RIS 2 Stage 0

Arup, AECOM, Systra & Amey

A46 – M5 Junction 9 to Teddington Hands Roundabout (Ashchurch Bypass)

Option Assessment Report

September 2018

Notice

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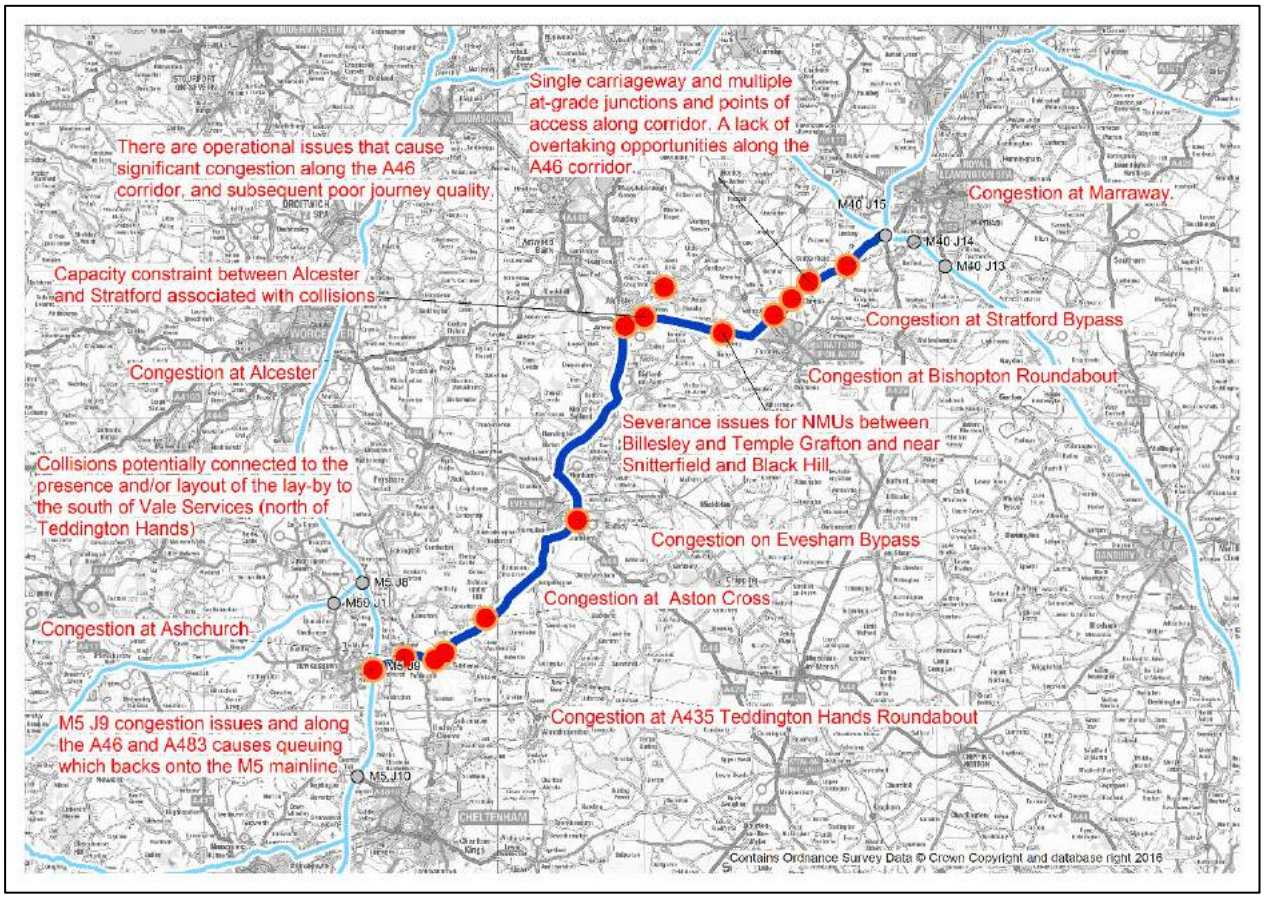
1 Introduction

A number of Route Strategies were undertaken to provide an analysis of the performance of the Strategic Road Network (SRN). One of these Route Strategies covered the South Midlands and identified key issues in the region, including on the A46. Following this, an Option Assessment Report (OAR) was produced which focused on the key issues and potential solutions on the A46 corridor from M5 Junction 9 to M40 Junction 15 (a distance of 34 miles).

Figure 1 shows the Route OAR study area and how it connects into the wider Strategic Road Network (SRN).

Figure 1: Route OAR Scope



The A46 is an important strategic link, connecting the M5 at Junction 9 to the M6 at Junction 2, north-east of Coventry. Crossing the counties of Gloucestershire, Worcestershire and Warwickshire, the route is an alternative to the Birmingham Motorway Box (M5/M42/M6), especially as a diversion route during incidents. The A46 travels east-west through the town of Ashchurch and also forms bypasses of the towns of Evesham and Stratford-upon-Avon. The A46 is a combination of single and dual carriageways.

