operation.

9.1.3 Safety Assessment

- Exit blocking on western arm of Hardwick Roundabout due to partial signalisation.
- Entry blocking on eastern arm due to partial signalisation. Eastern entry arm needs to be signalised due to close proximity of the roundabout give way and stop line on the circulatory.

9.1.4 Construction Methodology

Proposal 2 would be predominantly constructed through the centre of the existing Hardwick Junction Roundabout. Traffic management and carriageway lane restrictions would be required to construct the hamburger roundabout 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 within roundabout and verge areas within the busway alignment.
- Expose and protect or divert statutory undertakers' plant within the construction extents (preferably delivered pre works phase)
- Construct extended culvert section to the existing A428 culvert over the watercourse to the west of the junction.
- Install and maintain traffic management to the roundabout and approaches.
- Site clearance of remaining vegetation, affected street lighting assets and street furniture.
- Excavate the existing soft verge and the roundabout island
- Undertake amendments to the carriageway drainage system and install ducting for traffic signals.
- Excavate to formation level and lay sub-base to busway construction.
- Install new kerbing, construct new bound carriageway and footway layers.
- Replace affected street lighting infrastructure in revised position to suit junction and 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 lane closures, carriageway closures and diversions would be required due to the on-line nature of the scheme, with associated Temporary Traffic Regulation Orders.
- Land acquisition would be required within land areas to the east and west of Hardwick Roundabout to allow construction of the busway either side
- Construction into the verges of the existing roundabout would impact on buried services within the verges, requiring diversion or protection.

9.1.6 Property and Environmental Impacts

Proposal 2 requires land take from land to the east and west of the southern Hardwick Junction Roundabout, comprising of highway verge and privately owned arable land to the west, and highway verge and trees/scrub area to the east of the roundabout. To the east a balancing pond and associated infrastructure is present which provides drainage to the A428.

9.1.7 Proposal 2 SWOT Assessment

9.2 Proposal 3. - Provision of a burst-through bus junction on St Neots Road and reopen stopped-up St Neots Road with new junction

9.2.1 Junction Arrangement

- Proposal 3 would provide a burst-through junction on a proposed realigned section of St Neots Road west of Hardwick Roundabout.
- The southern arm from Hardwick Roundabout to the St Neots Road eastern section would be closed off to enable the busway to pass to the south side of the roundabout. To maintain access to St Neots Road eastern section a new signalised junction would be provided west of the Hardwick Roundabout, re-opening the existing closed section of St Neots Road.
- The proposed footway/cycleway would use a signalised crossing at the location of the burst-through.

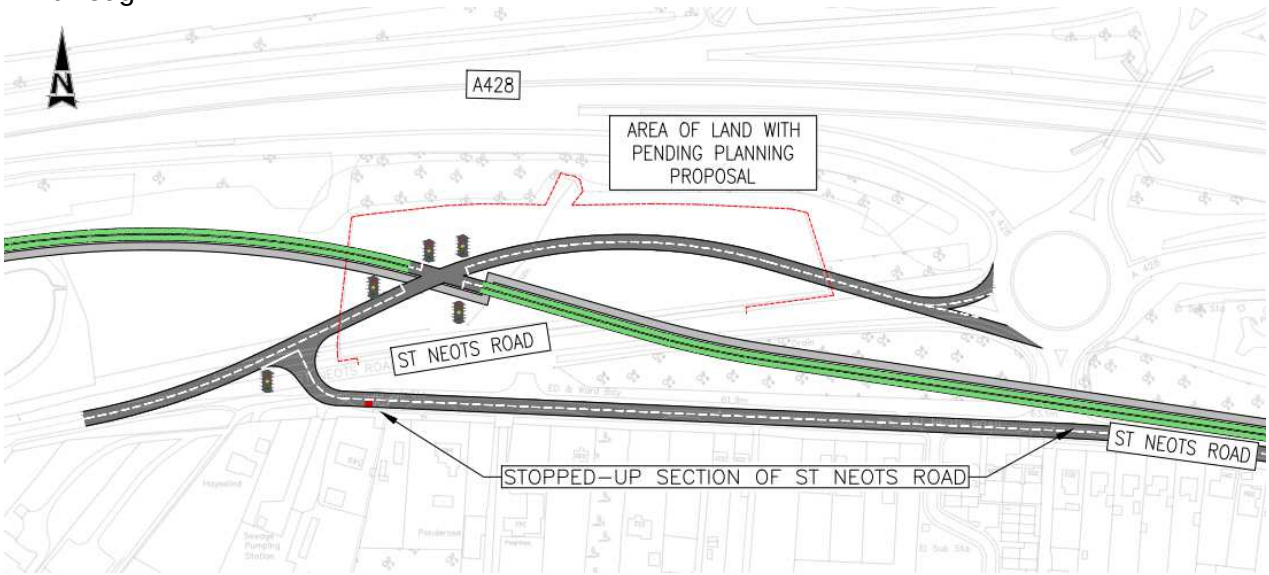


Figure 35 - Hardwick Junction Proposal 3 development

9.2.2 Transport Assessment

Proposal 3 would provide a realigned carriageway and burst-through away from Hardwick Roundabout. Traffic modelling outputs shows the junction to be operating at a 79.1% degree of saturation during am peak which is the middle of the three modelled junction proposals. The figure is close to the maximum 80% saturation defined as being the upper limit. During am peak the majority of traffic flow would be from St Neots Road eastbound approach, with the burst-through impacting on the repositioned signalised junction. During pm peak the junction is operating at 99.1% saturation, the highest of the three junction proposals and well in excess of the 80% figure.

9.2.3 Safety Assessment

Hardwick Roundabout would no longer be available for St Neots Road westbound traffic, being replaced by a T-junction. This is a lower level of junction provision and could result in an increase in the number and severity of collisions due to potential for high speed side impact collisions.

9.2.4 Construction Methodology

Proposal 3 would be constructed predominantly offline of the existing St Neots Road reducing the impact of the junction arrangement on traffic flow.

