A1303 Corridor VISSIM Model Forecasting and Option Assessment Report

Greater Cambridge Partnership

August 2017

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1. Introduction

1.1. Background

Atkins was commissioned by Skanska on behalf of Cambridgeshire County Council (CCC) to undertake a micro-simulation assessment of proposed bus priority options for the A1303 Madingley Road radial corridor in Cambridge. This work is in relation to the Cambourne to Cambridge Better Bus Journeys Project.

A range of options has been proposed to provide bus priority on the A428 corridor between Cambourne and Cambridge City Centre. This radial route is one of the most congested routes into the city and with plans for significant development at the Cambridge West and Cambourne sites a strategy is being developed to mitigate against the resulting increase in trips on the corridor.

Each of the proposed bus priority options has previously been tested in the newly refreshed Cambridge Sub-Regional Model 2 (CSRM2) to understand the wider strategic impact on mode shift and trip distribution. AN assessment is now required of the detailed operation of each option, with micro-simulation modelling identified as the most appropriate tool.

An existing VISSIM micro-simulation base model of the A1303 corridor validated to 2014 observations has been used as the basis for this assessment, with forecast year demand growth taken from the CSRM2.

1.2. Document Structure

Following this introduction, this report comprises the following sections:

- Chapter 2 introduces the existing available suite of transport models;
- Chapter 3 presents the scenarios that have been modelled;
- Chapter 4 describes the forecasting methodology;
- Chapter 5 presents model outputs and analysis of the relative performance of each proposed option; and
- Chapter 6 summarises the work undertaken and presents conclusions.

2. Transport Model Suite

This section introduces the available suite of existing transport models that have been used for the A1303 corridor option assessment.

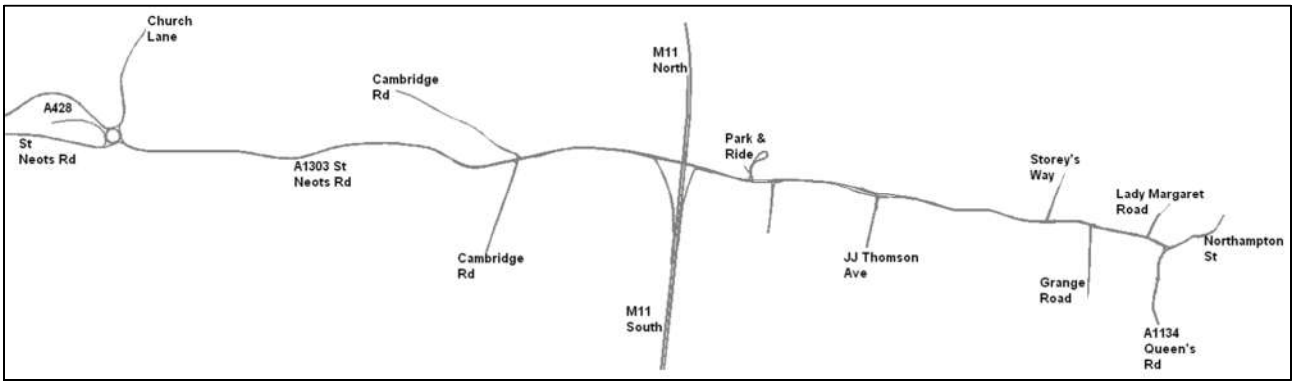
2.1. A1303 Madingley Road VISSIM Model

A micro-simulation model of the A1303 Madingley Road corridor was developed in VISSIM version 5.4 and validated to a base year of 2014. Micro-simulation models allow modelling of the detailed interaction of individual vehicles on the highway network. Figure 2-1 below presents the extent of the VISSIM model, which covers the length of the A1303 Madingley Road from the A428 roundabout in the west to the Northampton Street / Queens Road junction in the east. The model includes all significant side arms and junctions. The VISSIM model was constructed to represent the morning peak period from 07:00 to 10:00 and an evening peak period from 16:00 to 19:00.

Micro-simulation is the most suitable tool for understanding the detailed operation of schemes such as the proposed bus priority measures on the A1303 corridor, making this model a good basis for assessing the proposed schemes.

It should be noted that during the period in which the traffic count data that informed the 2014 Base model was collected there were roadworks in place on Madingley Road, reducing the capacity of the of a section of Madingley Road. The capacity restraint was replicated in the Base model. Whilst the Base model achieved a reasonable fit against observed traffic flows and journey times, the model tended to run fast in terms of journey times in the eastbound direction on Madingley Road between the Madingley Mulch roundabout and M11.

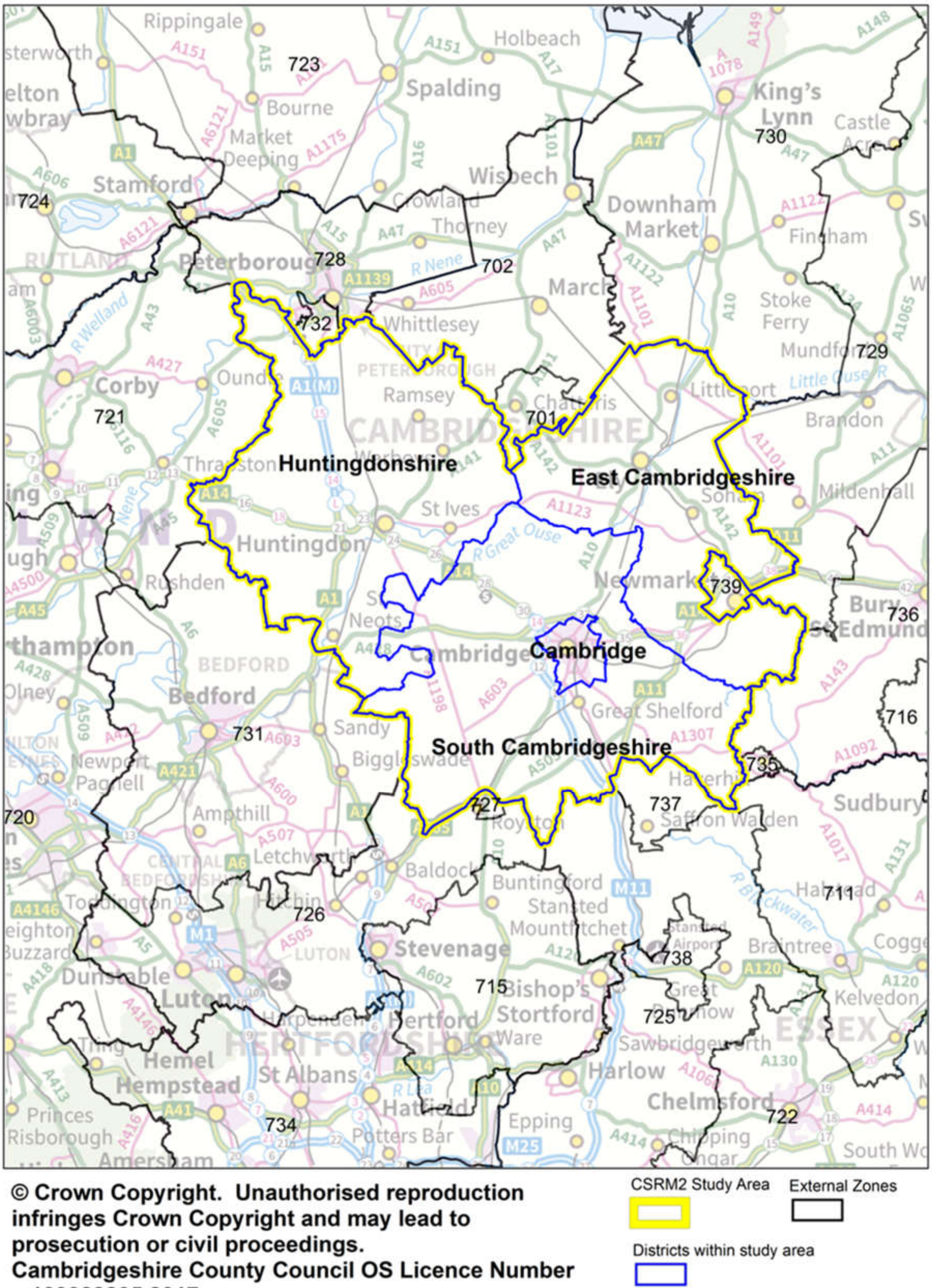
Figure 2-1 A1303 Madingley Road VISSIM Model Extents



2.2. Cambridge Sub-Regional Model 2

The recently refreshed CSRM2 is a strategic multi-modal transport model which was developed in line with WebTAG guidance. The model uses a standard and well understood transport modelling approach, allowing the forecasting of future travel demand, including highway traffic levels to be treated consistently within the same modelling framework with outputs consistent with the needs of economic appraisal. The model was developed for a Base year of 2015 and covers the Cambridgeshire districts of Cambridge, South Cambridgeshire, East Cambridgeshire and Huntingdonshire. Trips to/from the external area are also considered as part of the demand modelling process. Figure 2-2 below presents the CSRM2 study area.

Figure 2-2 CSRM2 study area, showing internal Districts and External zones



CSRM2 has a Highway Assignment Model (HAM) component which uses the SATURN software. The HAM was validated to a base year of 2015 against turning counts and journey times. Forecast year scenarios have been used to extract highway traffic growth scenarios for the VISSIM future year modelling.

Figure 2-3 below shows the detailed model area and Figure 2-4 presents the SATURN highway assignment network. The study area of the A1303 corridor is fully included in the detailed simulation area of the model as shown in Figure 2-1. The detailed simulation area is defined as the area over which significant impacts of interventions are certain and the modelling detail in this area would be characterised by: representation of all trip movements; small zones; very detailed networks; and junction modelling (including flow metering and blocking back).

Figure 2-3 Highway Assignment Model Area

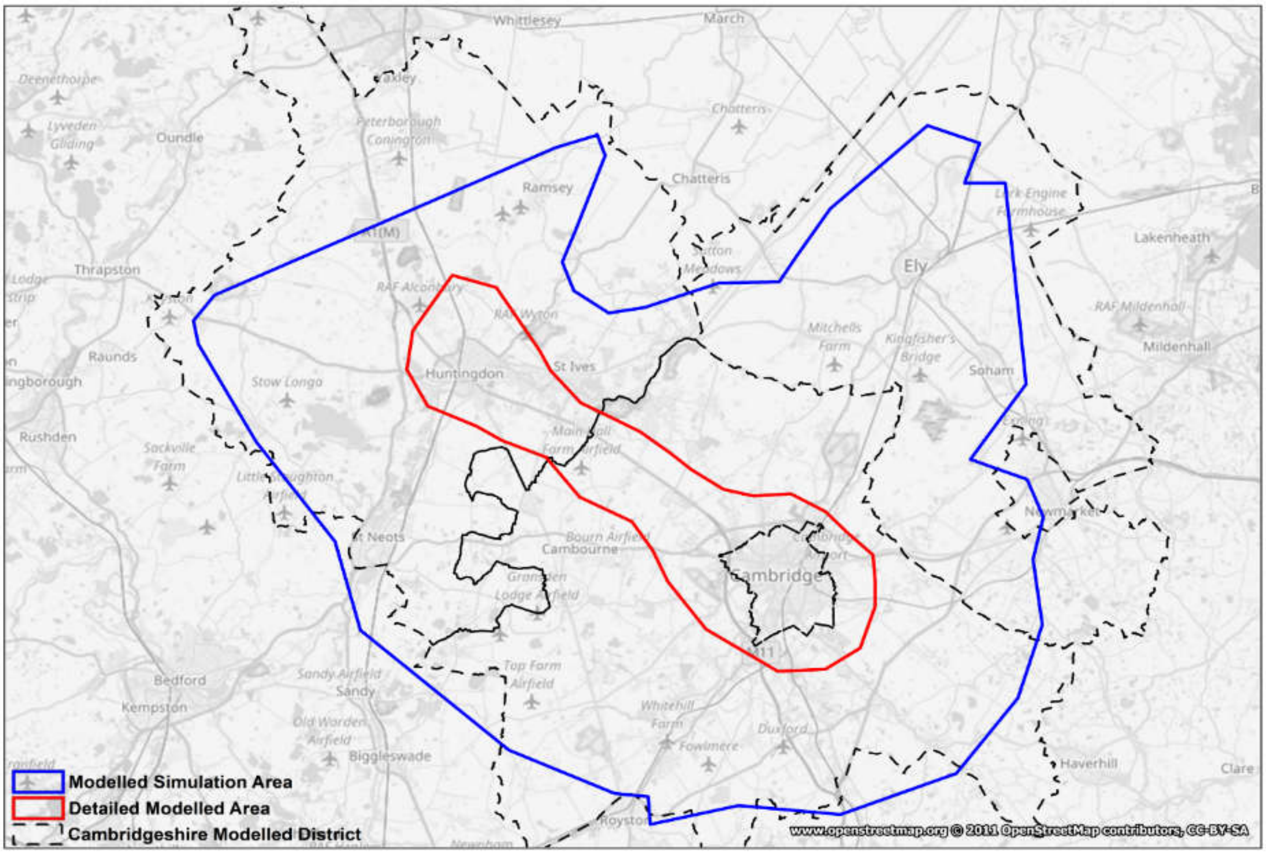


Figure 2-4 SATURN Model Network

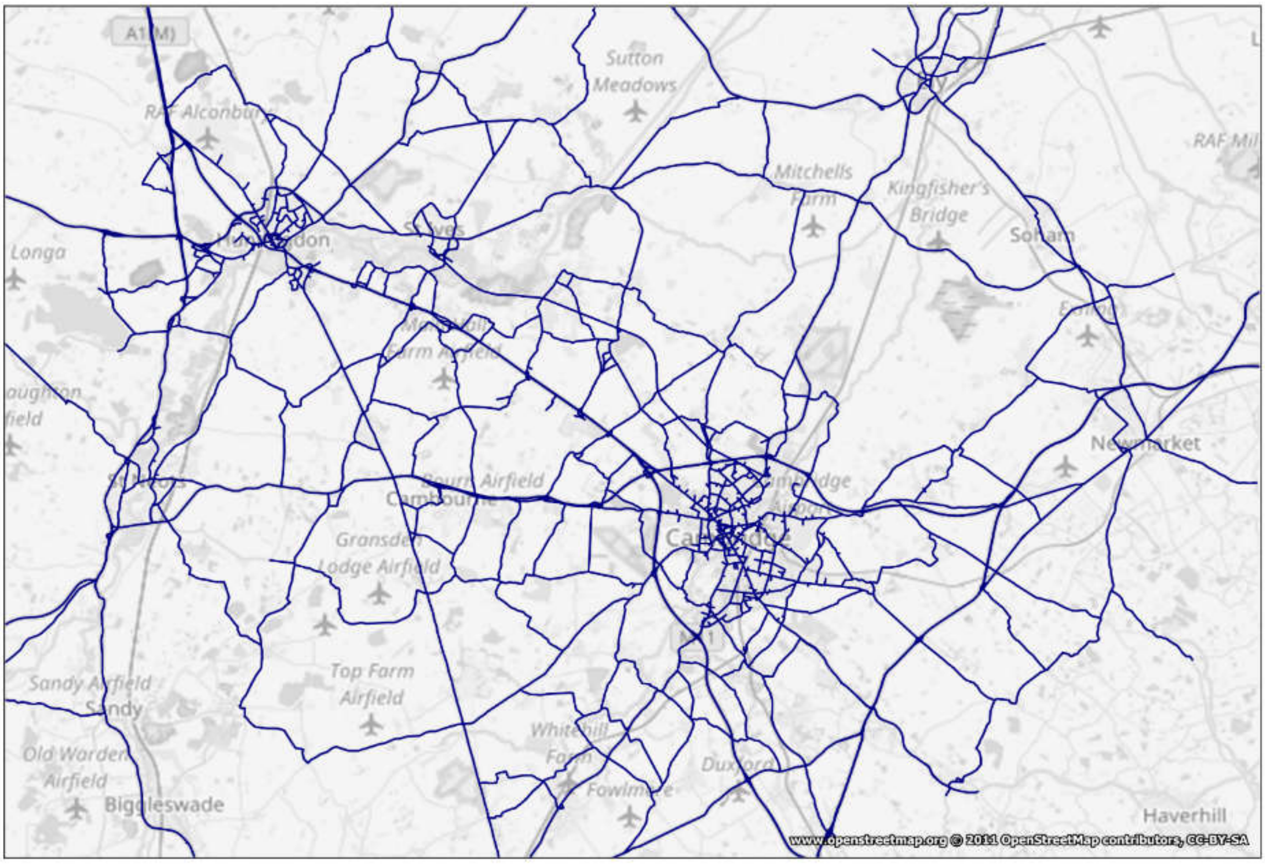
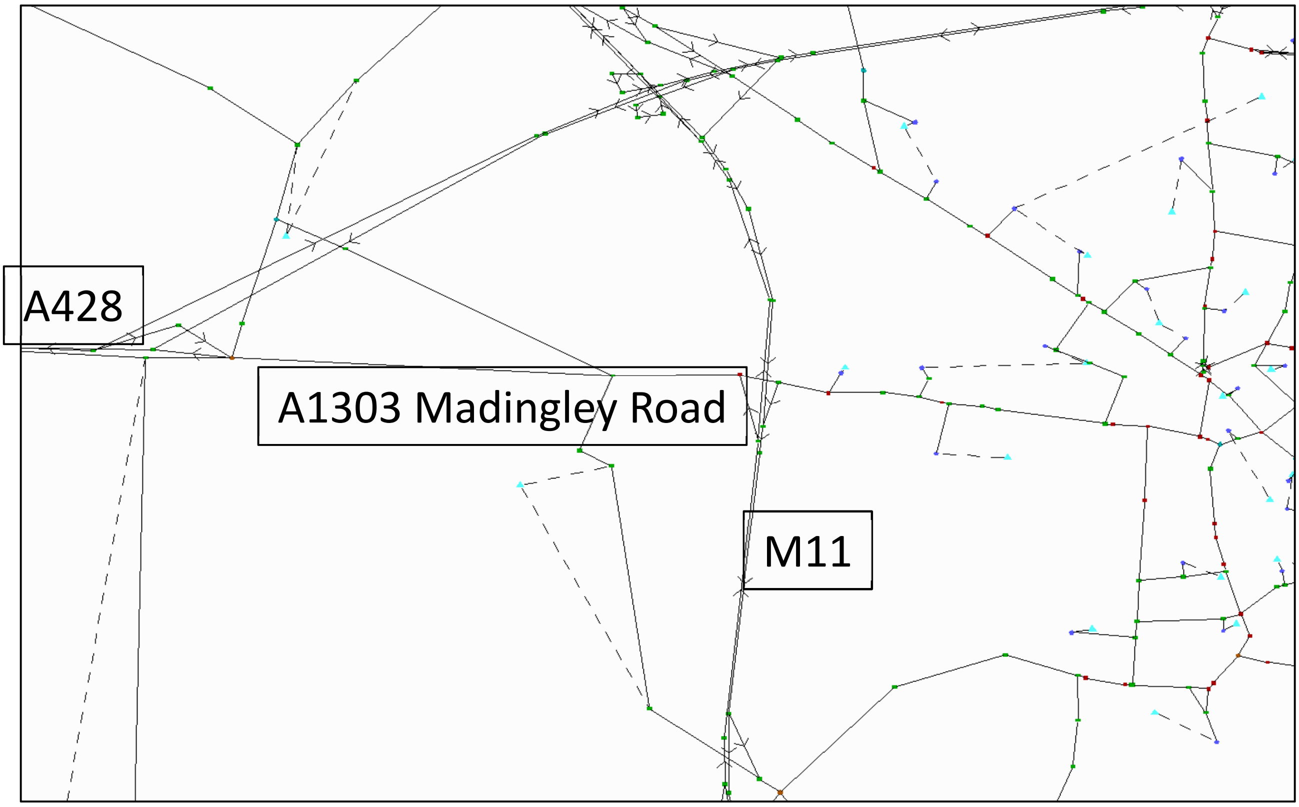