The OAR identified the need for a scheme on the A46 through Ashchurch, between M5 Junction 9 and the Teddington Hands roundabout, to address existing network performance, strategic and local network congestion and safety concerns. This report will look specifically at this 3-mile section of the A46.

This section of the A46 has remained largely unchanged since 1995, but has been the subject of several previous studies to identify potential improvement options. These include offline alignments and improvements to Junction 9.

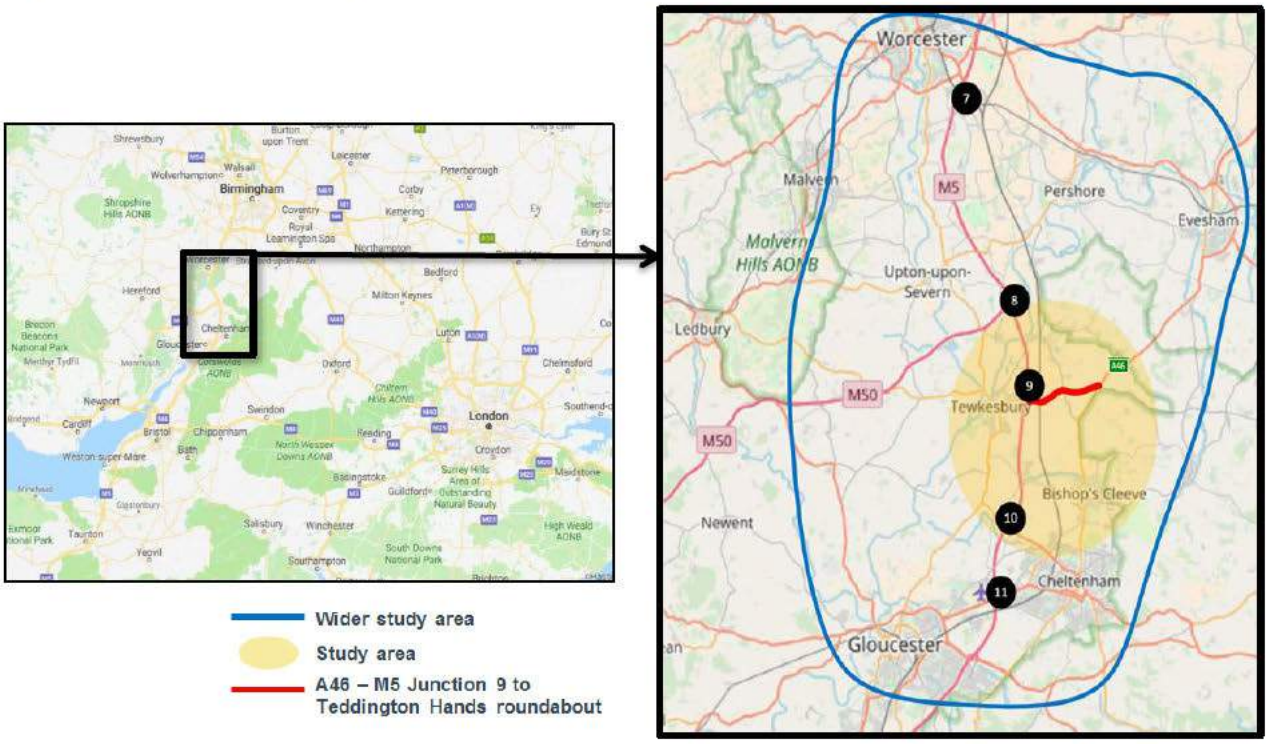
AECOM was commissioned to assess this study area further in accordance with Highways England's Project Control Framework (PCF) Stage 0 and the requirements of the WebTAG Transport Appraisal Process. This involved identifying and understanding the root cause of the existing problems around M5 Junction 9 and the A46, including: existing network performance, safety concerns and severance issues due to the current congestion. Options were developed to address the identified problems. The viability of the options was assessed from environmental, traffic, economic and engineering perspectives.

Traffic, economic and environmental assessment was undertaken for each of the options, which will ultimately be used to inform the business case and the identification of potential future schemes to take forward into the Road Investment Strategy (RIS) programme 2.

2 Geographic Area of Impact

The A46 scheme is located to the east of the M5 at Junction 9. Tewkesbury lies to the west of the motorway. Junction 9 is located approximately 13 miles to the south of Worcester and 10 miles to the north of Gloucester. The location of the study area is shown in Figure 2, with the 3-mile section through Ashchurch indicated by the thick red line.

Figure 2: Location and study area of scheme



The proposed scheme aims to encourage economic growth within the area and the wider A46 corridor. It also aims to make the network safer, support the smooth flow of traffic in the wider area by improving the flow of traffic on the A46, enable reliable journey times, make the route more resilient, and improve integration for NMUs within Ashchurch.