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 within the proposed construction area of the busway and St Neots Road realignment.
- Expose and protect or divert statutory undertakers' plant within the construction extents (preferably delivered pre works phase)
- Install new culvert structure(s) within the land area north of St Neots Road to bridge the watercourse through the site.
- Site clearance of remaining vegetation/landscaping.
- Construct carriageway and busway drainage systems and install ducting traffic signals.
- Excavate/fill earthworks to formation level and lay carriageway and busway sub-base.
- Install new kerbing.
- Construct carriageway pavement layers and busway guideway units to offline alignments.
- Install and maintain traffic management.
- Excavate existing verge for proposed St Neots Road junction arrangement.
- Construct and amend junction drainage and install traffic signal ducting.
- Excavate proposed junction to formation level and lay carriageway sub-base.
- Install new junction kerbing.
- Construct junction pavement layers
- Construct realigned St Neots Road tie-ins to existing carriageway
- Install traffic signal equipment.
- Install traffic signs and road markings
- Excavate existing southern arm from Hardwick Roundabout and return area to soft verge
- Reinstate verges and soft landscaped areas throughout site.
- Remove traffic management and demobilise site.

9.2.5 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.
- Noise mitigation measures would be required due to the close proximity of residential properties in St Neots Road.
- Land acquisition would be required west of the Hardwick Roundabout to realign St Neots Road and construct the busway. The area of land has been identified for future private development.
- The road realignment within the verges would require diversion or protection of utility services.

9.2.6 Property and Environmental Impacts

Proposal 3 requires land take from land west of the southern Hardwick Junction Roundabout, comprising privately owned arable land. To the south of St Neots Road the busway would pass through an area of semi mature trees/scrub. There are no statutory environmental designations on this area of trees. The old St Neots Road alignment would be reopened to through traffic impacting on residential properties along the road.

9.2.7 Proposal 3 SWOT Assessment

9.3 Proposal 6. - Provision of a burst-through bus junction on St Neots Road and reopen stopped-up St Neots Road with new junction

9.3.1 Junction Arrangement

- Proposal 6 would provide a burst-through junction of St Neots Road western section linking to buses on-carriageway along the currently stopped up section of the St Neots Road. A priority junction arrangement at the existing junction south of Hardwick Roundabout, with a give-way arrangement for eastbound traffic.
- A transition gate would be provided on the eastern section of St Neots Road to allow westbound buses priority access onto the carriageway.
- The proposed footway/cycleway would be aligned to the south of St Neots Road to link to properties and the village of Hardwick.
-

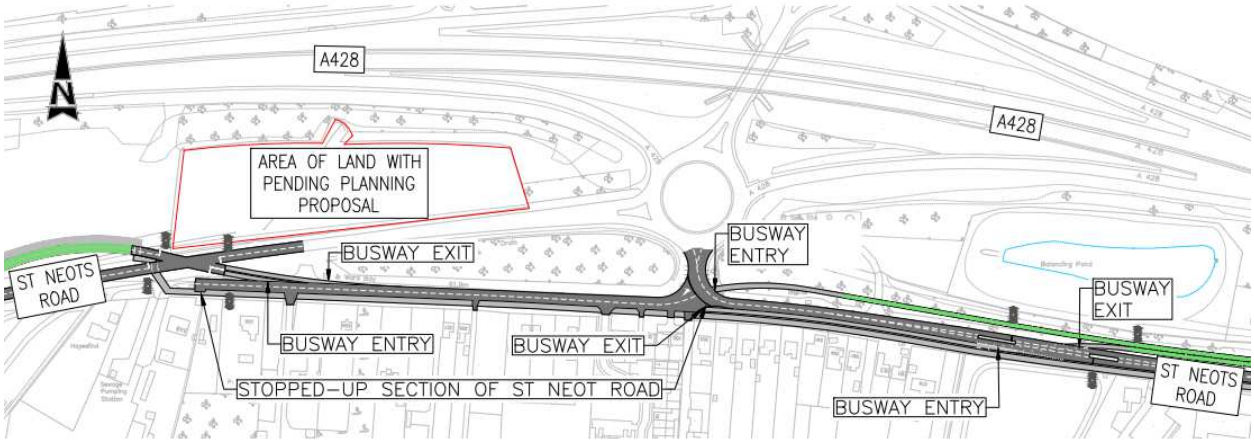


Figure 36 - Hardwick Junction Proposal 6 development

9.3.2 Transport Assessment

Proposal 6 would utilise on-carriageway provision through much of the Hardwick Junction. Traffic modelling shows the junction to be operating at a 31.5% degree of saturation during am peak which is the lowest of the three modelled proposals and below the maximum 80% saturation defined as being the upper limit. During pm peak the junction is operating at 30.3% saturation which is below the 80% maximum. The improved junction operation over the other two developed proposals for the Hardwick junction would potentially be at the detriment of busway operation. The use of on-carriageway sections and the need for buses to use a priority junction south of Hardwick Roundabout would impact negatively on the reliability and journey times of buses.

9.3.3 Safety Assessment

- Westbound buses may enter busway at speed due to proposed alignment, in front of the path of eastbound vehicles from the small number of private properties accessed beyond.

9.3.4 Construction Methodology

Proposal 6 would be constructed on the line of the existing St Neots Road carriageway to the east and west of the Hardwick Roundabout, and as a result would require traffic management and carriageway lane restrictions to construct the signalised burst-through and transition gate.

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 burst-through and transition gate positions
- 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/landscaping to St Neots Road verges.
- Excavate existing kerbing to St Neots Road and burst-through and transition gate positions.
- Construct carriageway drainage system alterations and install ducting traffic signals.
- Excavate to formation level and lay sub-base.
- Install new kerbing.
- Construct tie-ins to carriageway and place guideway sections.
- Install traffic signal equipment.
- Install traffic signs and road markings.
- Reinstate verges and soft landscaped areas.
- Remove traffic management and demobilise site.

9.3.5 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.
- Noise mitigation measures would be required due to the close proximity of residential properties in St Neots Road.
- The road realignment within the verges would require diversion or protection of utility services.

9.3.6 Property and Environmental Impacts

Proposal 6 requires minimal land-take utilising existing the carriageway and highway verges. The busway would utilise the stopped-up section of the old St Neots Road impacting on residential properties along the road.

9.3.7 Proposal 6 SWOT Assessment

9.4 Hardwick Junction Summary

Proposal 2 would utilise a 'hamburger' arrangement through the Hardwick Junction Roundabout providing bus priority and aligning the busway away from residential properties on St Neots Road. Junction modelling figures show that the arrangement does not perform well for the expected future traffic flow through the junction, however, even without any provision for a busway through the junction traffic modelling shows that the junction will still be performing close to capacity with expected increases in traffic flow. By incorporating a busway through the junction there would be scope to carry out improvements to the junction and improve its performance**.**

Proposal 3 would involve a complex junction arrangement to provide bus priority, closing the southern arm of the roundabout and realigning the A1303 carriageway west of the roundabout with a new junction, opening the existing closed section of St Neots Road to traffic. The proposal would impact on the proposed development site west of the roundabout and opening the stopped-up section of St Neots Road would result in increased traffic flows past residential porpoerties along that section. Traffic modelling shows poor expected junction performance.