Figure 2-5 A1303 Corridor SATURN Network Detail



2031 Foundation Case

A single 2031 forecast year scenario or Foundation Case was developed in CSRM2. The Foundation Case is intended to be a reasonable set of assumptions to test the effects of other schemes, in this case the effect of the proposed bus priority options on the A1303 corridor.

The growth in housing, employment and schools in this scenario is consistent with the Local Plans as provided by the individual District Councils. All growth assumptions are fully documented in the 2031 Foundation Case Inventory which is part of the CSRM documentation shared with CCC. The 2011 to 2031 growth in dwellings and employment at key sites related to the A1303 corridor are presented below in Table 2-1.

Table 2-1 A428 Corridor Development Sites

Site	Dwellings	Employment (jobs)
Bourn Airfield	1,360	1,700
Cambourne	499	2,300
Cambourne West	1,200	0
Cambridge West	0	4,005
Cambridge North West	1,155	1,095

These estimates are based on assumptions of the number of dwellings and jobs that would be in place by a 2031 scenario.

The Inventory also provides a reference of the transport schemes that have been assumed to be in place by 2031. Of relevance to the A1303 corridor are the A14 improvement and A428 Black Cat to Caxton Gibbet dualling schemes. Highway infrastructure associated with the Cambridge North West and Cambridge West development sites are also included.

The 2031 Foundation Case scenario has been used as the forecast year basis for the A1303 corridor VISSIM model scenarios.

3. Forecast Year Model Scenarios

This section details the forecast year proposed scenarios for the A1303 Madingley Road corridor developed in VISSIM. Table 3-1 summarises the five forecast year scenarios which have been modelled in VISSIM and the following sections provide detailed documentation of the specification for each scenario, detailing how each differs from the parent model. A range of bus priority options have been considered and filtered, with Options 1, 3a and 6 selected and taken forward for this detailed micro-simulation assessment. Indicative route alignments for the options are shown below in Figure 3-1.

Table 3-1 Modelled Scenarios

Scenario	Year	Description
Foundation Case (FC)	2031	Cambridge and South Cambridgeshire Local Plan levels of growth in housing and employment. Includes committed transport schemes including the A14 and A428 Caxton to Black Cat.
A1303 Do Minimum (DM)	2031	As per the FC with the inclusion of a proxy for the proposed City Deal Cambridge Access Study scheme.
Option 1	2031	As per the DM with the inclusion of an inbound (eastbound) bus lane on the A1303 St Neots Road.
Option 3a	2031	As per the DM with the inclusion of a dedicated off-line, bi-directional bus road running parallel to the A428 to the Cambridge West development site.
Option 6	2031	As per the DM with the inclusion of a tidal bus lane on the A1303 Madingley Road, running eastbound in the AM and westbound in the PM. The Park & Ride site in this scenario is moved from its current Madingley Road location to Scotland Farm, north of Cambourne.

Figure 3-1 Indicative Option 1 Route Alignment

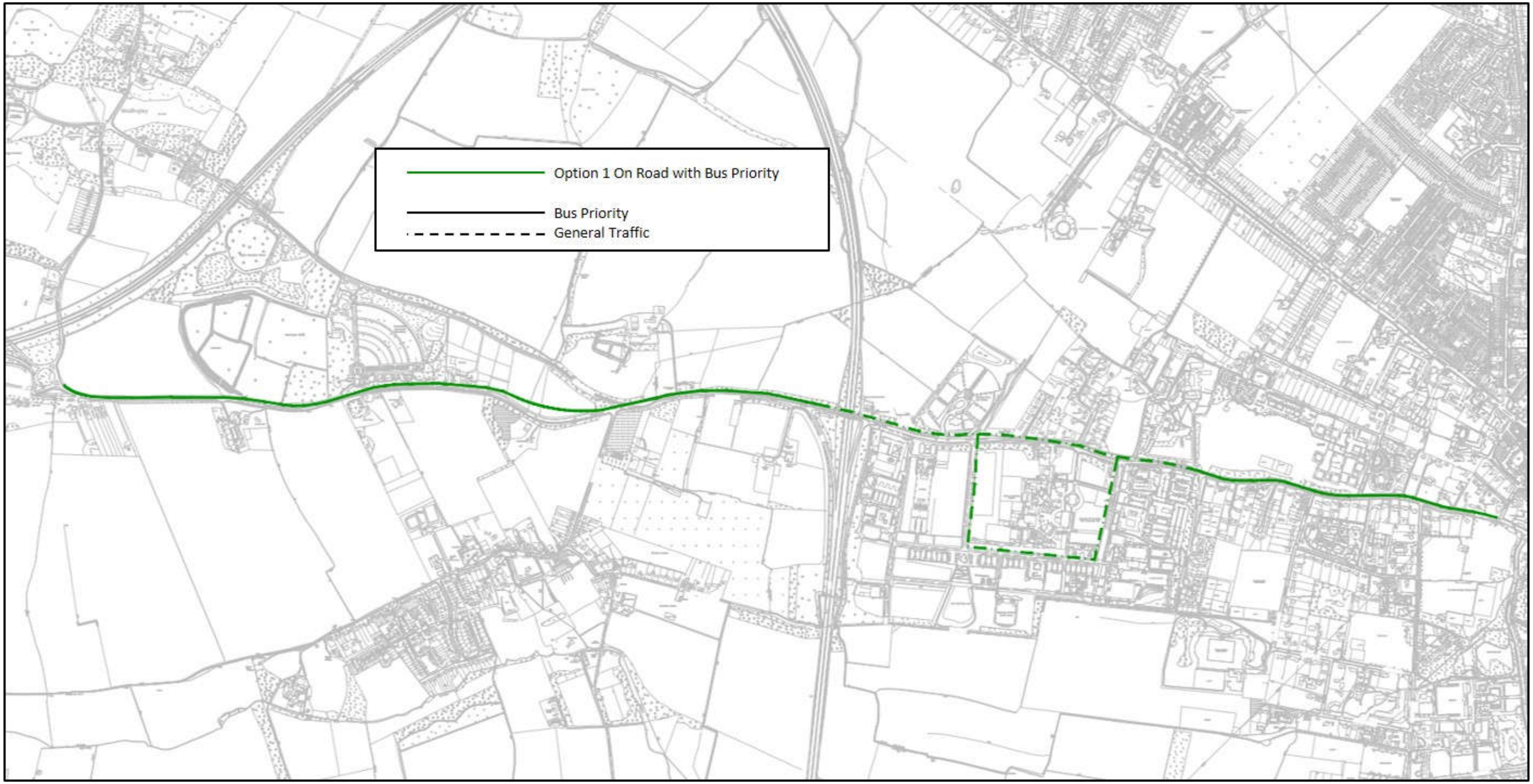


Figure 3-2 Indicative Option 3a Specific Route Alignments

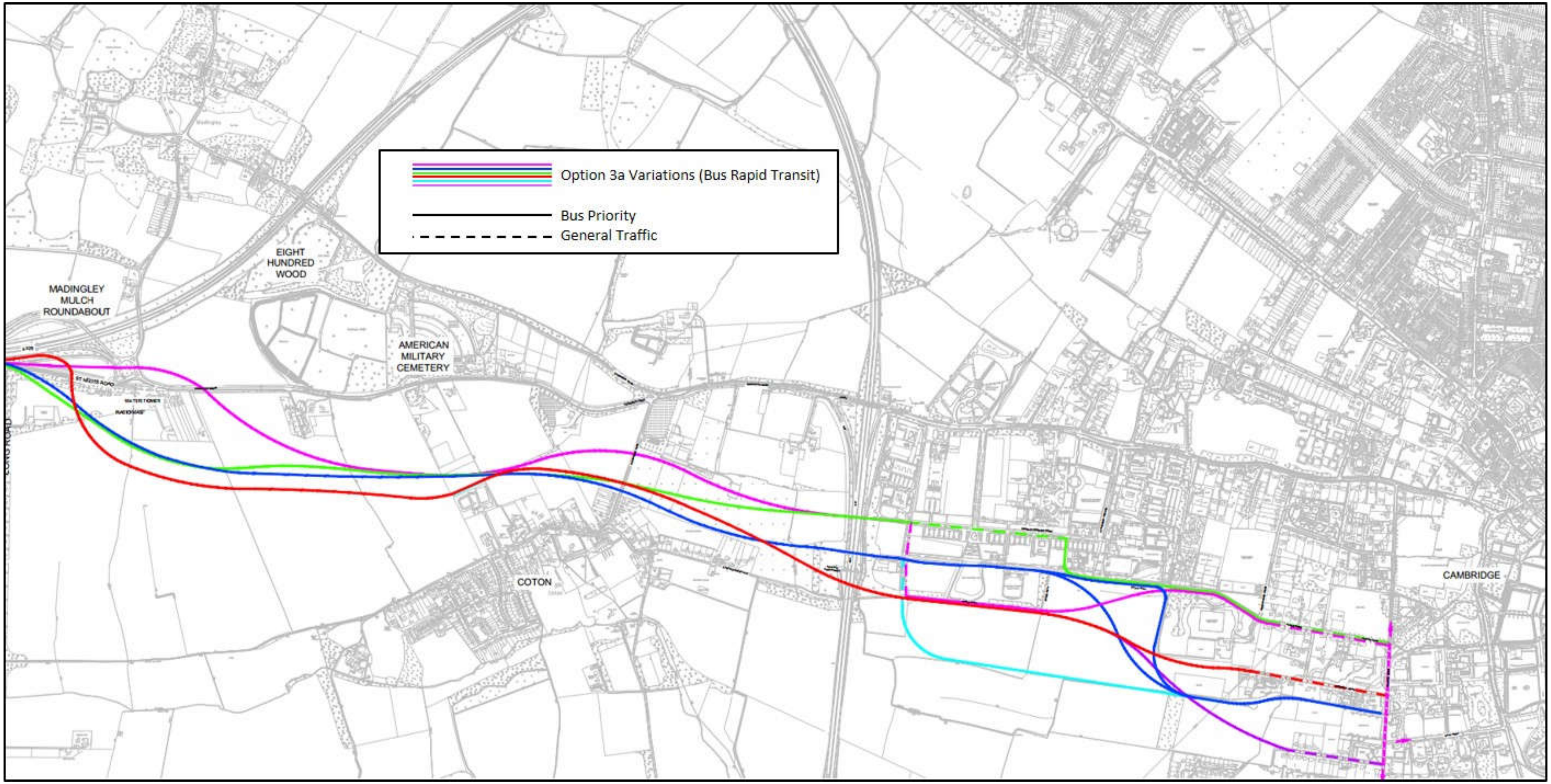
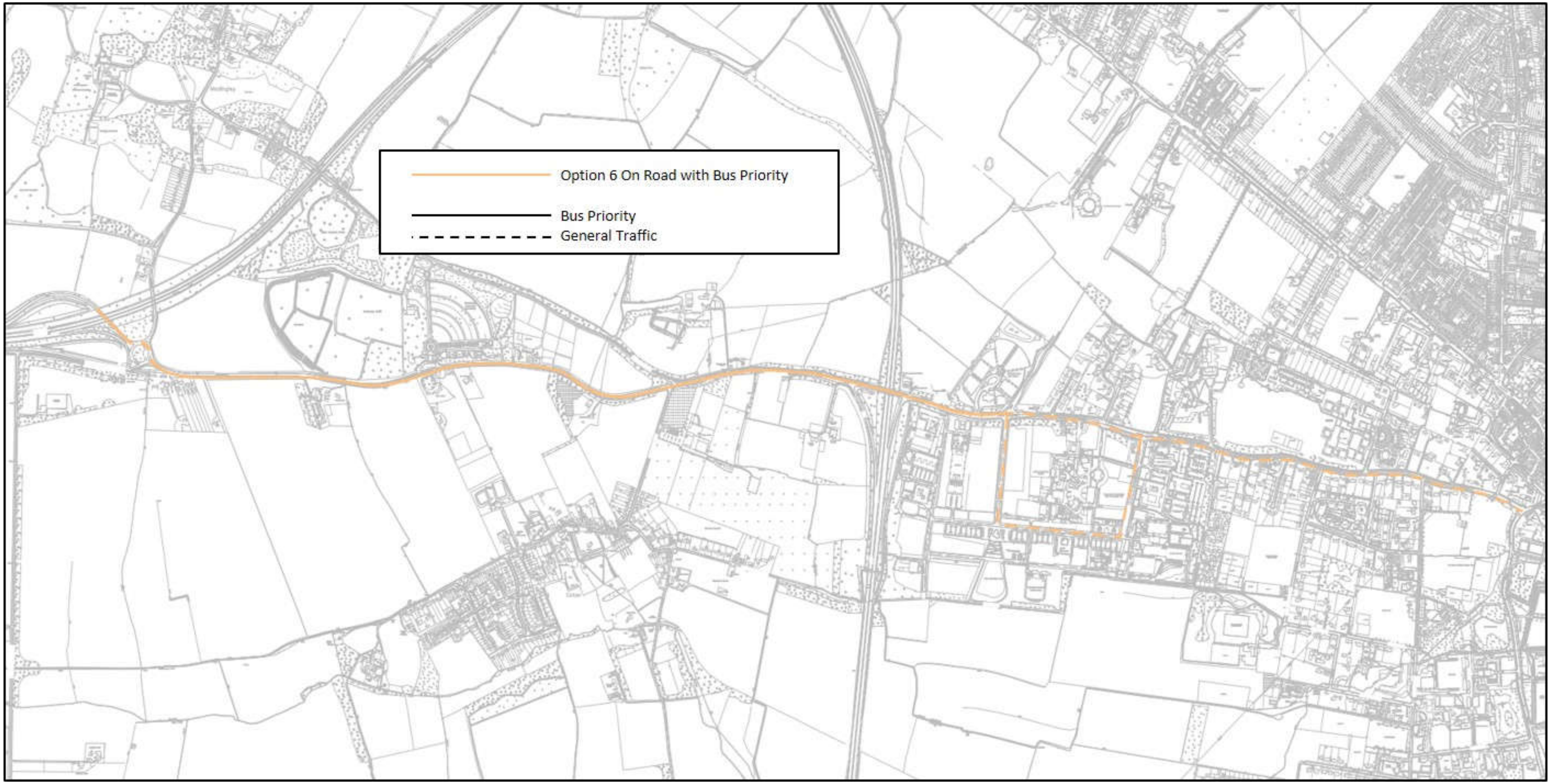


Figure 3-3 Indicative Option 6 Route Alignment



3.1. 2031 Foundation Case

The Foundation Case is based on the 2014 Base year model with the network updated to reflect current network conditions and to be consistent with the CSRM2 Foundation Case assumptions. This includes adding development access points on the A1303 corridor which were not included in the VISSIM 2014 Base model.