It should be noted that there is one other scheme being assessed as part of RIS2 which could impact on the study area. The scheme involves assessing the feasibility of upgrading M5 Junction 10 to an all movements junction to support planned development in the region, including the nationally-significant Cyber Business Park. One of the options proposed for the A46 Ashchurch scheme involves connecting to a redesigned M5 Junction 10.

3 Understanding the Current Situation

3.1 Transport Policy and Planning Guidance

In accordance with the WebTAG Transport Appraisal Process, it is important first to understand the current situation to inform the development of the scheme objectives and ultimately the generation of options. Therefore, the existing scheme has been considered in the context of relevant national, regional and local transport policy and planning guidance as set out below.

3.2 Transport Investment Strategies

The Transport Investment Strategies (TIS) set out four main objectives which Department for Transport (DfT) investment decisions should focus on. These are outlined below.

- **Create a transport network that works for users, wherever they live**. We know that transport users – people and businesses - want a network that is reliable, well-managed, and safe. Journeys that are easy, fast, and comfortable, with the right connections in the right places. Our intensively-used networks are ageing and face increased demand. People's work and leisure patterns - and therefore their travel behaviour are evolving;
- **Improve productivity and rebalance growth across the UK**. Reducing congestion and strengthening connectivity are both crucial for boosting our economy, through increasing local productivity and creating places in which people want to live and work. Our national productivity lags behind other countries and prosperity differs across the country;
- **Enhance our global competitiveness by making Britain a more attractive place to invest**. The transport sector makes trade possible. Investors need effective international connections to access new markets, integrate operations into their global supply chains and to conduct business efficiently. The UK is already well placed to meet these needs, but we are in constant competition with other countries to attract global business; and
- **Support the creation of new housing**. The housing market in the UK is not delivering the homes that people need. The Government's Housing White Paper set out a range of proposals to boost housing supply and create a more efficient housing market and transport investment should support this.

3.3 Road Investment Strategy

The Government developed the RIS which sets out a long-term programme of improvements to the SRN with funding allocated accordingly. The RIS comprises:

- A long-term vision for the SRN, outlining how DfT and Highways England will create smooth, smart and sustainable roads;
- A multi-year investment plan that will be used to improve the network and create better roads for users; and
- High level objectives for RIS1 (2015/16 to 2019/20).

This scheme is one of a number of potential priority schemes, arising from the Route Strategies, to be considered for investment within the Government's RIS2 covering 2020/21 to 2025/26.

The A46 Ashchurch scheme will build on the learnings from the successful delivery of RIS1 projects to ensure that DfT and Highways England requirements are met.

3.4 Highways England Strategic Business Plan

Highways England produced the *Strategic Business Plan* which describes how it will deliver the investment plan and achieve the Performance Specification to meet the requirements of the RIS.

The Performance Specification outlines the following eight areas that will be Highways England's focus:

- Making the network safer;
- Improving user satisfaction;
- Supporting the smooth flow of traffic;

- Encouraging economic growth;
- Delivering better environmental outcomes;
- Helping cyclists, walkers, and other vulnerable users of the network;
- Achieving real efficiency; and
- Keeping the network in good condition.

This scheme is being considered for inclusion within the RIS2 period, subject to developing a successful business case in comparison to those for other schemes and the available budget for the RIS2 period as a whole.

The A46 Ashchurch scheme will:

- ***Make the network safer and improve flow by providing additional capacity, shifting traffic off local and residential roads to prevent rat-running, and delivering a dedicated access route for through-traffic from A46 to M5;***
- ***Encourage economic growth by providing appropriate infrastructure to support the planned development in the study area; and***
- ***Achieve efficiency and improve resilience of the A46 as an alternative to the Motorway Box (M5/M42/M6), especially during incidents.***

3.5 National Infrastructure Plan (NIP) 2014

The NIP sets out an ambitious infrastructure vision for the next Parliament and beyond, reinforcing the Government's commitment to investing in infrastructure and improving its quality and performance. Within the NIP for roads the following objectives and needs are identified:

Objectives

The Government's aim is to create a national road network fit for the 21st century, which improves economic productivity and supports jobs and growth across the country. The national road network seeks to increase capacity, tackle congestion, support development, strengthen connectivity, improve reliability and resilience and ensure a road network of the best possible quality.

Needs

The road network is vital to the economic sustainability of the UK. Well-connected road infrastructure enables people to travel for work and leisure and businesses to move goods. Over 65% of freight movements and 90% of passenger miles are made by road. The long-term trend shows growing road traffic with vehicle miles travelled has increased 15% annually from 29 billion in 1949, to 324 billion vehicle miles in 2016.

Demand for travel on the SRN will increase with the expected rise in GDP and population. DfT estimates traffic flows in England in 2040 will be 27% to 57% higher than at 2013 levels. This increase is based on a range of forecasts of economic growth, motoring costs and the trend in individual travel behaviour. Such demand growth, unaccompanied by the required level of investment or appropriate policies to encourage mode shift, is likely to have a significant impact on levels of congestion.