Proposal 6 would provide a burst-through junction on the St Neots Road west of the Hardwick junction. The proposal would utilise the existing stopped-up section of St Neots Road for the busway. A give way arrangement would be provided for eastbound buses at the crossing of the southern arm of the Hardwick junction, resulting in potentially unreliable journey times and not meeting the requirements of bus rapid transit. Proposal 6 would be susceptible to traffic flows, and the operation of the arrangement for eastbound buses would benefit greatly from mitigation measures to discourage the use of St Neots Road to through traffic. Proposal 6 would have minimal impact on traffic flows at the junction, with traffic modelling data showing the junction would operate well within capacity.

In summary it is possible to provide bus priority junctions at Hardwick Junction compliant with bus rapid transit. Proposal 2 would provide a priority busway through the Hardwick Roundabout and with further improvement measures it would be feasible to improve the future performance of the junction. Proposal 3 would provide a smooth busway alignment and burst-through junction which would pass through an area of land identified for future development and would require the old section of St Neots Road to be reopened to through traffic, potentially impacting on residential properties along that section. Proposal 6 utilises an on-road section along the old St Neots Road with a give way arrangement eastbound to cross the southern arm of Hardwick Roundabout, increasing the risk of delays to journey times.

10 Hardwick Junction to Long Road

10.1 Existing Arrangement

St Neots Road between the Hardwick Junction and Long Road is a single carriageway 2.2km in length. The carriageway is subject to a 40mph speed limit from the Hardwick Roundabout east to the Hardwick village boundary, located approximately 400m west of the junction with Long Road. The road is then subject to national speed limit east of the Hardwick village boundary. A paved footway is provided of varying width (approx. 1.4-3m width) running parallel to the carriageway on the southern side for the length of the village; this links to the shared use footway/cycleway at the eastern extent beyond the Hardwick village boundary. Access is provided to residential properties and businesses along the south of St Neots Road within Hardwick village, some of which are provided with parking lay-bys.

Street lighting is provided at the western extent of the section on the immediate approach to the Hardwick Junction. Intermittent column mounted lighting is provided along the remaining length of the St Neots Road throughout the extents of Hardwick village comprising of short columns, the majority being aligned to the south of St Neots Road along the existing footway. The size and type of columns is such that they only serve to light the footway; the carriageway is unlit.

An on-carriageway cycleway is provided in both directions throughout Hardwick village. Where the speed limit changes to national speed limit at the eastern end of the section, the on-carriageway cycleway is terminated, requiring eastbound cyclists to dismount and cross the carriageway and join the off-carriageway shared use footway/cycleway, which continues eastwards past Long Road towards the Cambridge.

There are 9no existing bus stops located along the section of St Neots Road, 5no eastbound and 4no westbound. The majority are provided with laybys and a number of the westbound bus stops are located in parking laybys outside properties.

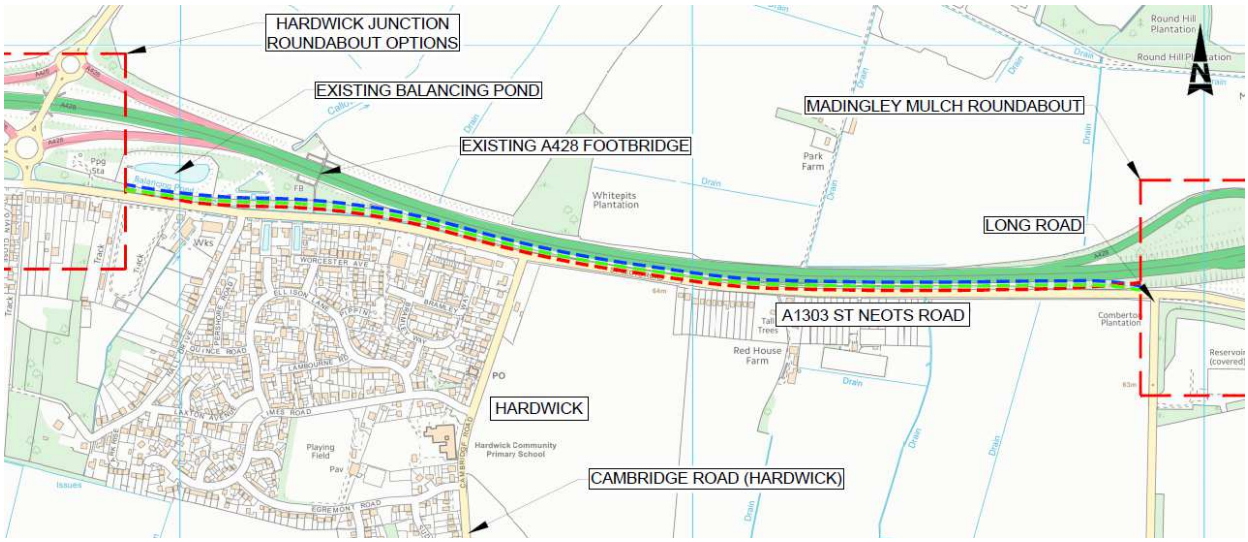


Figure 37 - Hardwick Junction to Long Road

To the north of St Neots Road is a narrow grass verge with mature hedge line and trees. Beyond is a strip of land between St Neots Road and the A428 Trunk Road. To the west this area of land contains a balancing pond provided for drainage of the A428. A public right of way passes through the area of land to cross the A428 via a pedestrian footbridge, linking Hardwick with Dry Drayton to the north.

The Option 3A busway route looks to utilise alignments through the area of land between the St Neots Road and the A428. There are a limited number of alignment proposals available through the land area due to the narrow width and the required construction of the busway and adjacent footway/cycleway/maintenance track.

Figure 37 - Hardwick Junction to Long Road – looking west

10.2 Existing constraints

10.2.1 Carriageway alignment and land constraints

A balancing pond serving the A428 carriageway is positioned to the western end of the land area with associated drainage infrastructure and gated access onto St Neots Road. This restricts alignment proposals for a busway through this area, to avoid the need to bridge the balancing pond.

The area of land between St Neots Road and the A428 narrows to 11m at the eastern end bounded to the north by a close boarded timber fencing adjacent to the A428 westbound carriageway, providing limited space to accommodate busway alignments. The land area within which busway alignments are proposed is generally 20m in width, up to 31m at the widest point.