Infrastructure

The following infrastructure changes were made to the 2014 Base network (listed West-East beginning at Madingley Mulch roundabout):

- The network between the M11 Junction 13 and Lansdowne Road was updated to remove the roadworks that were assumed to be in place in the base year network. This section has been changed to have two lanes in both directions. Heading eastwards, 60m before the M11 on-slip the two-lane link splits into two separate lanes: one straight ahead only; and one right turn only.
- The lane allocations of the M11 Junction 13 northbound off-slip have been reconfigured so that it is possible to turn right onto Madingley Road in both lanes, left in lane one only.
- Inclusion of the new Cambridge North West site access (opposite High Cross).
- The Madingley Road Park & Ride site and High Cross / NW Cambridge Access has been coded as a single compound junction. A separate LinSig model was produced to generate optimal signal timings, which were then manually optimised further based on observations from the VISSIM model run.

Bus Services

Bus service frequency on the corridor has been increased from 2014 base year levels. A total of 18 buses an hour run along Madingley Road in both directions during the AM and PM peaks. Table 3-2 below shows the frequency of the services coded in the network.

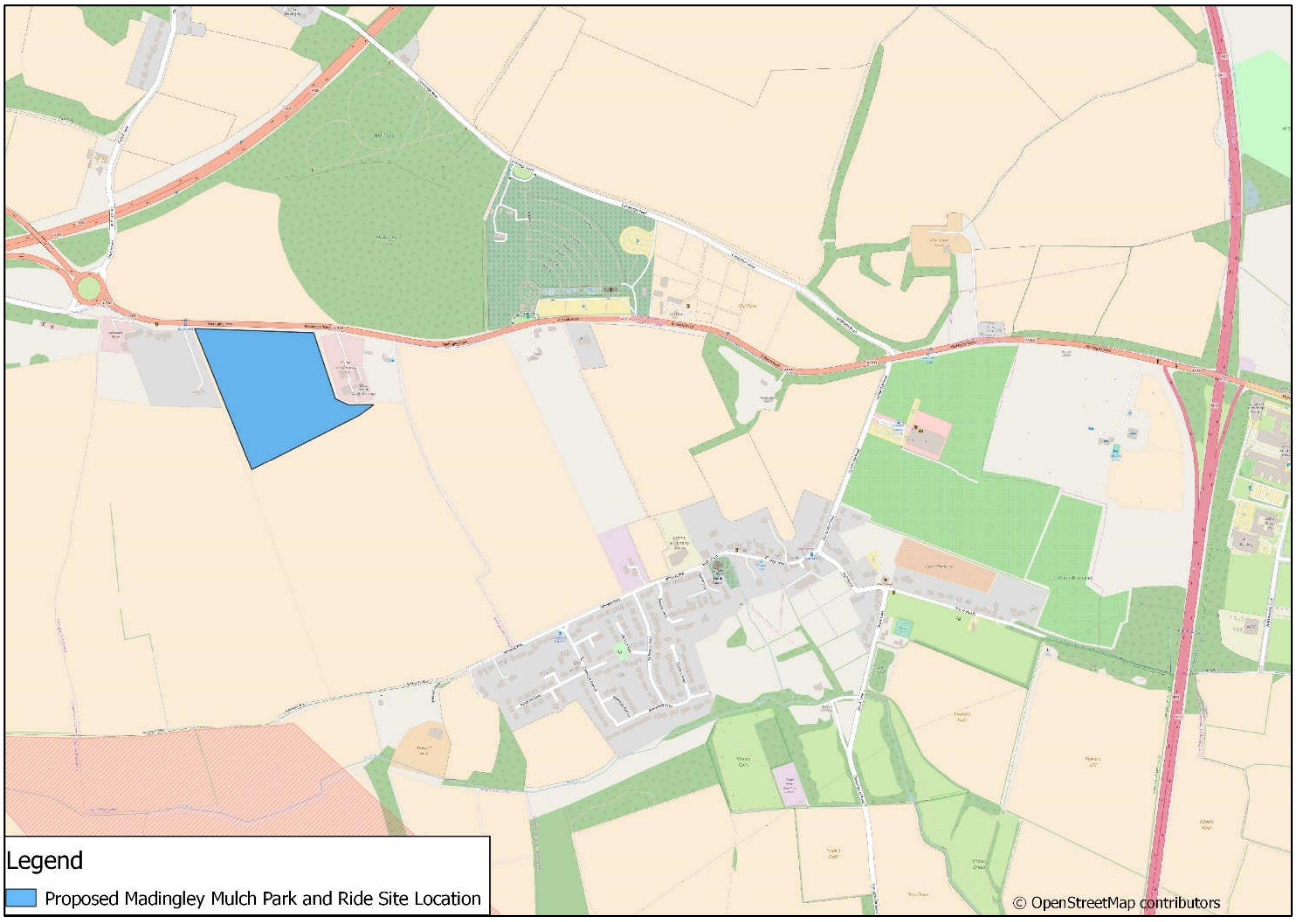
Table 3-2 Peak Hour Bus Service Frequency

Bus Service	Eastbound	Westbound
X3	2	2
X5	1	1
Citi 4	3	3
Uni 4	6	6
Park & Ride	3	3

3.2. 2031 A1303 Do Minimum

The A1303 Do Minimum is based on the 2031 Foundation Case network outlined in the previous section. The changes made to the 2031 Foundation Case network are the closure of Madingley Road Park & Ride at its current site, and the opening of Madingley Mulch Park & Ride site on the south side of Madingley Road as shown in Figure 3-4.

Figure 3-4 Indicative Madingley Mulch Park & Ride Site Location



Infrastructure

The following infrastructure changes were made to the 2031 Foundation Case network (listedwest-eastbeginning at Madingley Mulch roundabout):

- Closure of the existing Madingley Road Park & Ride site. The junction remains in place but the signals have been removed and there is no demand associated with the site.
- A new Park & Ride site on the south side of Madingley Road (referred to as Madingley Mulch Park & Ride) as shown above in Figure 3-4. A LinSig model was developed to provide optimised signal timings at the new junction. Further manual optimisation was undertaken based on observations from the VISSIM model.
- A second lane added to Madingley Road (eastbound) between Madingley Mulch Roundabout and entrance to the new Madingley Mulch Park & Ride facility. The exit from Madingley Mulch Roundabout to Madingley Road in the eastbound direction is increased from one to two lanes.
- Signal timings at the Cambridge West development site access junctions were further optimised in LinSig and refined from observations of the VISSIM model.

Bus Services

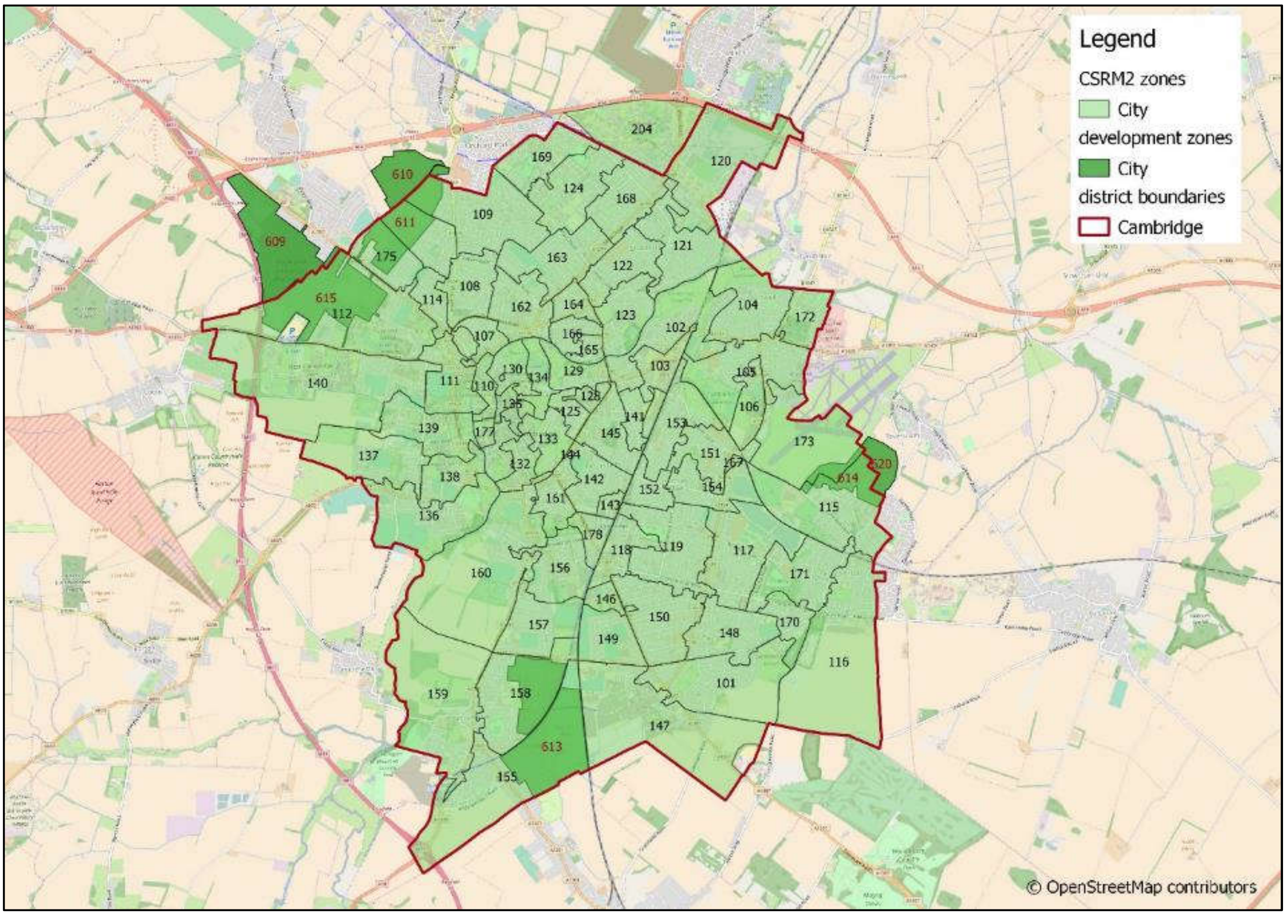
The frequency of bus services remains unchanged from the 2031 Foundation Case scenario with all buses that currently serve the existing Madingley Road Park & Ride site rerouted to serve the proposed Madingley Mulch Park & Ride site.

The X3, X5 and Citi 4 all serve the new Madingley Mulch Park & Ride site and Cambridge West. Uni 4 and Park & Ride site all serve the new Madingley Mulch Park & Ride site, but not Cambridge West. No changes were made to the remaining existing bus stops on the corridor.

Cambridge Access Study

This Do Minimum scenario includes a proxy for the Cambridge City Deal Access Study demand management scheme. It was recognised that there could be many forms the Access Study scheme will take, however a proxy was required that would adequately capture the transport response anticipated, rather than the precise mechanisms to be employed. The proxy applied here comprises of a 30-minute time penalty at the destination end for all car trips with a destination in the Cambridge district including Addenbrooke's and the Science Park, as shown in Figure 3-3. A 10-minute penalty is also applied to the destination end of the Northstowe and Cambourne development sites.

Figure 3-5 Cambridge Access Study Penalty Boundary



3.3. 2031 Option 1: Eastbound Bus Lane

The 2031 Option 1 model is based on the 2031 A1303 Do Minimum network outlined in the previous section. This option includes an inbound (eastbound), on-line bus lane from the Madingley Mulch roundabout to the M11 Junction 13 off-slip. The Madingley Mulch roundabout is also signalised.

Infrastructure

The following infrastructure changes were made to the 2031 A1303 Do Minimum network (listed West-East beginning at Madingley Mulch roundabout):

- A new bus lane on Madingley Road in the eastbound direction only, extending from the proposed new Madingley Mulch Park & Ride site through to the M11 Junction 13 off-slip.
- All buses are routed to use the new bus lane facility where possible.
- Signalisation of the Madingley Mulch Roundabout. A LinSig model was developed to provide optimised timings which were further optimised manually based on observations from the VISSIM model run.
- The network at the proposed Madingley Mulch Park & Ride access has been modified as there are now two lanes heading eastbound after the junction with the nearside lane being for buses only.

- Signalised junctions timings at Cambridge West, M11 Junction 13 and Grange Road manually optimised based on observations from the VISSIM run.

Bus Services

Bus services and bus stops are unchanged from the 2031 A1303 Do Minimum.

3.4. 2031 Option 3a: Off-Line Busway

The 2031 Option 3a model is based on the 2031 A1303 Do Minimum network. This option includes dedicated off-line, bi-directional busway running parallel to the A428 to the Cambridge West development site. The exact alignment of the proposed busway has not yet been defined, so an indicative route shown by the red line in Figure 3-1 has been coded in VISSIM.

Infrastructure

The following infrastructure changes were made to the 2031 A1303 Do Minimum network (listed West-Eastt beginning at Madingley Mulch roundabout):

- The proposed off-line busway, which runs parallel to Madingley Road from Madingley Mulch roundabout in the west to Grange Road has been included using Cambridge University Rugby Club Access. The busway curves round through the southern end of the proposed Madingley Mulch Park & Ride site. The actual scheme extends west to Cambourne, but this is beyond the extent of the VISSIM model.
- Bus speeds on the off-line busway are assumed to be 56mph on the section west of the M11, and 35mph on the section to the east of the M11. The lower speed limit on the eastern section of the busway reflects the need for the buses to traverse the bends in the busway through this section.
- A signalised junction created at the cross over points between the proposed busway and Cambridge Road with Vehicle-Actuated (VA) control to give buses priority.
- Signalised junctions at Cambridge West, M11 Junction 13 and Grange Road manually optimised based on observations from the VISSIM run.

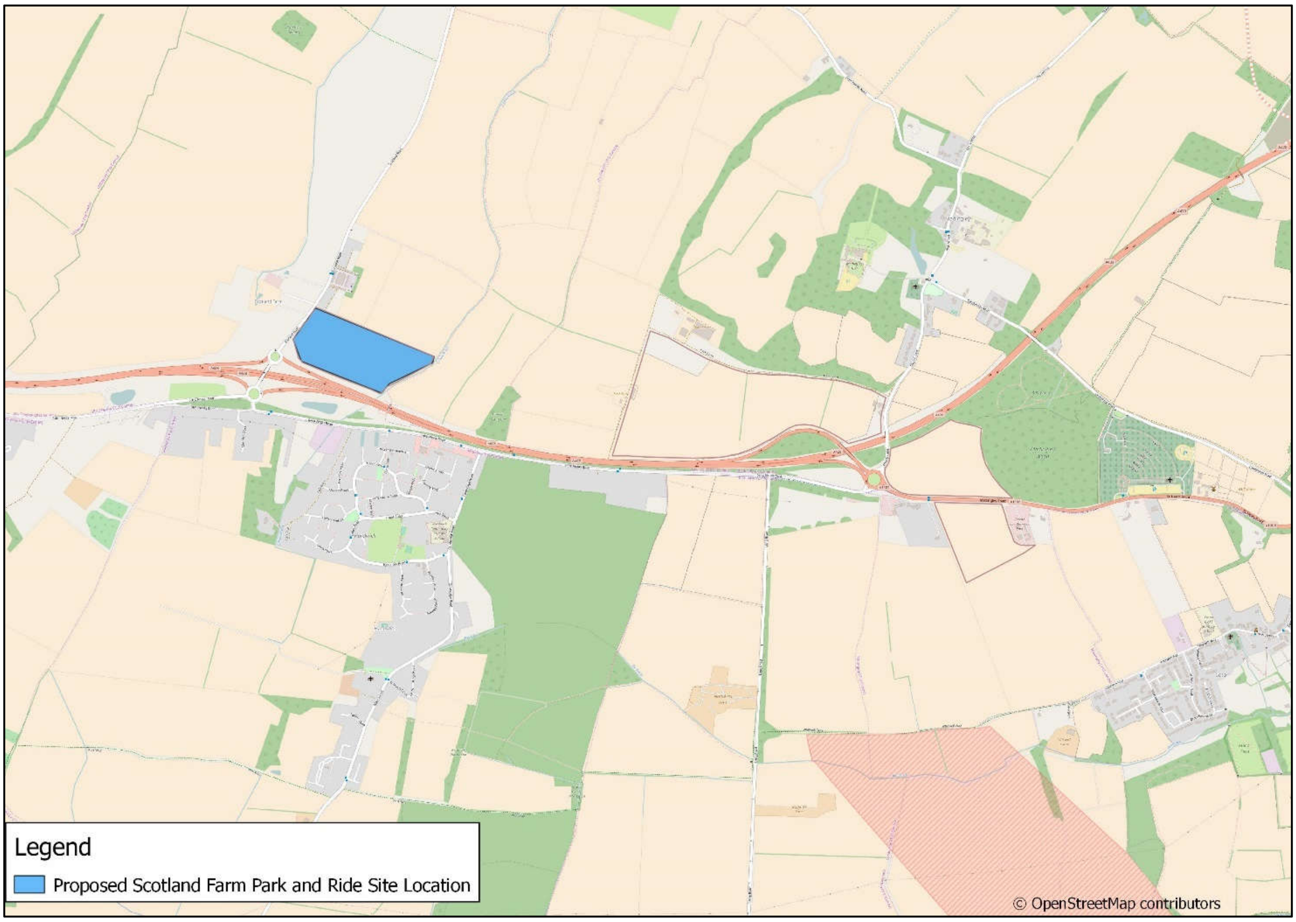
Bus Services

The frequency of bus services remains unchanged from the 2031 Foundation Case. Existing bus services which run along Madingley Road now use the busway. No public buses use Madingley Road. Two bus stops have been included on the busway: one at the proposed Madingley Mulch Park & Ride; and a second at West Cambridge (Ada Lovelace Lane). A 30 second dwell time has been assumed at each stop.