The SRN is a crucial element of our road infrastructure. In 2016, it accounted for 1.8% of the total road network in England, but carried 28% of all motor vehicle traffic and 59% of all HGV traffic.

Delivering the scheme would align with the NIP by increasing capacity on the SRN, seeking to reduce congestion, and improving reliability and resilience, encouraging economic growth in the local area.

3.6 Proposals for the Creation of a Major Road Network Consultation

As part of the TIS, the Government committed to creating a Major Road Network (MRN) across England. This consultation outlines the Government's proposals for this network and seeks views on its core principles, the definition of the network, investment planning, and eligibility and investment assessment.

In creating this network, the Government has five central policy objectives. These are:

- Reduce congestion – alleviate local and regional congestion, reduce traffic jams and bottlenecks;
- Support economic growth and rebalancing – support the delivery of the Industrial Strategy, contribute to a positive economic impact that is felt across the regions;
- Support housing delivery – unlock land for new housing developments;
- Support all road users – recognise the needs of all users, including cyclists, pedestrians and disabled people; and
- Support the SRN – complement and support the existing SRN by creating a more resilient road network in England.

Consideration has been given to how the options explored within the A46 Ashchurch study sit alongside the proposed MRN in the immediate vicinity.

As the A46 currently forms part of the SRN, any upgrade to the road will support the policy objectives of the MRN.

3.7 Local Transport Policy

The proposed scheme has been considered against the following local transport policies:

South Midlands Route Strategy

The South Midlands Route Strategy forms an important part of the evidence base for RIS2 and provides a high level view of the current performance of the Highways England road network. The Strategy highlights congestion on the A46 between M5 Junction 9 and M6 Junction 2 which could constrain economic growth and lead to an increase in incidents.

The A46 scheme would seek to address these issues between M5 Junction 9 and Teddington Hands roundabout.

Midlands Connect

Midlands Connect, a pan-Midlands partnership of local transport authorities, local enterprise partnerships and local business representatives working in collaboration with DfT have developed a transport strategy that identifies the major infrastructure projects needed to improve the connectivity of our region's key locations so we can help drive economic growth and power the Midlands Engine.

The A46 is a critical route through the Midlands, particularly in the movement of local and regional traffic. In addition, the A46 is critical in the resilience of the Birmingham Motorway Box (M5/M42/M6), especially during incidents.

Gloucestershire Local Enterprise Partnership (LEP) Strategic Economic Plan (SEP) for Growing Gloucestershire

The Plan aims to accelerate economic growth and address the particular challenges faced in Gloucestershire. One of the primary goals for the Plan is to deliver employment land in proximity to the M5, in particular at Junctions 9 and 10. The LEP supports the proposed developments on the A46, adjacent to the M5 at Junction 9, which is stated to create 3,300 jobs. The document states that the LEP will work with local authorities and Highways England on a long-term transport solution for congestion on the A46.

The A46 scheme will aim to ease congestion on the stretch, which will enable growth and support future employment growth in the area.

LEP Strategic Business / Economic Plan – Joint Core Strategy (JCS)

The JCS is a partnership between Gloucester City Council, Cheltenham Borough Council and Tewkesbury Borough Council.

The JCS was formed to produce a co-ordinated strategic development plan to show how this area will develop during the period up to 2031 and is steered by officers and elected members from each of the three local authorities. The JCS was signed off by the inspector on 27 October 2017, and adopted by the relevant authorities on 11 December 2017.

The A46 Ashchurch scheme will aim to meet the policies and guidance of the JCS by:

- ***Maintaining the efficiency and safety of the existing highway network; and***
- ***Mitigating environmental impacts.***

Gloucestershire Local Transport Plan (LTP) 2015 – 2031

The LTP sets the long term strategy for transport delivery within Gloucestershire from 2015 – 2031. The Plan sets out key policies and priority highway schemes that form the basis for decisions on transport investment in the future. The Plan aims to:

- Support sustainable economic growth;
- Enable community connectivity;
- Conserve the environment; and
- Improve community health and wellbeing.

The upgrade of the A46 between M5 Junction 9 and Teddington Hands roundabout will support the Plan's 'Highways' Policy Document priorities of maintaining a functioning highway network and attracting future investment for highway schemes.