Existing buried statutory undertakers' services are located along the St Neots Road corridor within the Highway Boundary running longitudinal to the carriageway. Within the extents for the section between Hardwick Roundabout and Long Road comprise of water mains, telecommunications services. Service provider's records and on site utility covers indicate that these are aligned within the northern verge of St Neots Road. The statutory undertakers' services would need to be relocated or protected where they conflict with proposed busway alignments subject to further detailed investigations on the exact location and depth of the apparatus at detailed design stage.

10.2.2 Non-motorised users

An existing public right of way crosses the land area linking Hardwick village to footpaths north of the A428 which lead to Dry Drayton. This public right of way crosses the A428 via a dedicated footbridge. The public right of way would need to be accommodated within the busway construction by provision of a short burst-through detail.
An existing footway is provided along the south side of St Neots Road.

10.2.3 Environmental

One area of protected trees (South Cambs Tree Preservation Orders) is within the extents of the busway land area, opposite the Cambridge Road Hardwick junction. The area of trees within the boundary have predominantly been cleared during the construction of the A428 Trunk Road. There are no other statutory environmental designations on the land area identified for the busway. To the north side of the area are young trees planted as part of landscaping provided by construction of the A428. The south side of the area alongside the northern edge of St Neots Road contains a number of mature trees and hedgerows which provide some screening of the area to properties along the south side of St Neots Road.

10.3 Hardwick Junction to Long Road Alignment Proposals

Proposal 1 – Two-way busway aligned adjacent to St Neots Road.

- The proposal would provide a busway to the northern side of St Neots Road aligned at a constant offset to the existing St Neots Road carriageway separated by narrow (1.5m) grass verge.
- The proposed footway/cycleway runs adjacent to the busway the full length, positioned to the north side.
- The existing footway to the south side of St Neots Road remains unaffected.

Figure 38 Hardwick Junction to Long Road Link - Proposal 1 Alignment

10.3.1 Link Alignment

The alignment of the Proposal 1 (Red) link follows the alignment of the A1303 St Neots Road at a 1.5m offset from the existing northern kerb line. The resulting busway alignment utilises a minimum guideway radius of approximately 1100m providing an 85kph design speed with a 2.5% superelevation located between the Hardwick Junction and Cambridge Road, Hardwick. A further 1500m alignment radius east of the Cambridge Road junction prior to the Hardwick village boundary. Interlinked alignments are straight or curved to achieve the maximum 120kph design speed. Due to the width required to construct the Proposal 1 alignment with an adjacent footway/cycleway, and the narrow area of land available, there would be limited scope to realign the busway to achieve a higher design speed without reconstructing the St Neots Road carriageway to achieve better carriageway alignment. The section width of the proposed arrangement would be 11m from the edge of the busway, with the minimum width of land available being 11m at the eastern end toward the Long Road Junction.
The position of the busway close to St Neots Road would provide good access for patrons from the village of Hardwick.

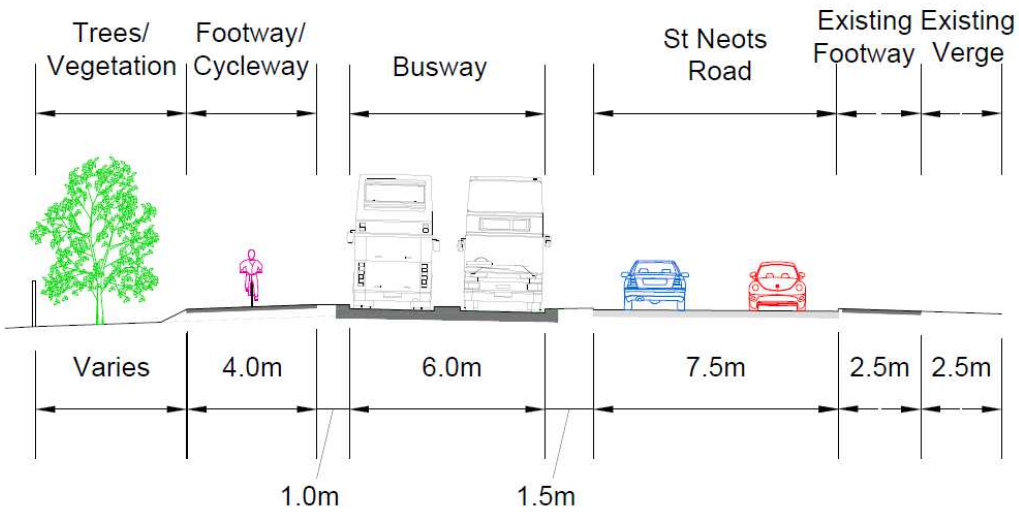


Figure 39 - Proposal 1 Typical Busway Section (facing east)

10.3.2 Safety Assessment

- Positioning of the busway adjacent to St Neots Road could result in headlights dazzling eastbound traffic due to the nearside opposing bus route. Provision of anti dazzle fencing could be required due to the proximity of the busway to the public highway and loss of existing vegetative screening.

10.3.3 Construction Risks

- Temporary traffic management comprising of lane closures or temporary narrowing of the St Neots Road carriageway would be required to carry out works adjcent to the road.
- Existing buried statutory undertakers' services along the northern side of St Neots Road corridor would be affected by the busway alignment and require lowering or diversion to enable the busway to be constructed.

10.3.4 Property and Environmental impacts

A search of environmental designations for the proposed Proposal 1 (Red) alignment land area has been carried out. One area of protected trees (South Cambs Tree Preservation Orders) would be within the extents of the busway alignment. The area of protected trees within this boundary have predominantly been cleared during the construction of the A428 Trunk Road.
The alignment would be close to the northern side of St Neots Road; this area retains a number of mature trees and hedgerows, which would need to be cleared to allow the busway to be constructed. The width of the busway and footway/cycleway arrangement would leave minimal land to provide additional mitigation planting between St Neots Road and the A428 to replace that lost by providing the busway.

Junction Proposals Compatible	
Junction proposals compatible	o All Junction Proposals

10.3.5 Proposal 1 SWOT Assessment

10.4 Proposal 2 – Two-way busway segregated from St Neots Road by a footway/cycleway

- The proposal would provide a busway to the northern side of St Neots Road aligned at a constant offset to the existing St Neots Road carriageway.
- The proposed footway/cycleway runss adjacent to the south side of the buswaybuswbusway for it's full length (adjacent to St Neots Road) with a wide 3.0m verge provided to give separation between the footway/cycleway and the carriageway.
- The existing footway to the south side of St Neots Road remains unaffected.