3.5. 2031 Option 6: Tidal Bus Lane on Madingley Road

The 2031 Option 6 model is based on the 2031 A1303 Do Minimum network. This option includes a tidal bus lane on the A1303 Madingley Road, running eastbound in the AM and westbound in the PM. The Park & Ride site in this scenario is moved from its proposed Madingley Road location to Scotland Farm, north of Cambourne as shown in Figure 3-6. The indicative design drawings of Option 6 are included in Appendix A.

Figure 3-6 Indicative Scotland Farm Park & Ride Site Location



Infrastructure

The following infrastructure changes were made to the 2031 A1303 Do Minimum network (listed west-eastbeginning at Madingley Mulch roundabout):

- A bus lane is added into the centre of Madingley Road between Madingley Mulch Roundabout and the High Cross junction using on line widening to create the extra lane. The bus lane is tidal and runs inbound (eastbound) in the AM and outbound (westbound) in the PM.
- New signal controller coded at the Cambridge Road / Madingley Road junction. Signal timings optimised visually in VISSIM, priority coded for buses as they approach the junction.
- Signalisation of the Madingley Mulch Roundabout. A LinSig model was developed to provide optimised timings which were further optimised manually based on observations from the VISSIM model run.
- All buses routed to use the new bus lane facility where possible. Bus stops along Madingley Road have been removed.
- Signalised junction timings at Cambridge West, M11 Junction 13 and Grange Road manually optimised based on observations from the VISSIM run.
- Control of the existing Madingley Road Park & Ride site is converted to a priority junction, however as the site is closed in this option no vehicles use the access.
- The proposed Scotland Farm Park and Ride is not included within the VISSIM model as it is outside of the VISSIM model area.

Bus Services

The frequency of bus services remains unchanged from the 2031 Foundation Case. Existing Madingley Road Park & Ride services would serve Scotland Farm under this scenario, however this is outside of network scope.

4. Forecasting Methodology

This chapter details the forecasting methodology that has been applied to growth the 2014 Base year demand to the 2031 forecast year for each modelled scenario.

4.1. Benchmarking

The existing A1303 corridor VISSIM base model was validated to traffic counts and journey times from the year 2014, whereas the CSRM2 has a base year of 2015. A check of traffic flows on the Madingley Road corridor between these two years was undertaken. The Madingley Road radial site which is monitored each year by CCC was selected for this comparison.

Table 4-1 below presents the peak hour traffic flows by direction which reveals that there was a small reduction in traffic between 2014 and 2015, recovering again in most cases by 2016. Being single day counts, this suggests that 2015 may have been a particularly light traffic flow day and that there has been little to no growth on the corridor over the three-year period 2014-2016. It is therefore considered that future growth can be applied directly to the 2014 Base VISSIM model from forecasts that pivot from the 2015 CSRM2 base, without the need for any further base year adjustment.

Table 4-1 Madingley Road Radial Traffic Flows 2014 - 2016

	0800 – 0900			1700 - 1800		
	2014	2015	2016	2014	2015	2016
Eastbound	1,152	1,113	1,191	430	417	466
Westbound	458	391	381	1,273	969	1,343
Combined	**1,610**	**1,504**	**1,572**	**1,703**	**1,386**	**1,809**

4.2. Growth Methodology

Each of the forecast year scenarios outlined in the previous chapter have previously been modelled in CSRM2 for a forecast year of 2031. The resulting forecast highway demand growth and distribution pattern can be taken from CSRM2 and applied to the 2014 VISSIM Base model.

Growth in highway demand has been taken from the SATURN HAM element of CSRM2. The SATCH program is a sub-programme of the SATURN strategic model and has been used to cordon the CSRM2 base and forecast year models, with the resulting growth applied to the 2014 VISSIM Base flows at a matrix origin-destination level. Table 4-2 below gives the total matrix growth applied for each scenario.

Table 4-2 Forecast Year (2031) Matrix Growth percentage relative to base year

	AM			PM		
	Light	Heavy	Total	Light	Heavy	Total
2031 Foundation Case	19%	21%	19%	22%	15%	21%
2031 A428 Do Minimum	21%	25%	21%	24%	18%	23%
2031 Option 1	21%	24%	21%	24%	18%	23%
2031 Option 3a	19%	25%	20%	23%	18%	22%
2031 Option 6	11%	26%	13%	13%	18%	13%

5. Option Appraisal

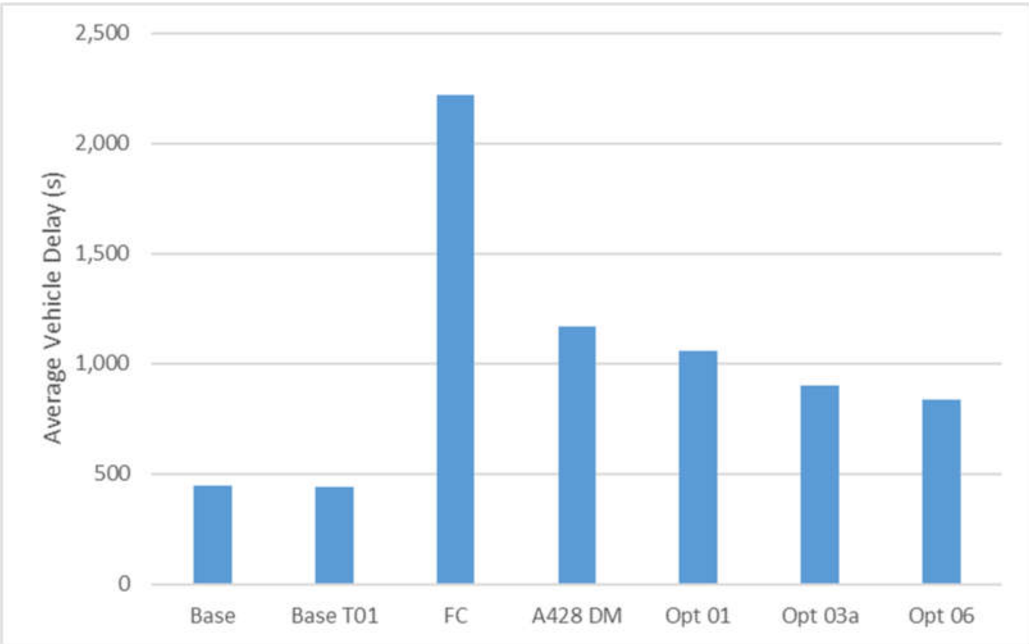
This Chapter assesses the options considered within the study, option 1, option 3a and option. The chapter provides commentary on the results from the VISSIM modelling of those three options.

5.1. Junction Performance

The average vehicle delay graphs (Figure 5-1 and Figure 5-2) give an indication of the delay to journey time for the average vehicle going through the network. The results shown are the sum of the average vehicle delay for each of the junctions captured within the extents of the VISSIM model.

For the AM peak (Figure 5-1) the average total junction delay per vehicle in the 2014 Base is approximately 450 seconds. With the significant increase in highway demand and no associated mitigation in the Foundation Case, the delay increases to over 2,200 seconds. With the introduction of the Cambridge Access Study proxy in the A428 DM scenario, the average delay is reduced to approximately 1,200 seconds. Each of the proposed options reduces the average vehicle delay further when compared against the Future Case. Option 6 provides the greatest reduction in delay with a total average delay of approximately 800 seconds.

Figure 5-1 AM Peak (0800-0900) - Average Vehicle Delay



For the PM peak (Figure 5-2) the average total junction delay per vehicle in the 2014 Base is just over 300 seconds. With the significant increase in highway demand and no associated mitigation in the Foundation Case, the delay increases to approximately 750 seconds. With the introduction of the Cambridge Access Study proxy in the A428 DM scenario, the average delay is reduced to approximately 600 seconds. Option 1 offers a further reduction in average delay compared to the Cambridge Access Study proxy scenario, however option 3 causes a slight increase in average delay. Option 6 significantly reduces average delay to a total delay of less than 400 seconds.

Figure 5-2 PM Peak (1700-1800) - Average Vehicle Delay

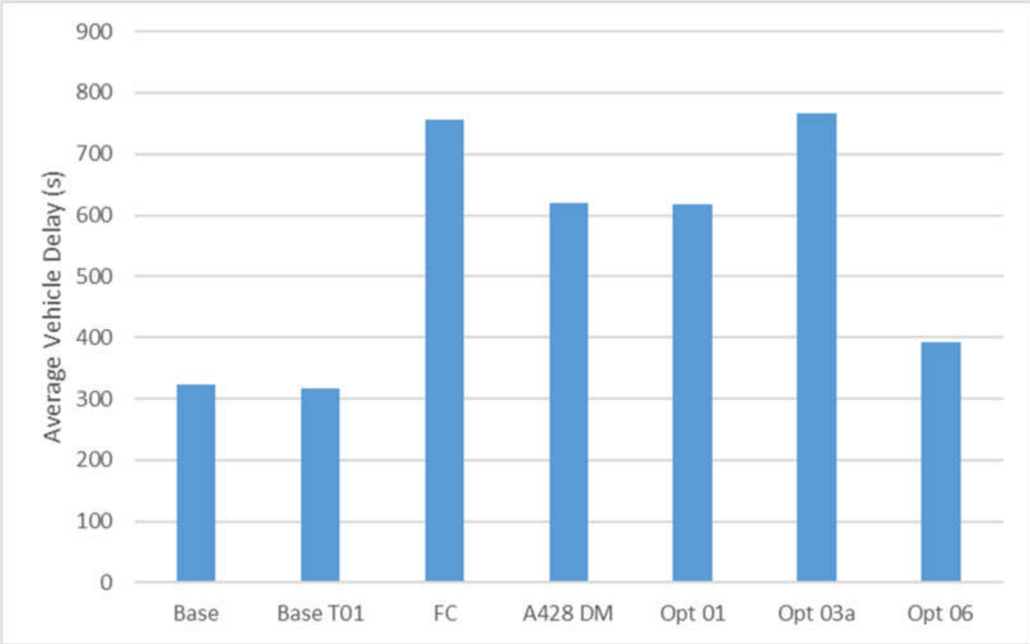


Figure 5-3 and Figure 5-4 show a breakdown of average vehicle delay for each of the junctions across the A1303 corridor in the AM and PM peaks respectively. For each of the junctions, a comparison is shown between the Base, Do Minimum, (Access Study proxy) Option 1, Option 3 and Option 6 results.

Figure 5-3 AM Peak (0800-0900) - Average Vehicle Delay (seconds)

The average delays indicated by the VISSIM modelling during the AM peak period shows how delays at various junctions along the A1303 network are likely to increase to a 2031 Do Minimum situation. The introduction of the options indicates that some delays are reduced at some junctions and in particular delays are reduced in all options at the M11 J13 for both the on-slip and off-slip junctions.

Figure 5-4 PM Peak (1700-1800) - Average Vehicle Delay (seconds)

The average delays indicated by the VISSIM modelling during the PM peak period shows similar delay patterns to the AM peak period where delays at various junctions along the A1303 network are likely to increase to a 2031 Do Minimum situation. The introduction of the options indicates that some delays are reduced at some junctions whereas other junctions the delay stays the same or increases. This is partly due to the model predicting where capacity is freed up it is just as readily used by diverting trips from other corridors.

5.2. Journey Times

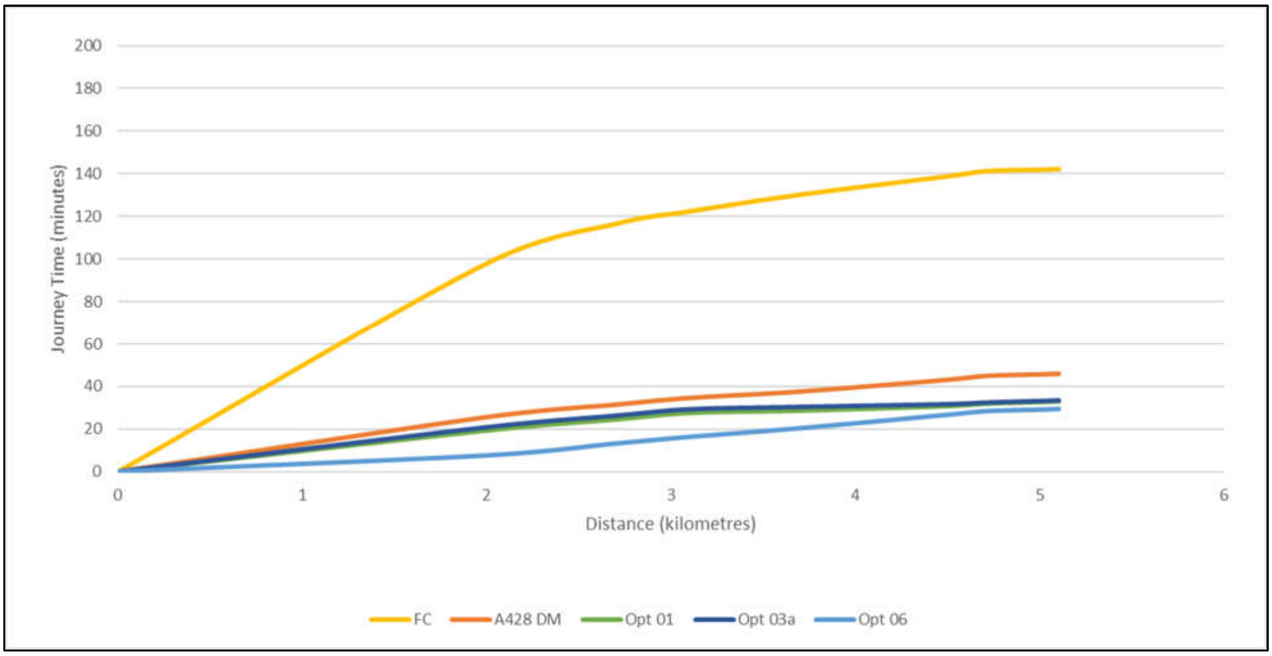
5.2.1. AM Peak (08:00-09:00)

Figure 5-5 presents cumulative journey times for the AM peak hour 08:00 to 09:00 in the critical inbound (eastbound) direction. The general traffic journey times reported are averages for all vehicles classes (excluding buses) on the A1303 corridor between the A428 roundabout in the west and Northampton Street in Cambridge in the east.

The 2014 Base model reported average AM peak hour eastbound journey times along the corridor of 15 minutes. With the significant increase in highway demand and no associated mitigation in the Foundation Case the journey time along this section increases to 142 minutes. With the introduction of the Cambridge Access Study proxy in the A428 DM scenario, the average journey time is reduced to 46 minutes, which is unsurprising given that the objective is to reduce traffic within the city to 10% below 2011 levels.

The model results indicate that Option 6 delivers the greatest improvement in journey time across the entire inbound route compared to the Access Study proxy scenario, with the most significant benefits on the section between the A428 roundabout and Cambridge Road. Journey times for the remainder of the route to Northampton Street are slightly slower in Option 6 than in Options 1 and 3a. All the proposed options are predicted to have inbound AM peak journey times of between 30 to 34 minutes, which is approximately double those reported in the 2014 base year model, which as recognised earlier in this document. This reinforces the need for further refinement of the VISSIM model during further stages of work. All options show an improved journey time when compared against the Do Minimum.