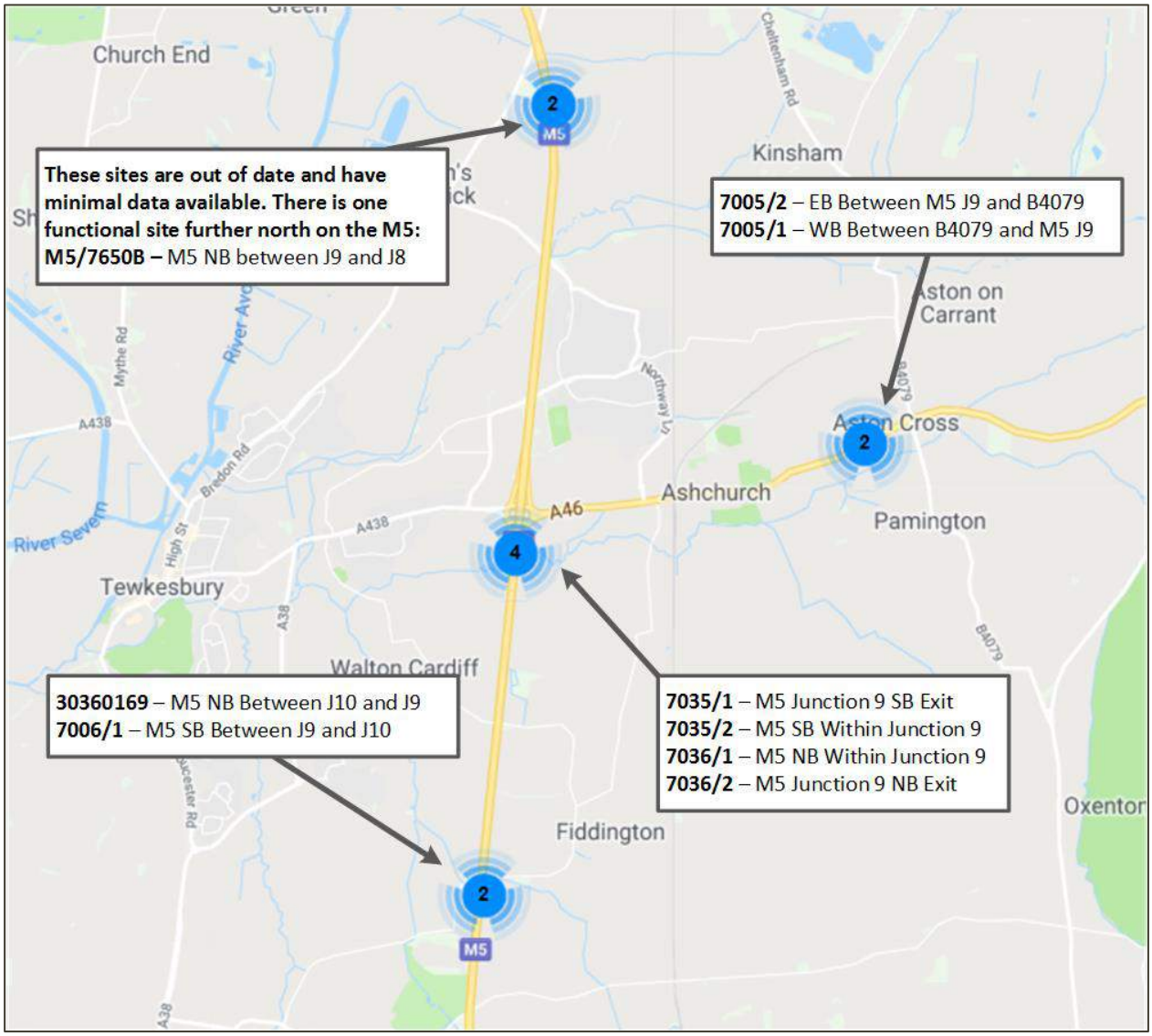
4 Traffic Flows

This section discusses travel demand in terms of the number of trips currently using the route, and the levels of service experienced.

4.1 WebTRIS Data

Traffic flow data has been obtained from the Highways England WebTRIS database, and used to understand traffic flows on the existing network, helping to establish the need for intervention. Both A46 eastbound and westbound data for 2017 was collected, where available. Data was also collected for the M5 between Junction 8 and Junction 10, where available. Additional data was obtained from the DfT, for various sites in the vicinity, to provide an indication of traffic volumes over time. The sites are shown on Figure 3.

Figure 3: Map of WebTRIS sites within the Study Area



4.2 Traffic Flow Variation

Data for the A46 in both the eastbound and westbound directions has been obtained from WebTRIS and analysed to provide an understanding of the daily flow profile along the route.

Daily Profile

Figure 4 shows average October 2017 weekday flows by hour.