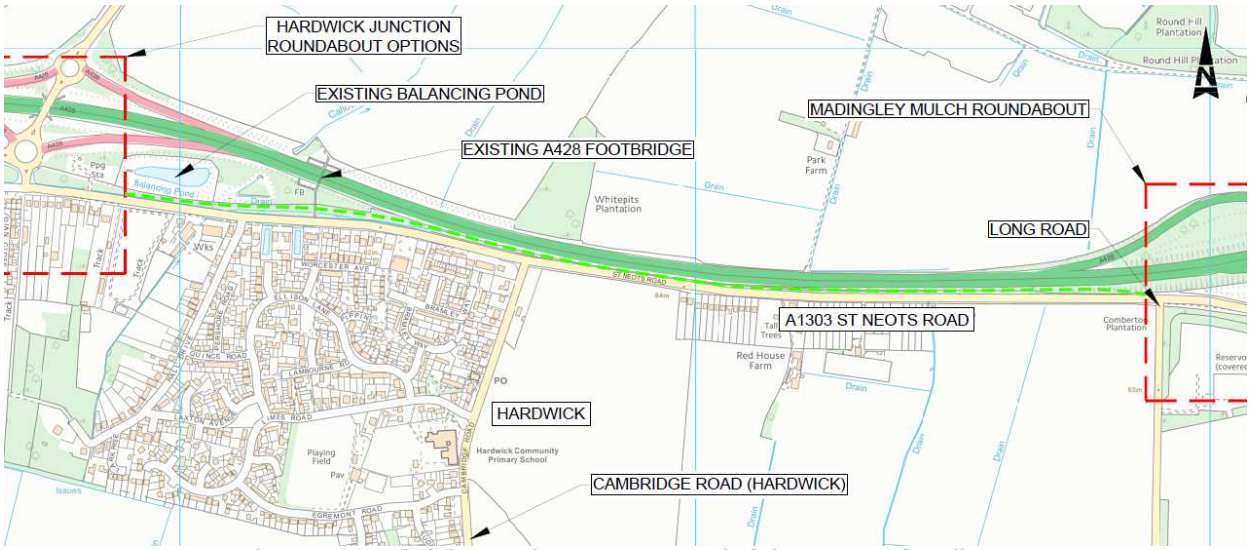


Figure 40 Hardwick Junction to Long Road Link - Proposal 2 Alignment

10.4.1 Link Alignment

The alignment of the Proposal 2 (Green) link follows the alignment of the A1303 St Neots Road at a 3.0m offset from the northern kerb line. The resulting alignment utilises a minimum radius of approximately 1100m providing an 85kph design speed with a 2.5% superelevation, located between the Hardwick Junction and Cambridge Road, Hardwick. A further 1500m radius alignment would be located east of the Cambridge Road junction prior to the Hardwick village boundary. Interlinked alignments are straight or curved to achieve the maximum 120kph design speed. The width of land required to accommodate the busway and footway cycleway arrangement shown in Figure 39 below would be in excess of the 11m minimum available within the proposed land area, and therefore there would be limited scope for further realignment to achieve an improved alignment beyond that required to construct the arrangement. The proposal would therefore require some amendment and realignment of St Neots Road at the eastern end of the link towards the Long Road junction, where the available land area narrows to the 11m minimum width, to provide sufficient land to construct the proposed arrangement.

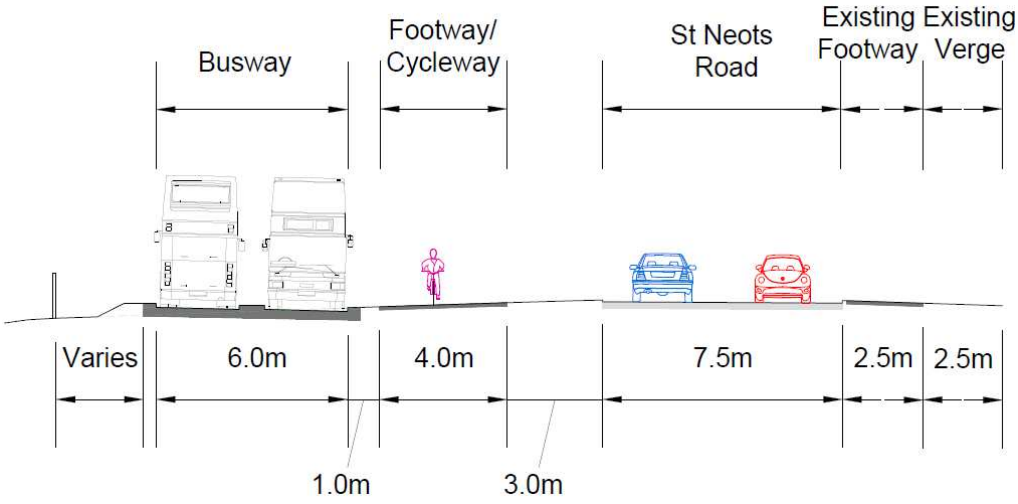


Figure 41 - Proposal 2 Typical Busway Section (facing east)

10.4.2 Safety Assessment

- Positioning of the busway adjacent to the boundary of the A428 Trunk Road could result in headlights dazzling westbound traffic due to the nearside opposing bus route. Provision of anti-dazzle fencing or upgrading existing fencing could be required due to the proximity of the busway to the public highway and loss of existing vegetative screening.

10.4.3 Construction Risks

- Temporary traffic management comprising of lane closures or temporary narrowing of the St Neots Road carriageway would be required to carry out works on and adjacent to the road.
- Realignment and narrowing of St Neots Road would be required at the western end of the link due to the land area north of the road being insufficient to construct the Proposal 2 busway and footway/cycleway arrangement.
- Existing buried statutory undertakers' services along the northern side of St Neots Road corridor would be affected by the busway alignment and require lowering or diversion to enable the busway to be constructed and for the road realignment at the eastern end of the link.

10.4.4 Property and Environmental impacts

There is one area of protected trees (South Cambs Tree Preservation Orders) within the extents of the busway alignment. The area of trees within the boundary have predominantly been cleared during the construction of the A428 Trunk Road. The alignment would be close to the northern side of St Neots Road, this area retains a number of mature trees and hedgerows. The 3m verge area proposed between St Neots Road and the footway/cycleway may enable some of the mature vegetated area to be retained, or additional planting to be provided. The width of the busway and footway/cycleway arrangement would leave minimal land to provide additional mitigation planting between St Neots Road and the A428 to replace that lost by providing the busway.