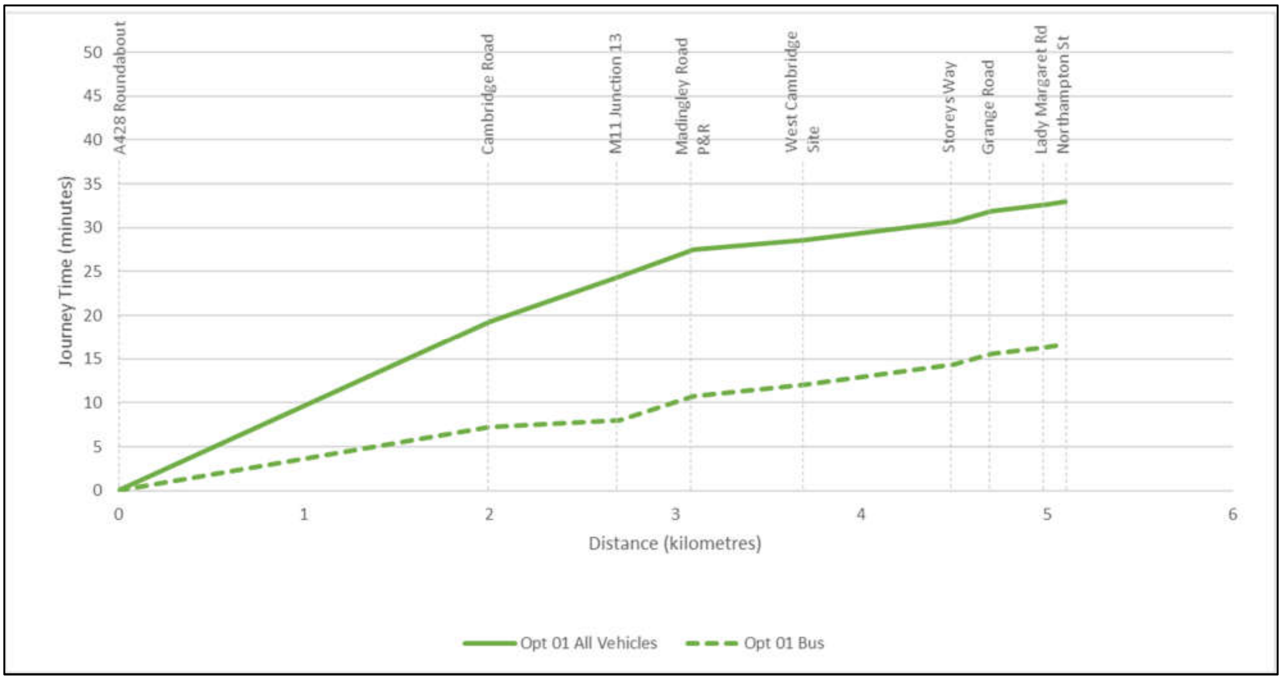
Figure 5-5 AM Peak - Inbound Journey Times (all vehicles)



Figures 5-6 to 5-8 compare the average general traffic journey times against the average bus journey times for each of the three proposed options.

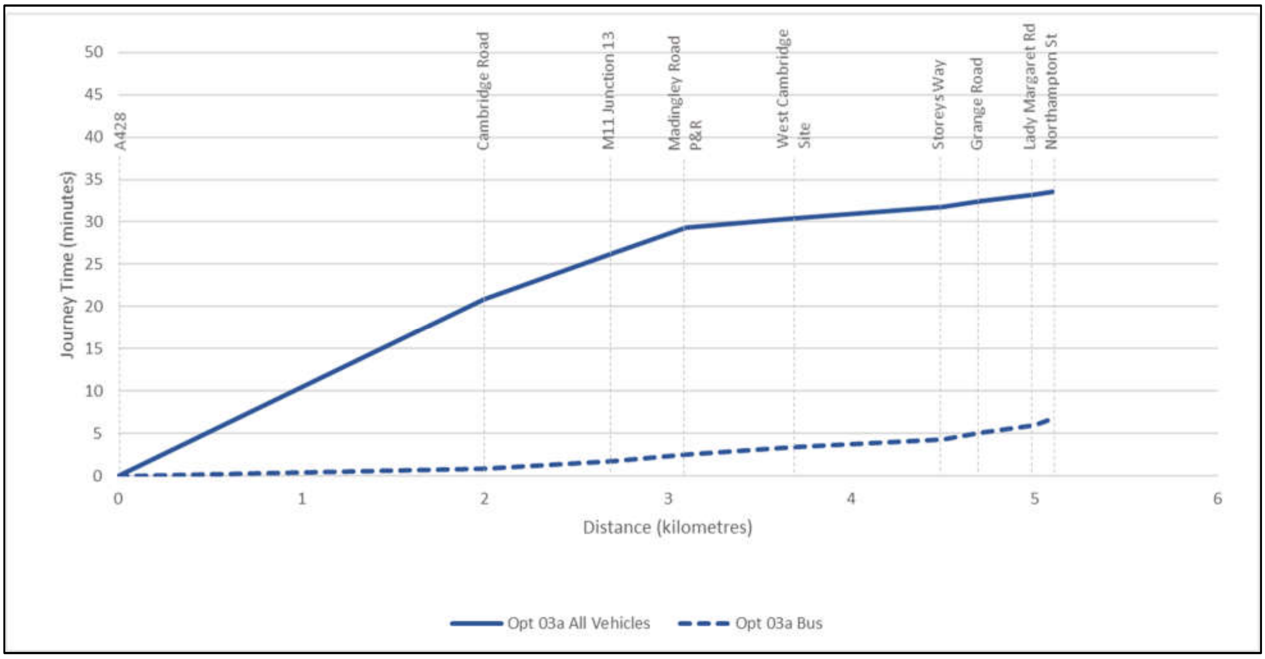
The results for general traffic and bus journey times for Option 1 eastbound are shown in Figure 5-6. The modelled average bus journey time in Option 1 between the A428 roundabout and M11 Junction 13 is approximately 8 minutes, indicating a saving of approximately 16 minutes when compared against general traffic journey time. Beyond the M11 and the end of the proposed scheme buses join the other traffic and have no priority therefore journey times are relatively consistent with the general traffic average in 2031.

Figure 5-6 AM Peak - Option 1 Inbound Journey Times



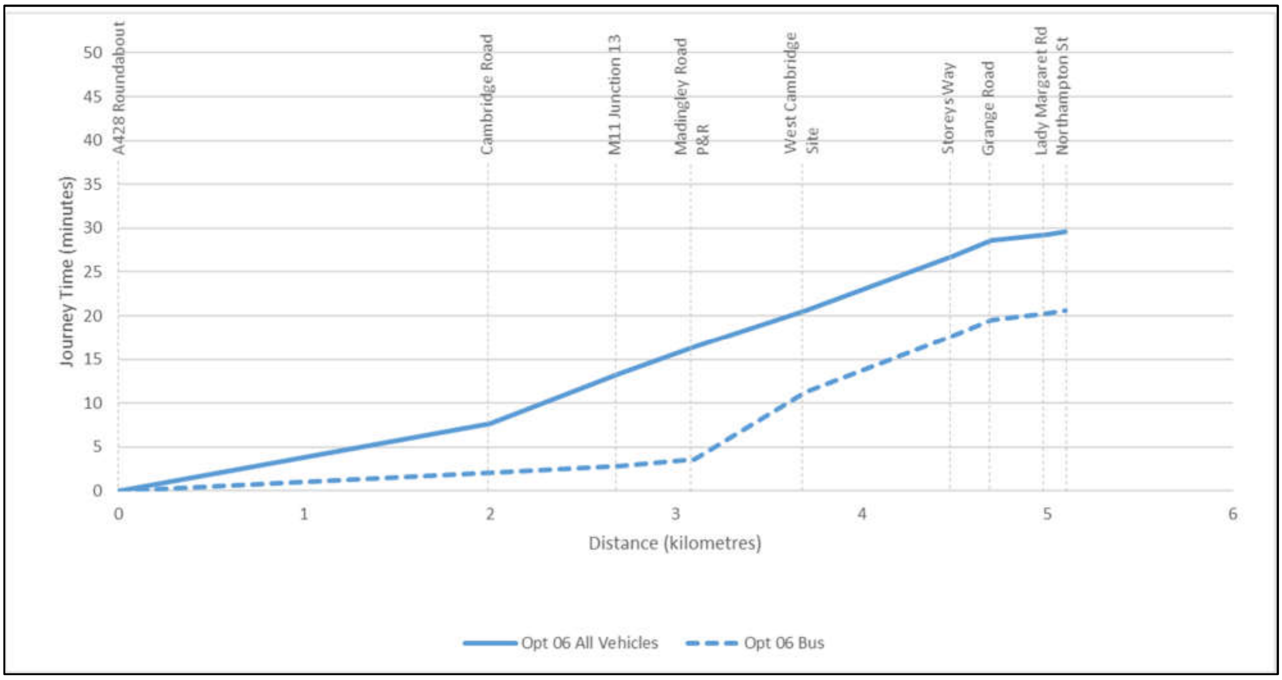
The results for general traffic and bus journey times for Option 3a are shown in Figure 5-7. Buses in Option 3a do not run along the same corridor as general traffic, and as such it is not possible to provide a direct comparison using VISSIM results. The bus journey times for the corresponding sections have therefore been estimated. The estimated results indicate a bus journey time of 7 minutes for the entire corridor, and a saving of approximately 27 minutes when compared against the general traffic journey time in 2031.

Figure 5-7 AM Peak - Option 3a Inbound Journey Times



The results for general traffic and bus journey times for Option 6 are shown in Figure 5-8. The modelled bus journey time in Option 6 between the A428 roundabout and M11 Junction 13 is approximately 3 minutes, indicating a saving of approximately 10 minutes when compared against general traffic journey time. Beyond the M11 and the end of the proposed scheme buses join the other traffic and have no priority therefore journey times are relatively consistent with the general traffic average in 2031.

Figure 5-8 AM Peak - Option 6 Inbound Journey Times



5.2.2. PM Peak (1700-1800)

Figure 5-9 presents cumulative times for the PM peak hour 17:00 to 18:00 in the critical outbound (westbound) direction.

The 2014 Base model reported average PM peak hour journey times along the corridor of 8 minutes. With the significant increase in highway demand and no associated mitigation in the Foundation Case, the journey time along this section remains at 8 minutes. With the introduction of the Cambridge Access Study proxy in the A428 DM scenario, the average journey time increases to 10 minutes. This increase is attributed to more orbital movements as vehicles avoid the City Centre.

Across the entire outbound route, Options 1 and 6 show a slight improvement in journey time when compared against the Do Minimum, by contrast Option 3a shows a slight increase in journey time.

Option 6 and Option 1 show a very slight improvement in journey time against the Do Minimum along the section between Northampton Street and M11 Junction 11, by contrast Option 3a shows an increase in journey time along this section. The journey times for all options between the M11 Junction 13 and the A428 roundabout are broadly similar.

Figure 5-9 PM Peak - Outbound Journey Times

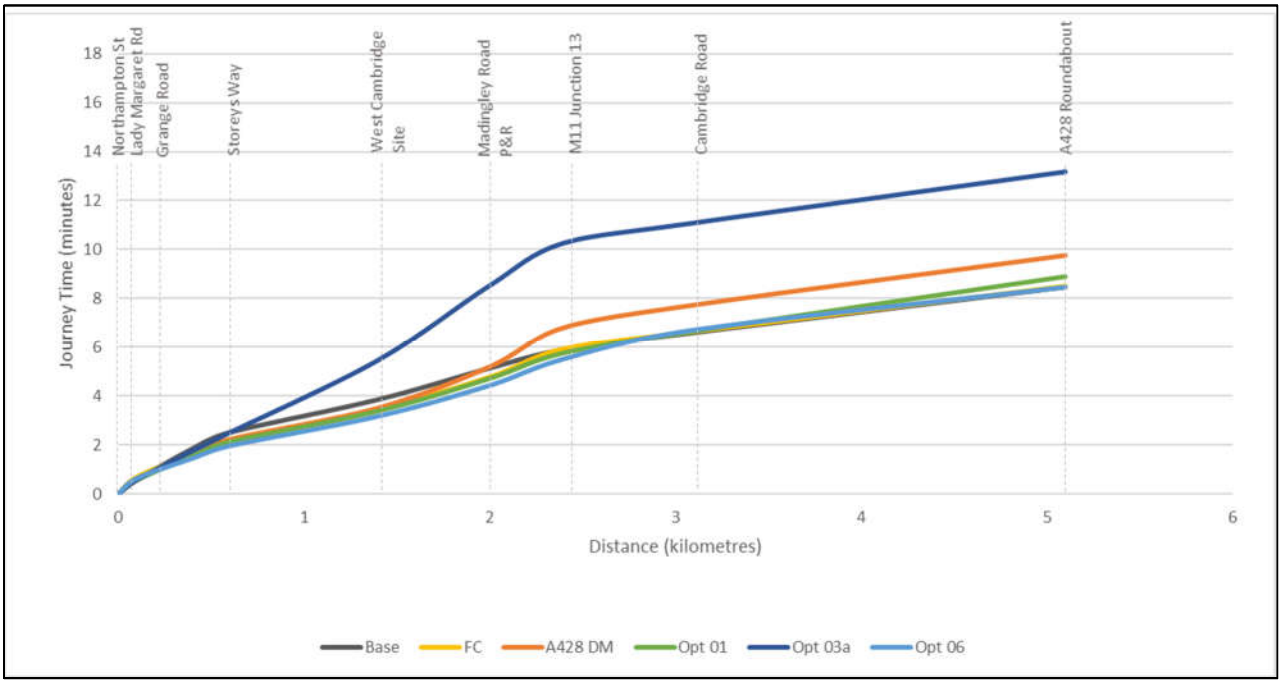


Figure 5-10, Figure 5-11 and Figure 5-12 compare the average general traffic journey times against the average bus journey times for each of the three proposed options. The congestion levels in the outbound (westbound) direction during the PM peak are significantly lower than those experienced in the inbound (eastbound) direction during the AM peak. The impact of this is reflected in the results which show that bus journey times across the entire corridor are slightly longer in Options 1 and 6 when compared to general traffic. Only in Option 3a, where bus traffic runs along its own corridor and the number of bus stops is reduced, does the bus journey time fall below that of general traffic. Buses in Option 3a do not run along the same corridor as general traffic, and as such it is not possible to provide a direct comparison using VISSIM results. The bus journey times for the corresponding sections have therefore been estimated.