Figure 4: A46 Daily Flow Profile

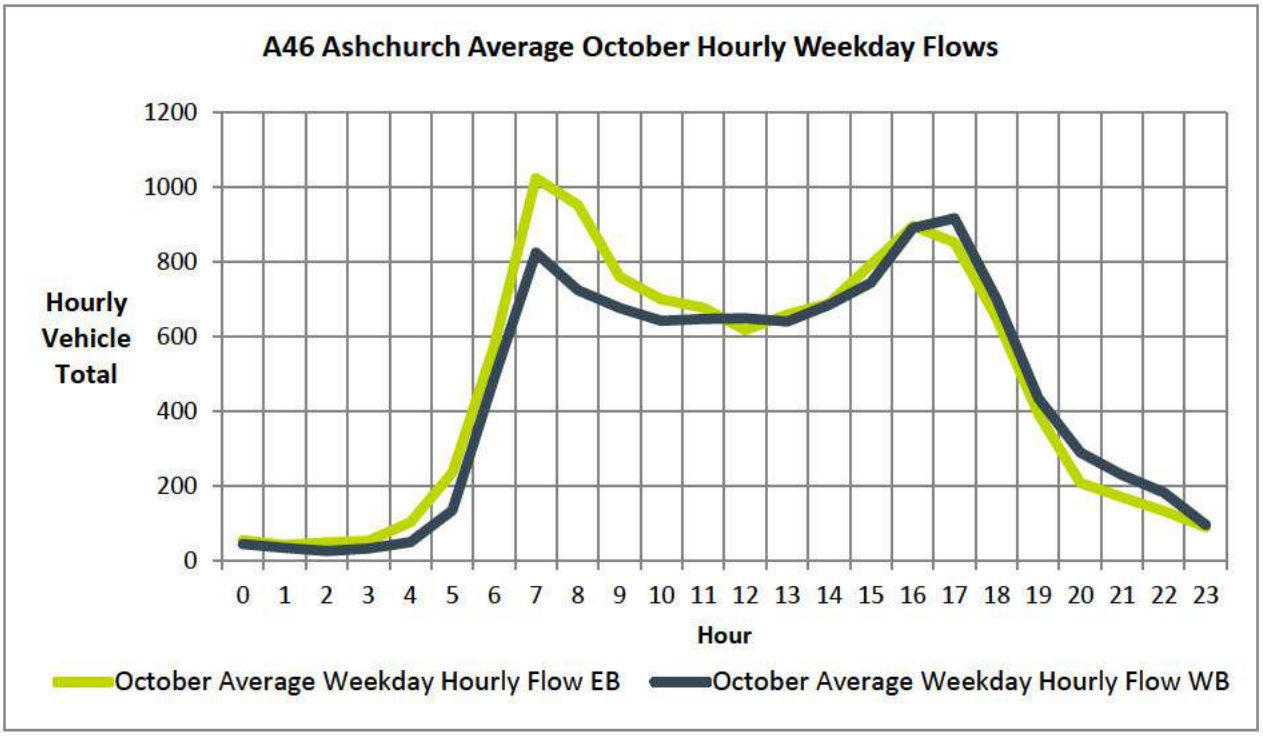


Figure 4 shows that the A46 follows a typical pattern, with a clear morning peak at approximately 07:00, an evening peak at approximately 16:00, and an inter-peak period of lower flows. This pattern reflects the commuting movements to and from Ashchurch. The higher eastbound peak during the AM period reflects traffic re-routing onto the A435 and the B4079 to access Cheltenham and M5 Junction 10. This is likely due to trying to avoid the congestion that is present on the southbound off-slip of M5 Junction 10 during the AM peak.

Figure 5 and Figure 6 show that there is a clear AM commuting peak between 7:00 and 8:00, with a wider peak between 16:00 and 18:00 for the PM peak period. Looking at the October weekday daily flow profiles for the M5 in the southbound and northbound directions respectively, flows are relatively lower during the interpeak period between these times.

Flows are higher during the AM peak, reflecting that the majority of travel to work trips are made from Ashchurch and Tewkesbury towards Gloucester and Cheltenham. This is also reflected in Figure 6, which shows that flows travelling northbound on the M5 between Junction 10 and Junction 9 are higher during the PM peak period. This accounts for the opposite trips travelling from work to home.

Figure 5: M5 Southbound Daily Flow Profile (October Weekday)[1]