Junction Proposals Compatible	
Junction proposals compatible	o Hardwick Junction Proposals 2, 3 & 6

10.4.5 Proposal 2 SWOT Assessment

10.5 Proposal 3 – Two-way busway aligned adjacent to St Neots Road, upgraded footway/cycleway to the southern side of St Neots Road

- The proposal would provide a busway to the north side of St Neots Road aligned at a constant offset to the existing St Neots Road carriageway separated by narrow (1.5m) grass verge.
- The proposed footway/cycleway would be positioned to the southern side of St Neots Road away from the busway, upgrading the existing St Neots Road footway.

Figure 42 Hardwick Junction to Long Road Link - Proposal 3 Alignment

10.5.1 Link Alignment

The alignment of the Proposal 3 (Blue) link would follow the alignment of the A1303 St Neots Road at a 1.5m offset from the northern kerb line. The resulting alignment would provide a minimum radius of approximately 1100m providing an 85kph design speed with a 2.5% superelevation, located between the Hardwick Junction and Cambridge Road, Hardwick. A further 1500m radius alignment is located east of the Cambridge Road junction prior to the Hardwick village boundary. Interlinked alignments are straight or curved to achieve the maximum 120kph design speed. The positioning of the footway/cycleway away from the busway as indicated in Figure 43 reduces the construction width required in the area of land giving potential for the busway alignment to be smoothed - see Proposal 3b. Provision of a maintenance track would be lost due to the positioning of the footway/cycleway to the south side of St Neots Road. The Proposal 3 alignment would therefore maintain a constant offset to St Neots Road to provide maintenance access to the guideway.
The position of the busway close to St Neots Road would provide good access for patrons from the village of Hardwick.

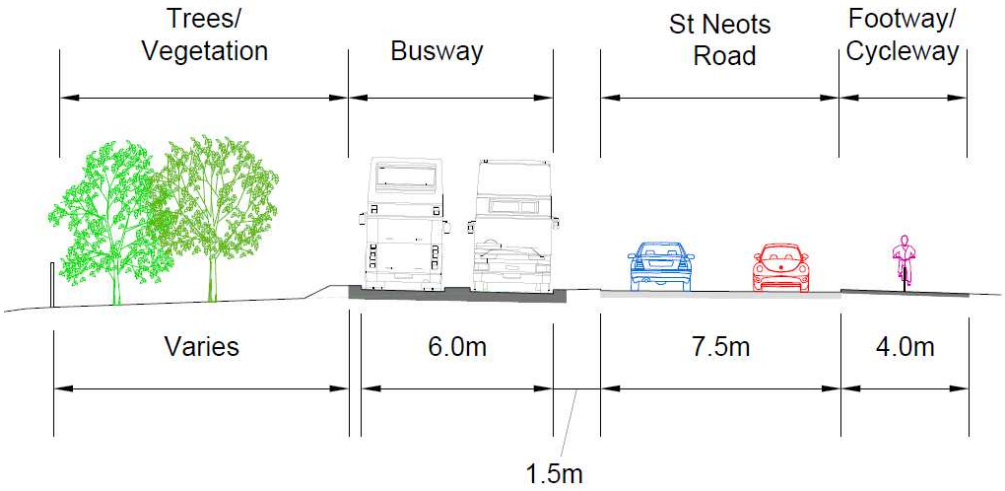


Figure 43 - Proposal 3 Typical Busway Section (facing east)

10.5.2 Safety Assessment

- Positioning of the busway adjacent to St Neots Road could result in headlights dazzling eastbound traffic due to nearside opposing bus route. Provision of anti dazzle fencing may be required due to the proximity of the busway to the public highway and loss of existing vegetative screening.
- Upgrading the existing footway on the southern side of St Neots Road to a footway/cycleway would result in pedestrians and cyclists having to cross multiple property accesses and road junctions, increasing the risk of conflict between cyclists and pedestrians and vehicles crossing the footway/cycleway.

10.5.3 Construction Risks

- Temporary traffic management comprising of lane closures or temporary narrowing of the St Neots Road carriageway would be required to carry out works on and adjacent to the road.
- Existing buried statutory undertakers' services along the northern side of St Neots Road corridor would be affected by the busway alignment and require lowering or diversion to enable the busway to be constructed.
- Construction of the footway on the southern side of St Neots Road would require careful management of property accesses.

10.5.4 Property and Environmental impacts

There is one area of protected trees (South Cambs Tree Preservation Orders) would be within the extents of the busway alignment. The area of trees within the boundary have predominantly been cleared during the construction of the A428 Trunk Road. The alignment would be close to the northern side of St Neots Road and would require removal of mature trees and hedgerows located adjacent to St Neots Road. The narrower section width of Proposal 3 compared with other proposals allows for a greater area of planting, to provide screening of the A428 to properties south of St Neots Road.

Upgrading of the existing footway on the south side of St Neots Road to provide a footway/cycleway would impact on soft verge areas outside existing residential properties along St Neots Road. Potential mitigation measures to provide additional planting area along the St Neots Road corridor through Hardwick village could therefore be provided as discussed in Section 10.7 of this Report.

Junction Proposals Compatible	
Junction proposals compatible	o Hardwick Junction Proposals 2, 3 & 6

10.5.5 Proposal 3a SWOT Assessment

10.6 Proposal 3b – Two-way busway aligned away from to St Neots Road, upgraded footway/cycleway to the southern side of St Neots Road

- The proposal would provide a busway to the north side of St Neots Road aligned at a variable offset to the existing St Neots Road carriageway to provide greatest design speed and retention of existing vegetation and screening between the busway and St Neots Road. See Figures 45 and 46.
- The proposed footway/cycleway would be positioned to the southern side of St Neots Road away from the busway, upgrading the existing footway provision.
- Additional areas of planting are proposed south of St Neots Road to provide screening to properties fronting the road. Further information on mitigation works to St Neots Road, Hardwick is covered in Section 10.7 of this Report.

Figure 44 Hardwick Junction to Long Road Link - Proposal 3b Alignment

10.6.1 Link Alignment

Proposal 3b is designed for a smooth alignment to provide 120kph design speed along the length of the link, giving a variable offset from St Neots Road. Along the existing St Neots Road the majority of mature trees and hedges are positioned close to the St Neots Road northern verge. The positioning of the footway/cycleway to the southbound side of the road, as shown in Figures 45 and 46 would reduce the required construction width of the busway arrangement in the northern verge. The design of the Proposal 3b busway has been aligned away from St Neots Road to retain as many existing mature trees and hedges and screen the busway from properties in St Neots Road. Further mitigation measures may be provided including additional planting to the St Neots Road Corridor, refer to Section 10.7 of this Report. Due to the distance the busway is from the carriageway short lengths of additional maintenance track would be required in areas where it deviates from the St Neots Road alignment.