Figure 5-10 PM Peak - Option 1 Outbound Journey Times

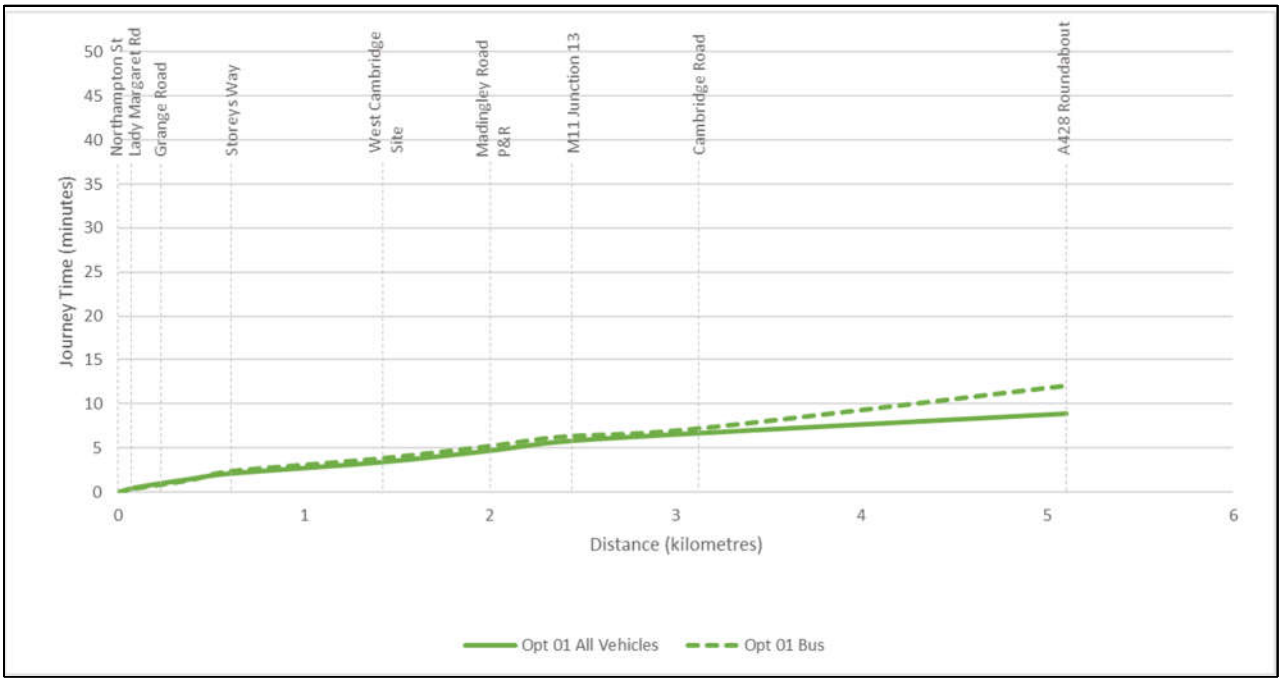


Figure 5-11 PM Peak - Option 3a Outbound Journey Times

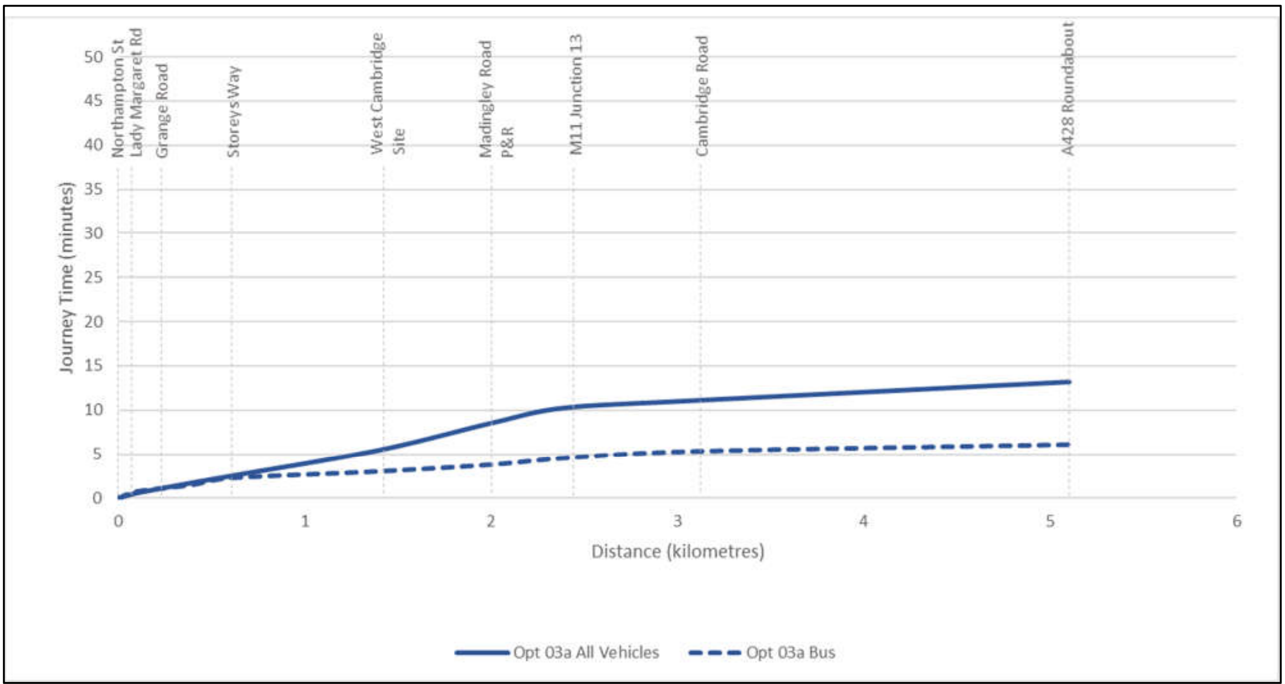
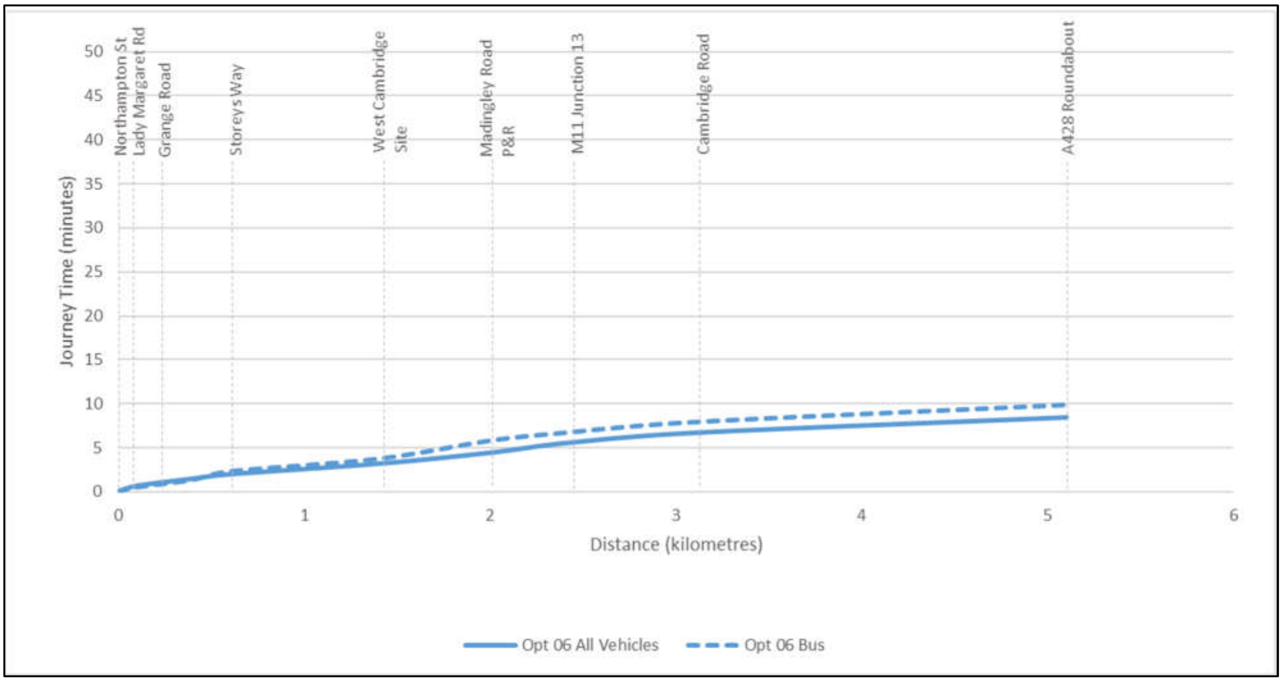


Figure 5-12 PM Peak - Option 6 Outbound Journey Times

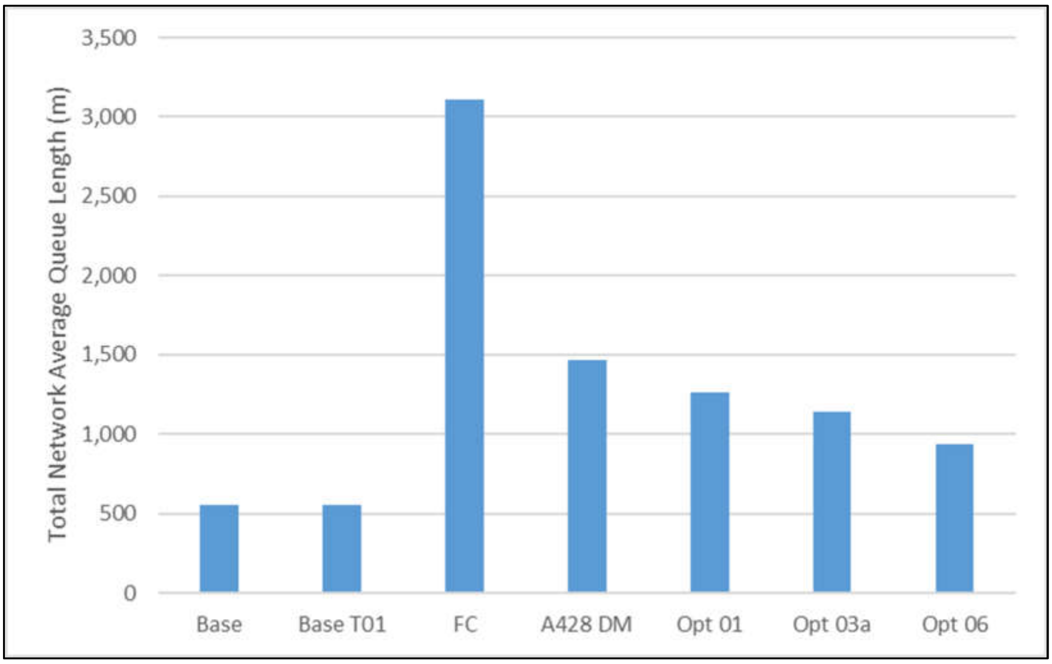


5.3. Queue Lengths

Figure 5-13 and Figure 5-14 show a comparison of the aggregated network wide average queue lengths in metres for each of the options. In the 2014 Base scenario AM peak, the average queue length is just over 500 metres. With increase in demand and no associated mitigation the total average queue length in the Foundarion Case increase to over 3,000 metres. With the introduction of the Cambridge Access Study proxy in the Do Minimum scenario, average queue lengths are approximately halved to just under 1,500 metres.

Each of the options delivers further benefits in terms of queue reduction when compared against the Do Minimum. Option 6 delivers the greatest reduction in queue lengths when compared against the Do Minimum, with a total network average of approximately 900 metres.

Figure 5-13 AM Peak - Total Network Queue Length



In the 2014 Base scenario PM peak, the average queue length is just above 300 metres. With increase in demand and no associated mitigation the total average queue length in the Foundation Case increases to approximately 850 metres. With the introduction of the Cambridge Access Study proxy in the Do Minimum scenario, average queue lengths are reduced to under 700 metres. Options 1 and 3a cause slightly increased average queue lengths whereas Option 6 reduces queue lengths with an average queue length of approximately 250 metres. This is partly due to Option 6 haveig a Park andRide site outside of the A1303 corridor.

Figure 5-14 PM Peak - Total Network Average Queue Length

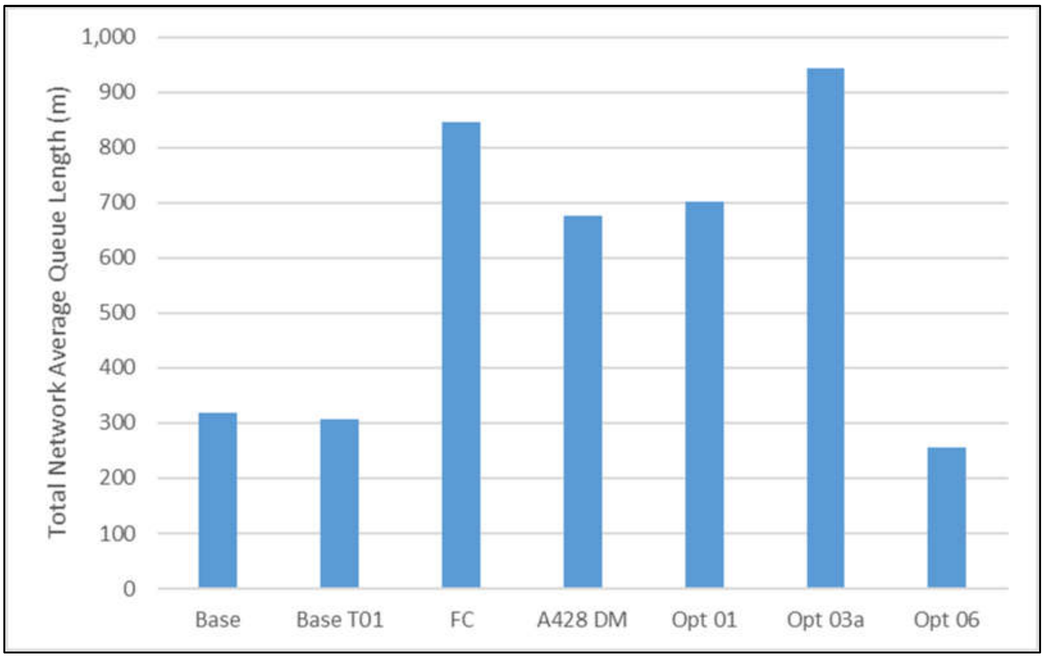


Figure 5-15 and Figure 5-16 show a breakdown of average queue lengths at each of the junctions along the A1303 corridor for the AM and PM peaks respectively. For each of the junctions, a comparison is shown between the Do Minimum, Option 1, Option 3 and Option 6 results.

Figure 5-15 AM Peak (0800-0900) - Average Queue Length (metres)

Figure 5-16 PM Peak (1700-1800) - Average Queue Length (metres)

The queue length figures show how the VISSIM modelling has predicted queue lengths to increase in the 2031 Do Minimum period. With the option testing, there is some variation in queue lengths at the respective junctions shown within the peak periods. In particular, the A1303/Northampton Street junction shows an increase in queuing in the 2031 Do Minimum scenario and reducing queuing for all options tested.

5.4. Network Statistics

5.4.1. AM Peak (0800-0900)

Figure 5-17 and Figure 5-18 show the total network delay and average network speed results from the modelled AM peak hour 0800-0900 respectively.

Total network delay is the sum of time spent in congested conditions for all vehicles. The average network speed is the average speed of all vehicles on the network during the reported time period. Note that for both outputs the reported values are for all vehicles in the network during the defined time period, so this includes those vehicles travelling north/south on the M11 as well as those travelling on Madingley Road.

In the 2014 Base year, there is a total of approximately 500 hours of delay in the AM peak hour. With the increased levels of highway demand in the 2031 Foundation Case, the model predicts that delay will increase significantly, reaching almost 4,000 hours. The Do Minimum, which includes a proxy for the proposed City Deal Access Study scheme almost halves this delay to approximately 2,000 hours as car trips are deterred from travelling to destinations in Cambridge. Each of the proposed options further reduce the total network delay when compared to the Do Minimum.

Option 6 delivers the greatest reduction in delay against the Do Minimum, with a total network delay of approximately 1,000 hours. It is considered that one of the reasons Option 6 delivers the greatest reduction is due to the location of the park and ride site at Scotland Farm having the effect of reducing traffic along the A1303.The results for average network speed are shown in Figure 5-18. Option 6 also delivers the greatest increase in average speed when compared against the Do Minimum.

Figure 5-17 AM Peak - Total Network Delay

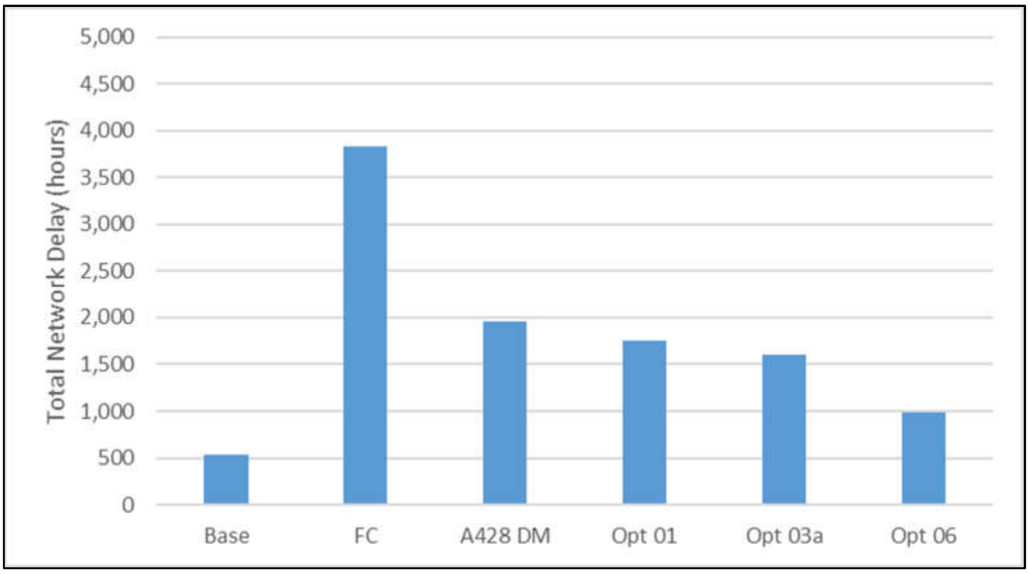
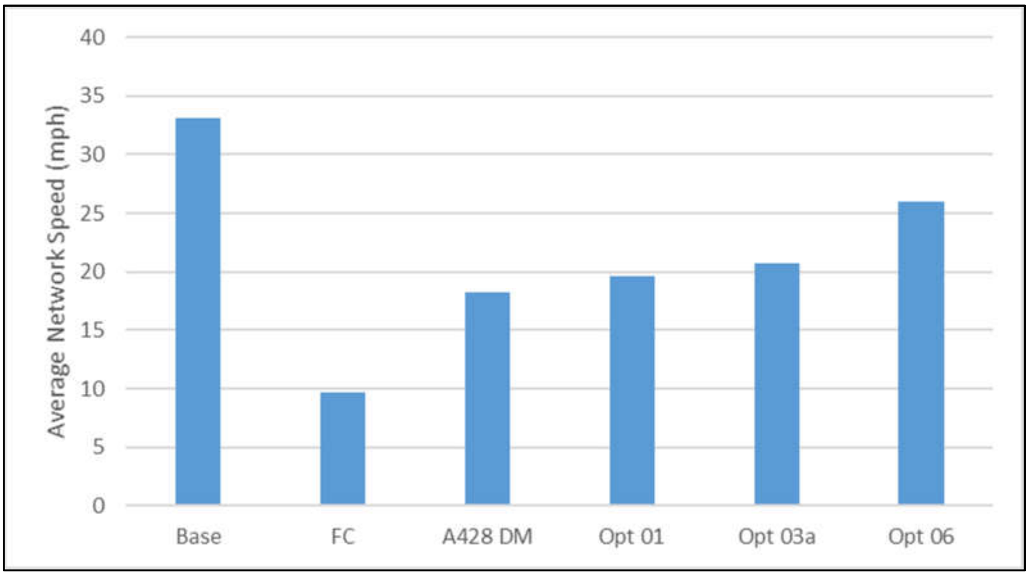


Figure 5-18 AM Peak- Average Speed



5.4.2. PM Peak (1700-1800)

Figure 5-19 and Figure 5-20 show the total network delay and average network speed results from the modelled PM peak hour 1700-1800 respectively.