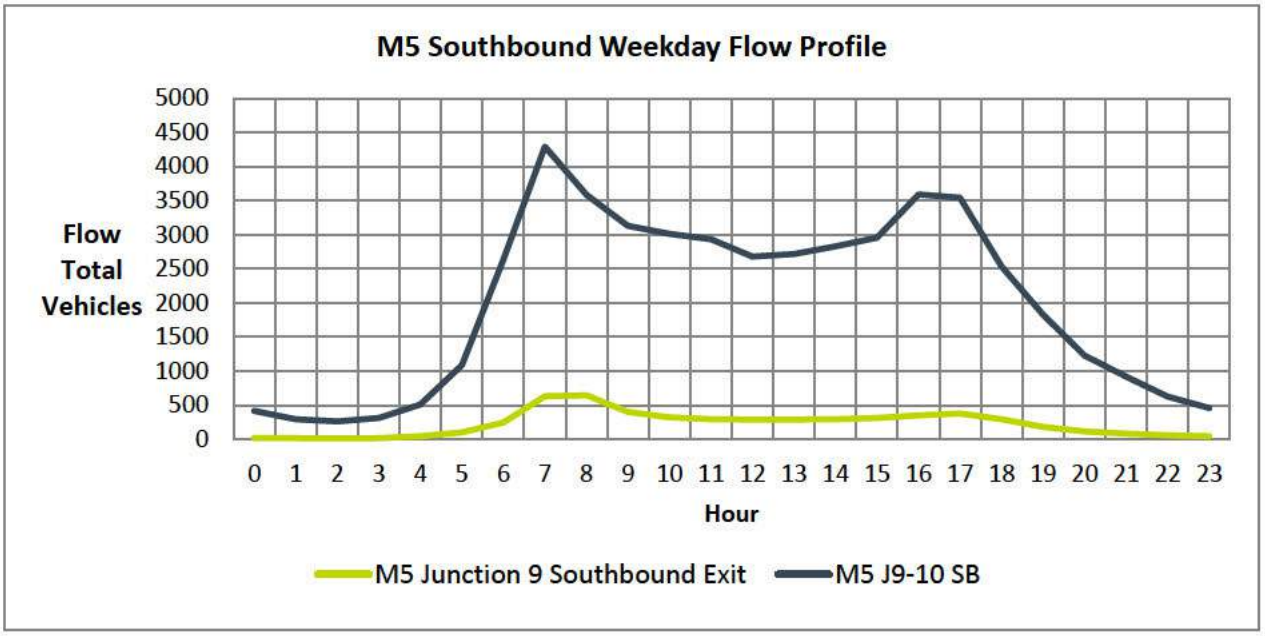
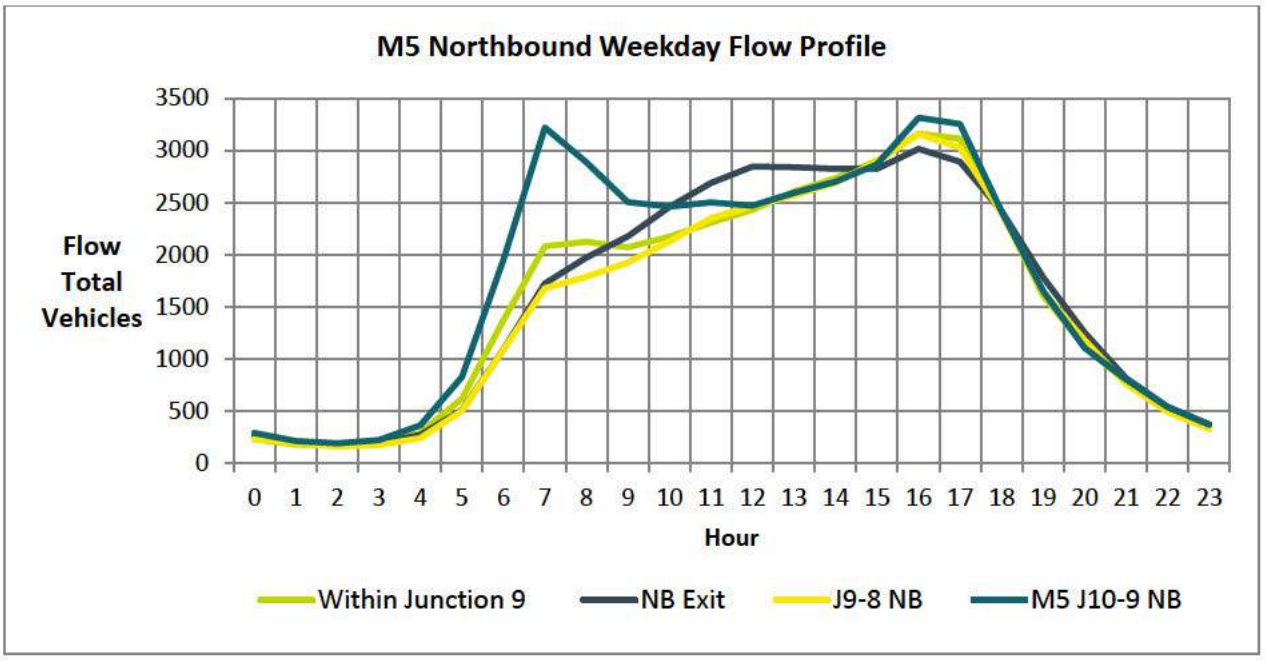