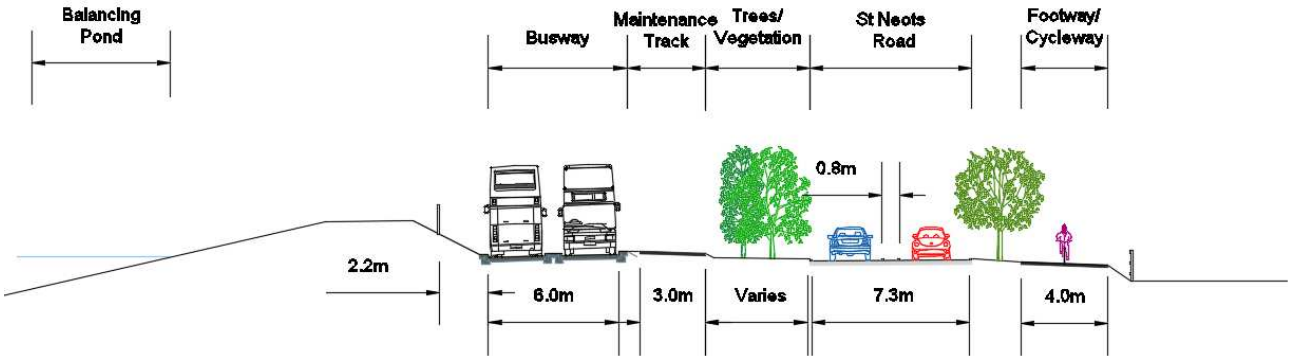


Figure 45 - Proposal 3B Typical Busway Section adjacent to balancing pond (facing east)

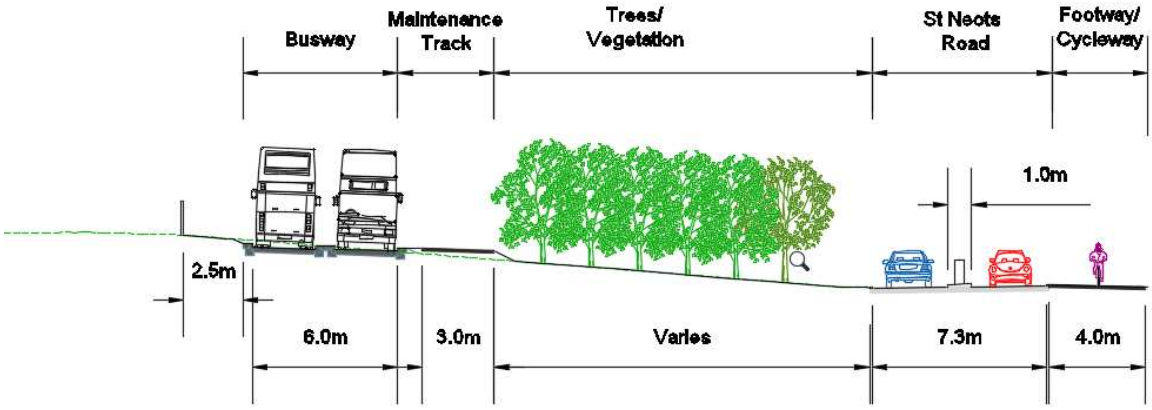


Figure 46 - Proposal 3B Typical Busway Section north of Hardwick Village (facing east)

10.6.2 Safety Assessment

- Positioning of the busway adjacent to the boundary of the A428 Trunk Road could result in headlights dazzling westbound traffic due to the nearside opposing bus route. Provision of anti-dazzle fencing or upgrading existing fencing could be required due to the proximity of the busway to the public highway and loss of existing vegetative screening.
- Upgrading the existing footway on the southern side of St Neots Road to a footway/cycleway, would result in pedestrians and cyclists having to cross multiple property accesses and road junctions, increasing the risk of conflict between cyclists and pedestrians and vehicles crossing the footway/cycleway.

10.6.3 Construction Risks

- Temporary traffic management comprising of lane closures or temporary narrowing of the St Neots Road carriageway would be required to carry out works on and adjacent to the road.
- Construction of the footway on the southern side of St Neots Road would require careful management of property accesses.

10.6.4 Property and Environmental impacts

One area of protected trees (South Cambs Tree Preservation Orders) is within the extents of the busway alignment. The area of trees within the boundary have predominantly been cleared during the construction of the A428 Trunk Road. The alignment would be away to the northern side of St Neots Road to reduce the impact on mature trees and hedgerows located adjacent to St Neots

Road. The narrow section width allows for a greater area of planting, to provide screening of the A428 to properties south of St Neots Road.

As with Proposal 3a, upgrading of the existing footway on the south side of St Neots Road to provide a footway/cycleway would impact on soft verge areas outside existing residential properties along St Neots Road. Potential mitigation measures to provide additional planting area along the St Neots Road corridor through Hardwick village could therefore be provided as discussed in Section 10.7 of this Report.

Junction Proposals Compatible	
Junction proposals compatible	o Hardwick Junction Proposals 2, 3 & 6

10.6.5 Proposal 3b SWOT Assessment

10.7 St Neots Road, Hardwick - Mitigation Measures

10.7.1 Existing Arrangement

The A1303 St Neots Road between Hardwick and the Long Road junction is a two-way single carriageway which, prior to the construction of the adjacent A428 dual carriageway, formed a main link into Cambridge from the west. The road passes through the northern extent of the village of Hardwick and is subject to a 40mph speed limit through the extents of the village. East of the Hardwick village the road is subject to a national speed limit through to Madingley Mulch Roundabout. The road has good alignment with a wide corridor which could encourage higher vehicle speeds.

As part of the Cambourne to Cambridge Better Bus Journeys project, mitigation measures could be introduced to provide enhancements to St Neots Road through Hardwick village and encourage compliance with the published speed limits. Enhancements could also include increased planting to mitigate any screening loss resulting from removal of vegetation as part of the construction of the busway along the St Neots Road corridor.

10.7.2 St Neots Road Enhancements

Measures could be introduced along the St Neots Road corridor to enhance the village environment and in doing so encourage speed limit compliance. These measures could be taken to reduce or avoid effects resulting from the provision of the busway. Environmental enhancements could be delivered as part of the project through the creation of new landscaped areas and in doing so provide ecological habitats. The overall approach to the design measures would be defined by local and national policy and guidance.