In the 2014 Base year, there is a total of approximately 500 hours of delay in the PM peak hour. With the increased levels of highway demand in the 2031 Foundation Case, the model predicts that delay will increase significantly, reaching approximately 1,400 hours. The Do Minimum, which includes a proxy for the proposed City Deal Access Study scheme very slightly reduces the amount of delay.

Of the three options, Option 6 delivers the greatest reduction in delay against the Do Minimum, with a total network delay of approximately 500 hours. The results for average network speed are shown in Figure 5-20. Option 6 also delivers the greatest increase in average speed when compared against the Do Minimum. The results for Option 1 are broadly similar with the Do Minimum, while Option 3a shows an increase in network delay and reduction in average speed.

Figure 5-19 PM Peak - Total Network Delay

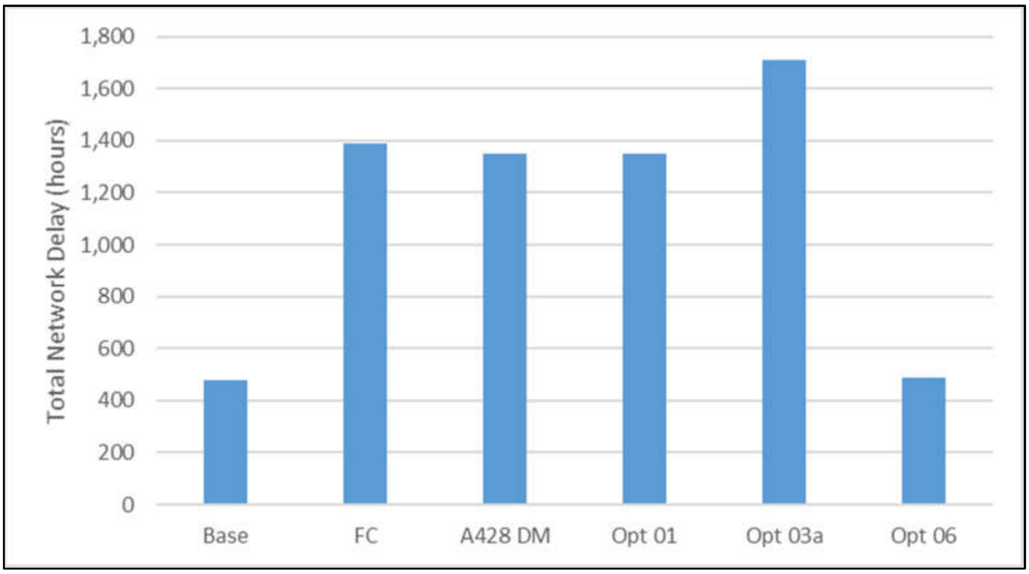
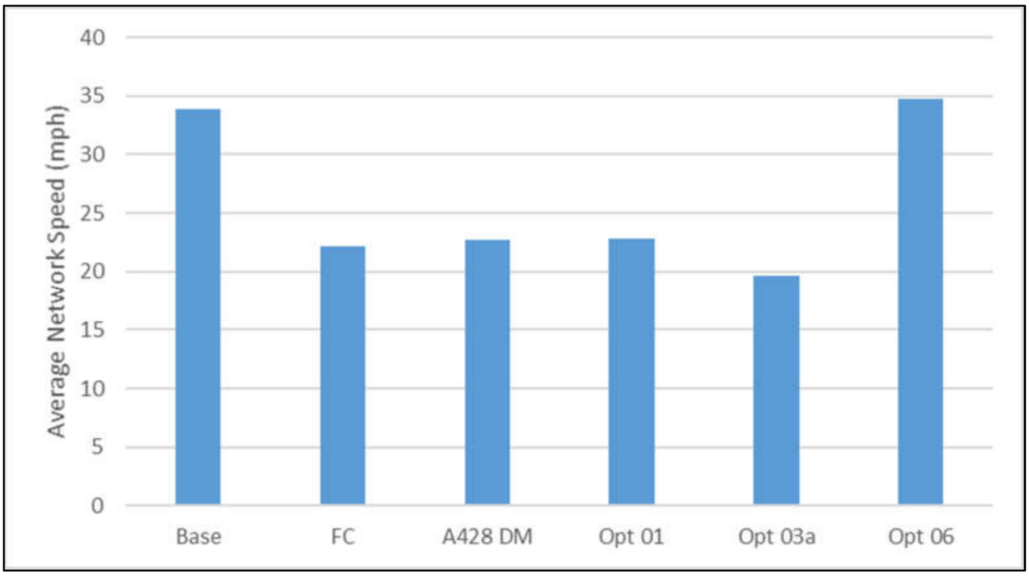


Figure 5-20 PM Peak - Average Network Speed


40
35
30
25
20
15
10
5
0
Average Network Speed (mph)
Base
FC
A428 DM
Opt 01
Opt 03a
Opt 06

6. Summary and Conclusions

The existing validated A1303 2014 Base VISSIM model has been used as a basis upon which to develop forecast year models to assess each of the proposed bus priority options for the corridor. 2031 forecast year models have been developed for each of the proposed options, with growth in highway traffic taken from the Cambridge Sub-Regional Model.

The options considered include an off-road busway, Option 3a, and two on-road options, Option 1 and Option 6.

In the critical eastbound (towards Cambridge) direction in the AM peak hour (0800-0900) the VISSIM model predicts that with no transport mitigation, Local Plan levels of growth in traffic volumes by 2031 (Foundation Case) will result in a significant increase in delay and journey times on the A1303 corridor between the A428 roundabout and Northampton Street. Journey times on this section are predicted to increase by over 100 minutes.

The introduction of a proxy for the proposed Cambridge City Deal Access Study scheme is likely to encourage mode shift to public transport and active modes, reducing journey times on the corridor significantly. Journey times however remain at more than three times the reported 2014 Base model level. This is partly due the data from the CSRM model which predicts more traffic using Madingley Road in the peak periods than the 2014 base.

All three proposed bus priority options encourage further mode shift to public transport, resulting in further reductions in average journey times for all vehicles when compared to the City Access proxy scenario. Option 6 is predicted to provide journey time improvements between the A428 roundabout and the Cambridge Road junction due to reduced demand driven by the relocation of the Park & Ride site to Scotland Farm However it should be noted that the impact local to Scotland Farm has not been modelled as it is not included in the VISSIM model network area.

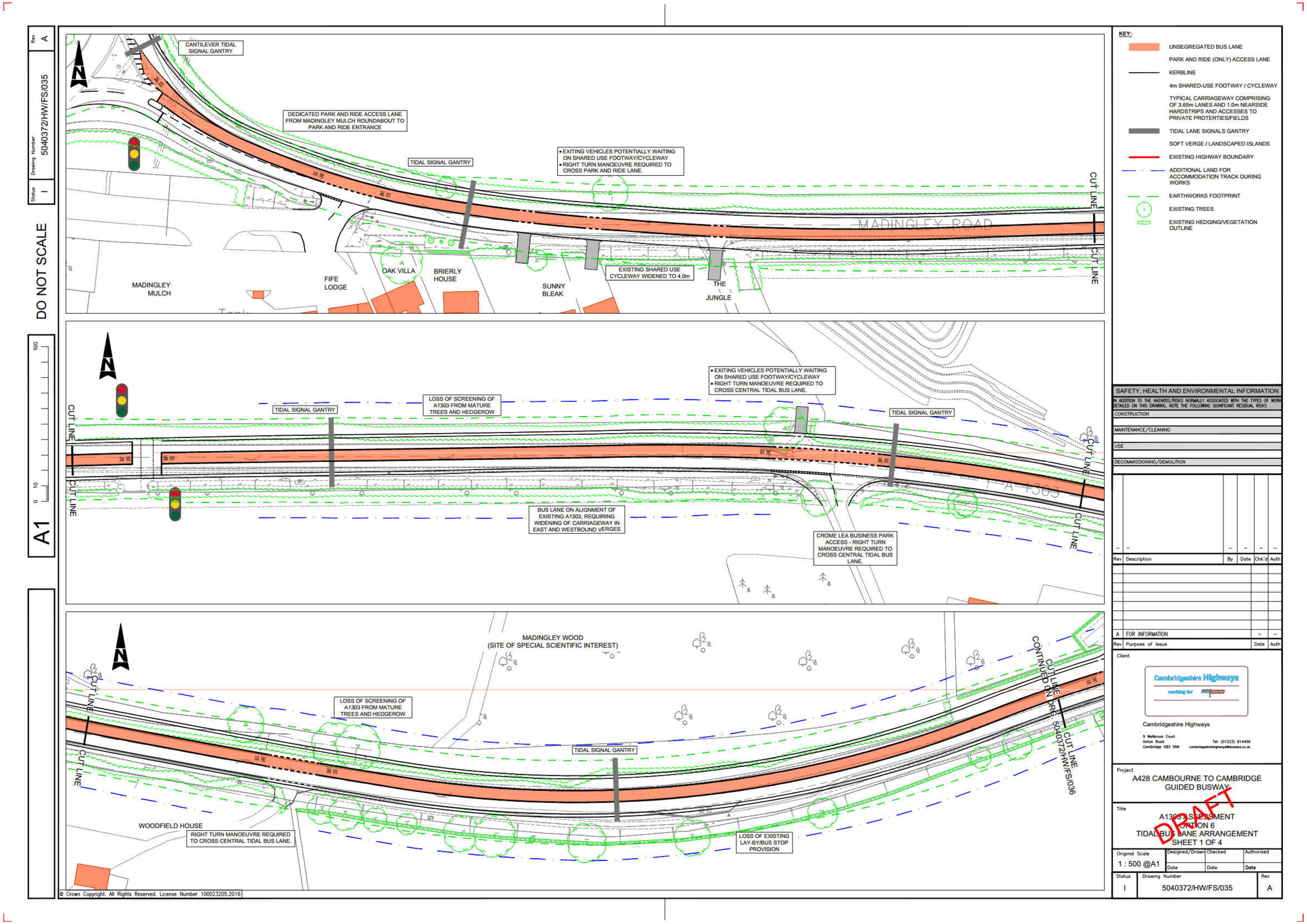
Bus priority over regular traffic on the most congested sections of the A1303 corridor results in bus journey times which are faster than those for other vehicles in each of the three proposed options. Option 3a is the best performing option for average bus journey times at 6 minutes for the length of the modelled corridor. Bus journey times for Option 3a and 6 are predicted to be 17 and 21 minutes respectively. Each option represents an improvement in journey time over regular traffic of between 9 and 16 minutes.

The Cambridge Access Study is critical in encouraging mode share and ensuring that predicted levels of traffic growth by 2031 can be accommodated by the highway network.

All the proposed options are predicted to result in mode shift away from car to more sustainable modes, reducing average journey times on the corridor for all vehicles. However eastbound AM peak journey times for regular traffic are predicted to remain at double the reported 2014 Base model levels. It is considered that further analysis of the VISSIM model as the Options are developed should be considered in order to provide further data to support the Full Business Case for the next stage of project work.

Appendix A. Option 6 Drawings

A.1. 2031 Option 6: Tidal Bus Lane on Madingley Road


CANTILEVER TIDAL SIGNAL GANTRY
DEDICATED PARK AND RIDE ACCESS LANE FROM MADINGLEY MULCH ROUNDABOUT TO PARK AND RIDE ENTRANCE
TIDAL SIGNAL GANTRY
• EXITING VEHICLES POTENTIALLY WAITING ON SHARED USE FOOTWAY/CYCLEWAY
• RIGHT TURN MANOEUVRE REQUIRED TO CROSS PARK AND RIDE LANE.
MADINGLEY ROAD
CUT LINE
EXISTING SHARED USE CYCLEWAY WIDENED TO 4.0m
MADINGLEY MULCH
FIFE LODGE
OAK VILLA
BRIERLY HOUSE
SUNNY BLEAK
THE JUNGLE
LOSS OF SCREENING OF A1303 FROM MATURE TREES AND HEDGEROW
• EXITING VEHICLES POTENTIALLY WAITING ON SHARED USE FOOTWAY/CYCLEWAY
• RIGHT TURN MANOEUVRE REQUIRED TO CROSS CENTRAL TIDAL BUS LANE.
BUS LANE ON ALIGNMENT OF EXISTING A1303, REQUIRING WIDENING OF CARRIAGEWAY IN EAST AND WESTBOUND VERGES
CROME LEA BUSINESS PARK ACCESS - RIGHT TURN MANOEUVRE REQUIRED TO CROSS CENTRAL TIDAL BUS LANE.
A1303
MADINGLEY WOOD
(SITE OF SPECIAL SCIENTIFIC INTEREST)
WOODFIELD HOUSE
RIGHT TURN MANOEUVRE REQUIRED TO CROSS CENTRAL TIDAL BUS LANE.
LOSS OF EXISTING LAY-BY/BUS STOP PROVISION
CONTINUED ON DRG. 5040372/HW/FS/036
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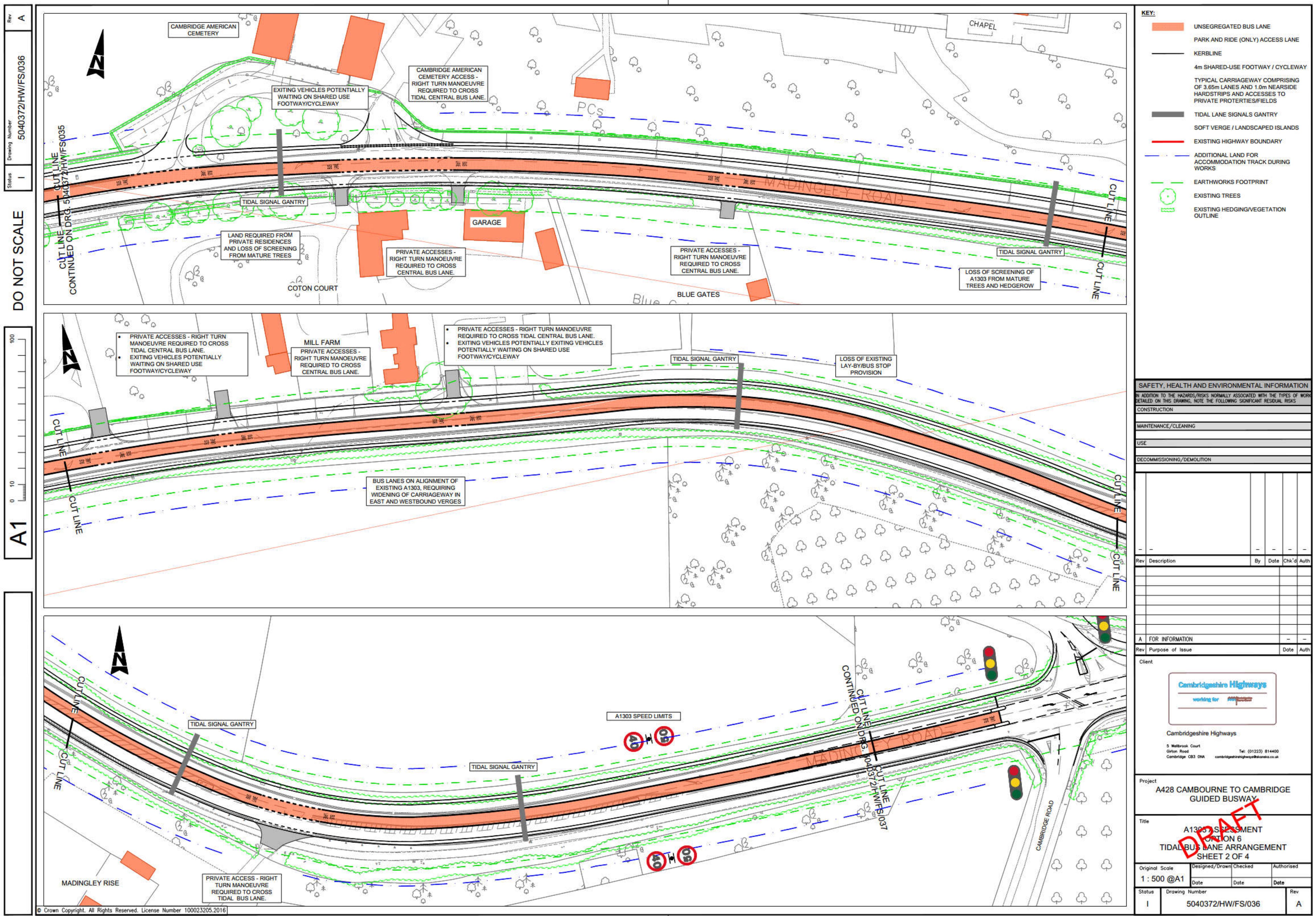
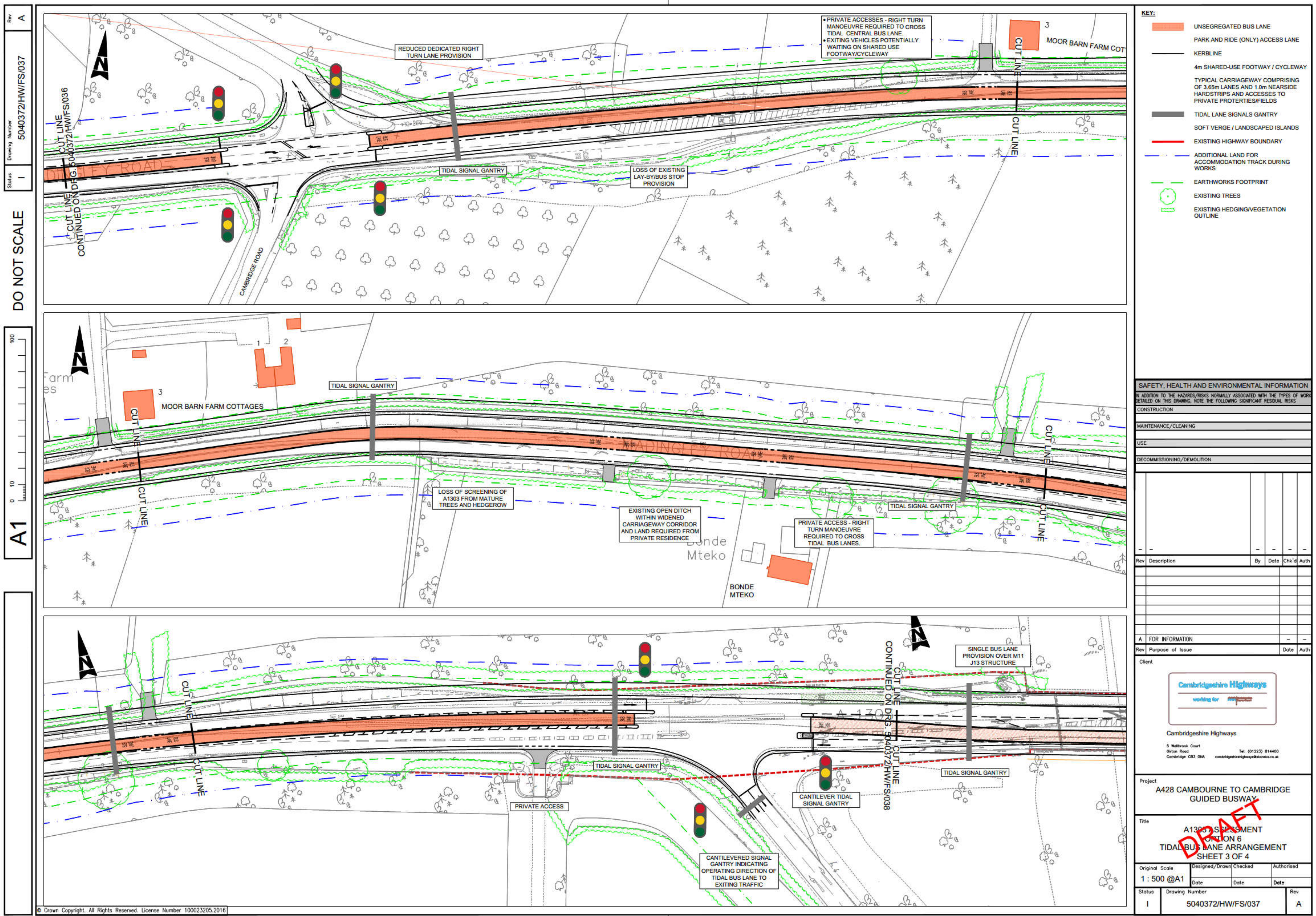
DO NOT SCALE
A1
Rev A
Drawing Number 5040372/HW/FS/035
Status I
KEY:
UNSEGREGATED BUS LANE
PARK AND RIDE (ONLY) ACCESS LANE
KERBLINE
4m SHARED-USE FOOTWAY / CYCLEWAY
TYPICAL CARRIAGEWAY COMPRISING OF 3.65m LANES AND 1.0m NEARSIDE HARDSTRIPS AND ACCESSES TO PRIVATE PROTERTIES/FIELDS
TIDAL LANE SIGNALS GANTRY
SOFT VERGE / LANDSCAPED ISLANDS
EXISTING HIGHWAY BOUNDARY
ADDITIONAL LAND FOR ACCOMMODATION TRACK DURING WORKS
EARTHWORKS FOOTPRINT
EXISTING TREES
EXISTING HEDGING/VEGETATION OUTLINE
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
CONSTRUCTION
MAINTENANCE/CLEANING
USE
DECOMMISSIONING/DEMOLITION
Rev Description By Date Chk'd Auth
A FOR INFORMATION
Rev Purpose of Issue Date Auth
Client
Cambridgeshire Highways
Project
A428 CAMBOURNE TO CAMBRIDGE GUIDED BUSWAY
Title
A1303 ASSESSMENT OPTION 6
TIDAL BUS LANE ARRANGEMENT
SHEET 1 OF 4
DRAFT
Original Scale 1 : 500 @A1
Designed/Drawn Checked Authorised
Status I
Drawing Number 5040372/HW/FS/035
Rev A


CAMBRIDGE AMERICAN CEMETERY
EXITING VEHICLES POTENTIALLY WAITING ON SHARED USE FOOTWAY/CYCLEWAY
CAMBRIDGE AMERICAN CEMETERY ACCESS - RIGHT TURN MANOEUVRE REQUIRED TO CROSS TIDAL CENTRAL BUS LANE.
CHAPEL
TIDAL SIGNAL GANTRY
GARAGE
LAND REQUIRED FROM PRIVATE RESIDENCES AND LOSS OF SCREENING FROM MATURE TREES
PRIVATE ACCESSES - RIGHT TURN MANOEUVRE REQUIRED TO CROSS CENTRAL BUS LANE.
COTON COURT
BLUE GATES
LOSS OF SCREENING OF A1303 FROM MATURE TREES AND HEDGEROW
MADINGLEY ROAD
CUT LINE
CONTINUED ON DRG. 5040372/HW/FS/035
PRIVATE ACCESSES - RIGHT TURN MANOEUVRE REQUIRED TO CROSS TIDAL CENTRAL BUS LANE. EXITING VEHICLES POTENTIALLY WAITING ON SHARED USE FOOTWAY/CYCLEWAY
MILL FARM
LOSS OF EXISTING LAY-BY/BUS STOP PROVISION
BUS LANES ON ALIGNMENT OF EXISTING A1303, REQUIRING WIDENING OF CARRIAGEWAY IN EAST AND WESTBOUND VERGES
A1303 SPEED LIMITS
CONTINUED ON DRG. 5040372/HW/FS/037
MADINGLEY RISE
PRIVATE ACCESS - RIGHT TURN MANOEUVRE REQUIRED TO CROSS TIDAL BUS LANE.
CAMBRIDGE ROAD
© Crown Copyright. All Rights Reserved. License Number 100023205.2016
KEY:
UNSEGREGATED BUS LANE
PARK AND RIDE (ONLY) ACCESS LANE
KERBLINE
4m SHARED-USE FOOTWAY / CYCLEWAY
TYPICAL CARRIAGEWAY COMPRISING OF 3.65m LANES AND 1.0m NEARSIDE HARDSTRIPS AND ACCESSES TO PRIVATE PROTERTIES/FIELDS
TIDAL LANE SIGNALS GANTRY
SOFT VERGE / LANDSCAPED ISLANDS
EXISTING HIGHWAY BOUNDARY
ADDITIONAL LAND FOR ACCOMMODATION TRACK DURING WORKS
EARTHWORKS FOOTPRINT
EXISTING TREES
EXISTING HEDGING/VEGETATION OUTLINE
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
CONSTRUCTION
MAINTENANCE/CLEANING
USE
DECOMMISSIONING/DEMOLITION
A FOR INFORMATION
Client
Cambridgeshire Highways
Project
A428 CAMBOURNE TO CAMBRIDGE GUIDED BUSWAY
Title
A1303 ASSESSMENT OPTION 6 TIDAL BUS LANE ARRANGEMENT SHEET 2 OF 4
DRAFT
Original Scale 1 : 500 @A1
Status I
Drawing Number 5040372/HW/FS/036
Rev A
DO NOT SCALE
A1



DO NOT SCALE
A1
Rev A
Drawing Number 5040372/HW/FS/037
Status I
REDUCED DEDICATED RIGHT TURN LANE PROVISION
PRIVATE ACCESSES - RIGHT TURN MANOEUVRE REQUIRED TO CROSS TIDAL CENTRAL BUS LANE.
EXISTING VEHICLES POTENTIALLY WAITING ON SHARED USE FOOTWAY/CYCLEWAY
MOOR BARN FARM COT
CUT LINE
CUT LINE CONTINUED ON DRG. 5040372/HW/FS/036
TIDAL SIGNAL GANTRY
LOSS OF EXISTING LAY-BY/BUS STOP PROVISION
CAMBRIDGE ROAD
MOOR BARN FARM COTTAGES
LOSS OF SCREENING OF A1303 FROM MATURE TREES AND HEDGEROW
EXISTING OPEN DITCH WITHIN WIDENED CARRIAGEWAY CORRIDOR AND LAND REQUIRED FROM PRIVATE RESIDENCE
PRIVATE ACCESS - RIGHT TURN MANOEUVRE REQUIRED TO CROSS TIDAL BUS LANES.
BONDE MTEKO
SINGLE BUS LANE PROVISION OVER M11 J13 STRUCTURE
CUT LINE CONTINUED ON DRG. 5040372/HW/FS/038
PRIVATE ACCESS
CANTILEVER TIDAL SIGNAL GANTRY
CANTILEVERED SIGNAL GANTRY INDICATING OPERATING DIRECTION OF TIDAL BUS LANE TO EXITING TRAFFIC
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KEY:
UNSEGREGATED BUS LANE
PARK AND RIDE (ONLY) ACCESS LANE
KERBLINE
4m SHARED-USE FOOTWAY / CYCLEWAY
TYPICAL CARRIAGEWAY COMPRISING OF 3.65m LANES AND 1.0m NEARSIDE HARDSTRIPS AND ACCESSES TO PRIVATE PROTERTIES/FIELDS
TIDAL LANE SIGNALS GANTRY
SOFT VERGE / LANDSCAPED ISLANDS
EXISTING HIGHWAY BOUNDARY
ADDITIONAL LAND FOR ACCOMMODATION TRACK DURING WORKS
EARTHWORKS FOOTPRINT
EXISTING TREES
EXISTING HEDGING/VEGETATION OUTLINE
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
CONSTRUCTION
MAINTENANCE/CLEANING
USE
DECOMMISSIONING/DEMOLITION
A FOR INFORMATION
Client
Cambridgeshire Highways
Project
A428 CAMBOURNE TO CAMBRIDGE GUIDED BUSWAY
Title
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DRAFT
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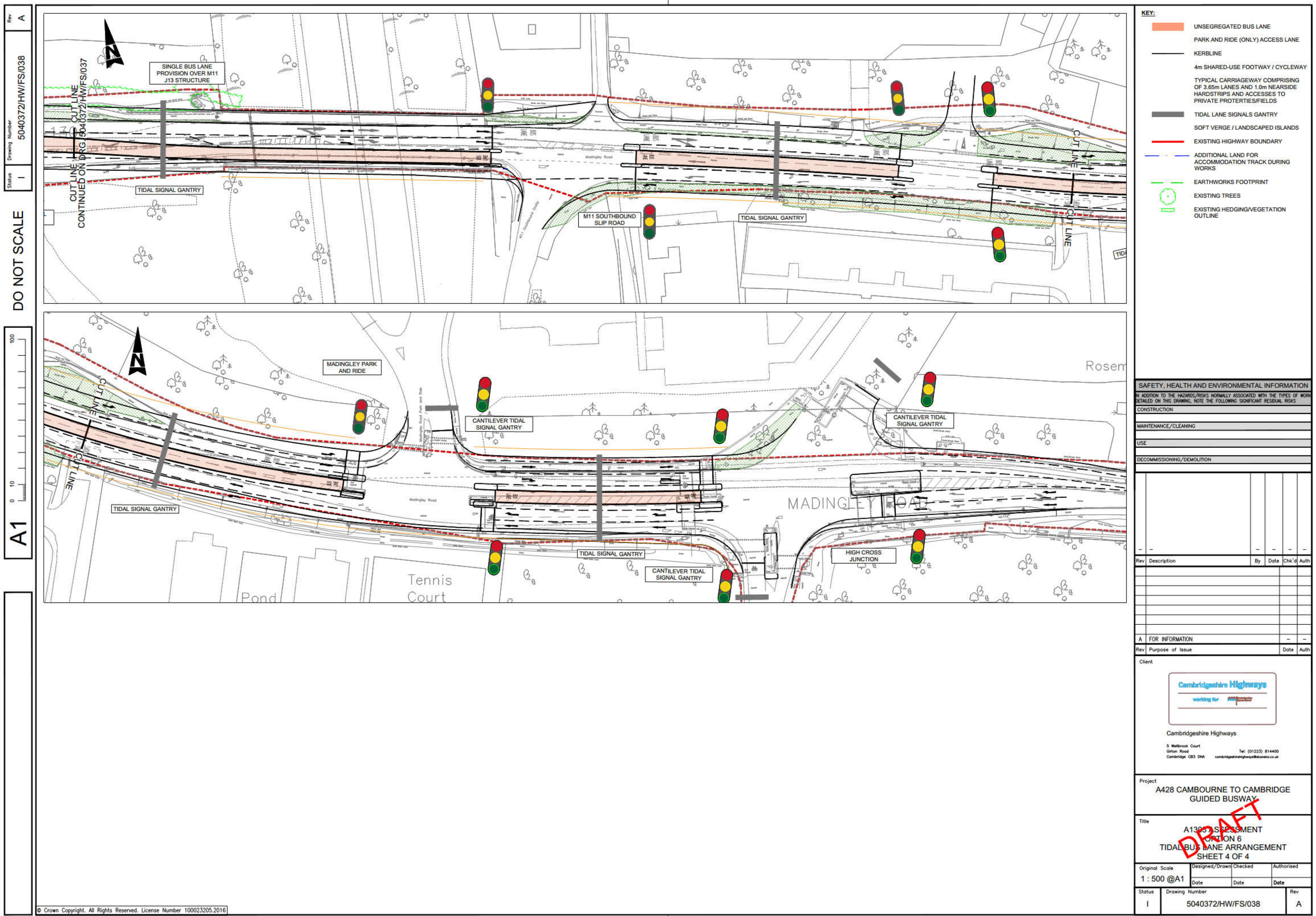
Drawing Number 5040372/HW/FS/037
Rev A



SINGLE BUS LANE PROVISION OVER M11 J13 STRUCTURE
TIDAL SIGNAL GANTRY
CUT LINE
CUT LINE CONTINUED ON DRG 5040372/HW/FS/037
M11 SOUTHBOUND SLIP ROAD
MADINGLEY PARK AND RIDE
CANTILEVER TIDAL SIGNAL GANTRY
HIGH CROSS JUNCTION
MADINGLEY ROAD
Tennis Court
Pond
DO NOT SCALE
A1
KEY:
UNSEGREGATED BUS LANE
PARK AND RIDE (ONLY) ACCESS LANE
KERBLINE
4m SHARED-USE FOOTWAY / CYCLEWAY
TYPICAL CARRIAGEWAY COMPRISING OF 3.65m LANES AND 1.0m NEARSIDE HARDSTRIPS AND ACCESSES TO PRIVATE PROTERTIES/FIELDS
TIDAL LANE SIGNALS GANTRY
SOFT VERGE / LANDSCAPED ISLANDS
EXISTING HIGHWAY BOUNDARY
ADDITIONAL LAND FOR ACCOMMODATION TRACK DURING WORKS
EARTHWORKS FOOTPRINT
EXISTING TREES
EXISTING HEDGING/VEGETATION OUTLINE
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
CONSTRUCTION
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Title
A1303 ASSESSMENT OPTION 6 TIDAL BUS LANE ARRANGEMENT SHEET 4 OF 4
DRAFT
Original Scale 1 : 500 @A1
Status I
Drawing Number 5040372/HW/FS/038
Rev A
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