Potential enhancement measures could comprise of;

- Improved gateway features on the approach to Hardwick. Highlighting speed limit and entry into a village environment to encourage reduced speed.
- Landscaping to reduce the openness of the route and visually reduce the width of the corridor.
- Provision of traffic islands within the centre of the carriageway to encourage reduced speed, with speed limit repeater markings.
- Provision of central hatch and edge line road markings along the carriageway to visually reduce the carriageway width.

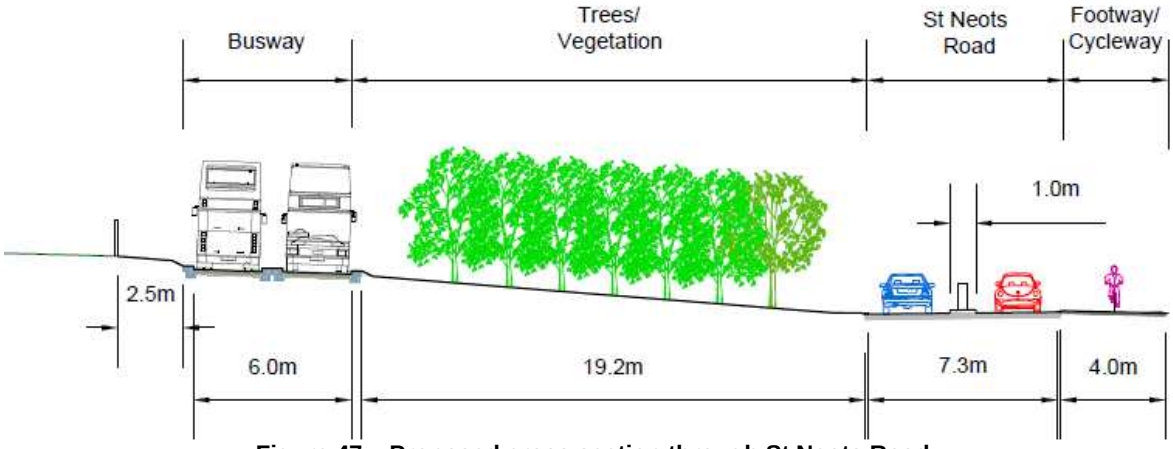


Figure 47 – Proposed cross section through St Neots Road

Figure 48 – Proposed Extract of St Neots Road Enhancements

The impact of a segregated busway to the north of the St Neots Road within the land area between St Neots Road and the A428 could introduce design measures that ensure new infrastructure integrates into the existing landscape and protects the character of open space and green belt. The Design Criteria could consider the following issues:

- Location of infrastructure through assessing proximity to and the relationship with the existing built up areas.

- Siting – positioning of infrastructure to minimise visual intrusion on the existing landscape through considering issues such as ground levels, slopes and other natural features and also minimising impact on important features such as ecological and heritage assets.

- Design – materials used for landscaping would form new, high quality infrastructure, minimising environmental impact and integrating with existing infrastructure.

Dependant on the busway alignment proposal the availability of land to provide landscaping and the position of these areas in relation to St Neots Road would vary. Proposal 3 and 3b provide the greatest potential to provide additional landscaping between St Neots Road and the A428, by providing a footway cycleway south of St Neots Road, but in doing so reduce the potential to plant in the southern verge area. Proposal 3b being positioned away from the edge of St Neots Road gives greatest potential to provide planting to reduce the visual width of the corridor.

10.8 Hardwick Junction to Long Road Summary

Proposals 1 (Red) and Proposal 2 (Green) would provide varying busways and footway/cycleway arrangements aligned to the northern side of St Neots Road. St Neots Road has curves in the road alignment and the parallel busway arrangements would provide lower design speeds as a result of following this alignment. Proposals 1 and 2 would provide a footway/cycleway alongside the busway resulting in a wide construction width. This would largely remove the area of mature vegetation along the northern side of St Neots Road, resulting in loss of the majority of vegetative screening along the link. The benefit of these arrangements is that they would position the busway close to St Neots Road to provide easy access for patrons. The position of the footway/cycleway north of St Neots Road provides an uninterrupted link segregated from traffic.

Proposal 3 (Blue) would provide a busway aligned to the north side of St Neots Road, this alignment would replicate the alignment of St Neots Road impacting on busway design speed. Proposal 3 would provide a footway/cycleway on the southern side of St Neots Road, upgrading the existing footway. The reduced width of construction north of St Neots Road would reduce the amount of land area required. However, the proposal is aligned close to St Neots Road and whilst this would make the busway more easily accessible to patrons, it would position the busway where the majority of mature vegetation is located, resulting in loss of screening. The footway/cycleway positioned to the south of St Neots Road gives greater scope to provide planting in the retained area north of the road. Positioning the footway/cycleway to the south of St Neots Road provides easier access from Hardwick village, but would result in it crossing numerous property accesses and junctions along the length.

Proposal 3b (Blue) would provide a busway with a designed alignment positioned away from St Neots Road where possible. The proposal benefits from a designed alignment to achieve the maximum 120kph design speed. Being aligned away from St Neots Road the proposal allows for retaining much of the existing mature hedge line and trees along the St Neots Road, retaining vegetative screening of the busway for residential properties opposite. In positioning the busway away from St Neots Road would mean accessibility and the visual incentive to use the busway would be reduced for patrons from Hardwick village compared with other proposals. The footway/cycleway being positioned to the south of St Neots Road for Proposal 3b allows for a greater vegetated area to be retained, but would require it to cross numerous property accesses and junctions.

In summary, it is feasible to provide a segregated busway and footway/cycleway along the St Neots Road between the Hardwick Junction and Long Road Junction. Proposals 1, 2 and 3 would all provide good access for patrons from Hardwick village. Proposal 3b would provide a busway capable of maximum design speed and has greater scope to enhance the St Neots Road corridor through retention of existing vegetation and introduction of newly planted areas.

11 Conclusions and Next Steps

The Future Investment Programme section of the Cambourne to Cambridge Better Bus Journeys project, between Bourn Roundabout and the Long Road Junction, has the ability to provide a segregated two-way busway and footway/cycleway along the length of the Option 3A busway corridor, with bus priority junction arrangements provided at Bourn Roundabout and Hardwick Junction. Busway alignments and junction arrangements have been developed to provide bus rapid transit whilst aiming to minimise the impact on properties, the environment and traffic flows along the length of the routes.

Consultation with local stakeholders is encouraged to determine the impact the proposals would have and capture any specific requirements. Furthermore, it should be noted that this engineering assessment forms only a part of the wider business case development process which is currently underway and should therefore be looked at in conjunction with other work streams when developing the proposals further.

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