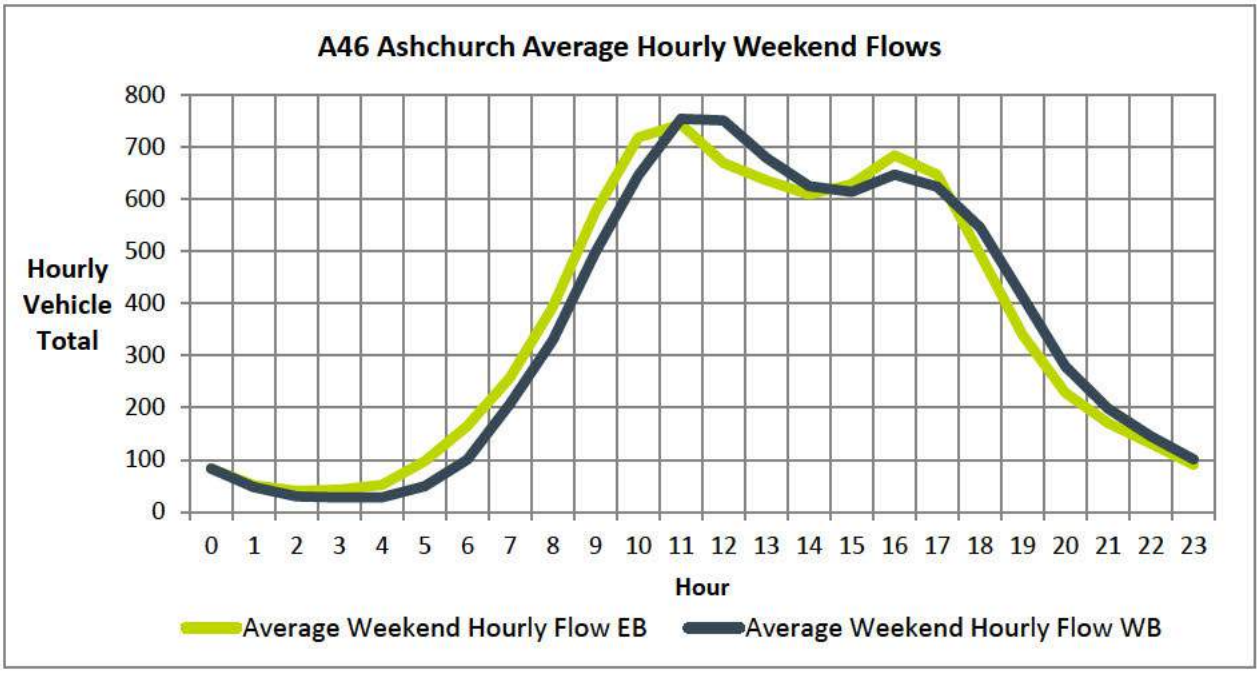
Figure 6: M5 Northbound Daily Flow Profile (October Weekday)



The A46 weekend flow profile is shown in Figure 7. Figure 7 shows a later peak time than during the week, in line with typical patterns. There is a steady rise in traffic flows, peaking at approximately 11:00, with a short period of slightly lower flows. There is a brief second peak before traffic levels decline to low overnight levels. Overall, flows are lower on the weekend than on weekdays in the area.

[1] Southbound flows within Junction 9 and between Junction 8 and 9 are unavailable.

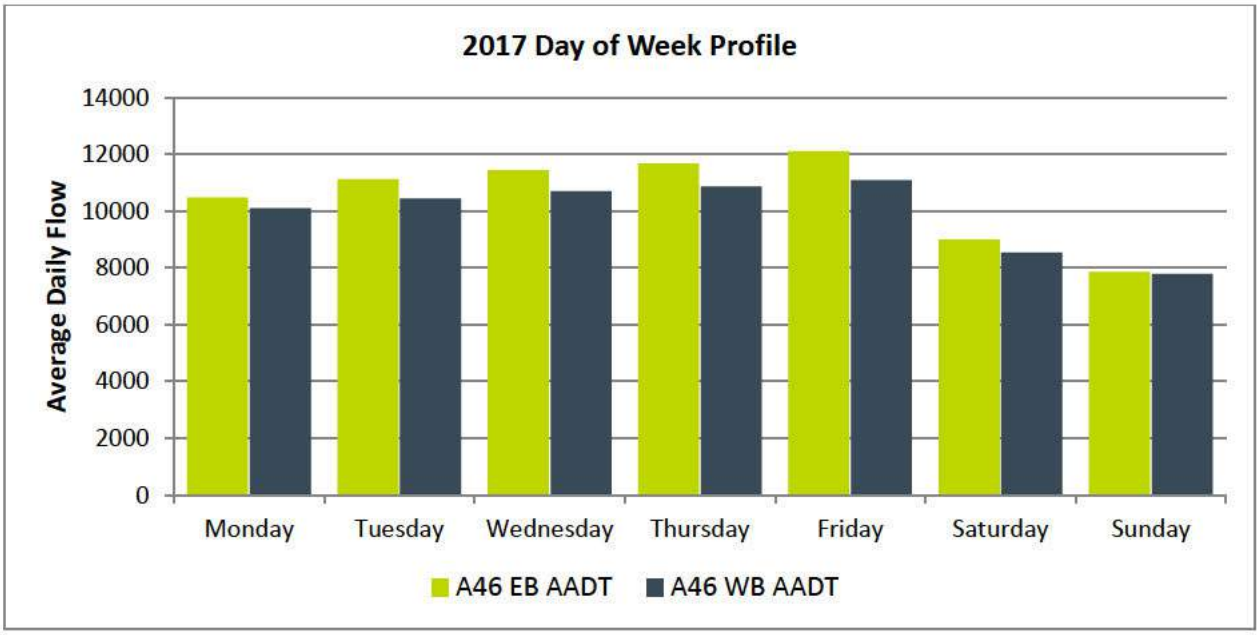
Figure 7: Daily Flow Profile – weekend



Weekday Flow Variation

Figure 8 shows the day of week flow profile for the A46 between Junction 9 and Aston Cross in both directions. Friday is recorded as having both the highest eastbound and westbound movements of the week.

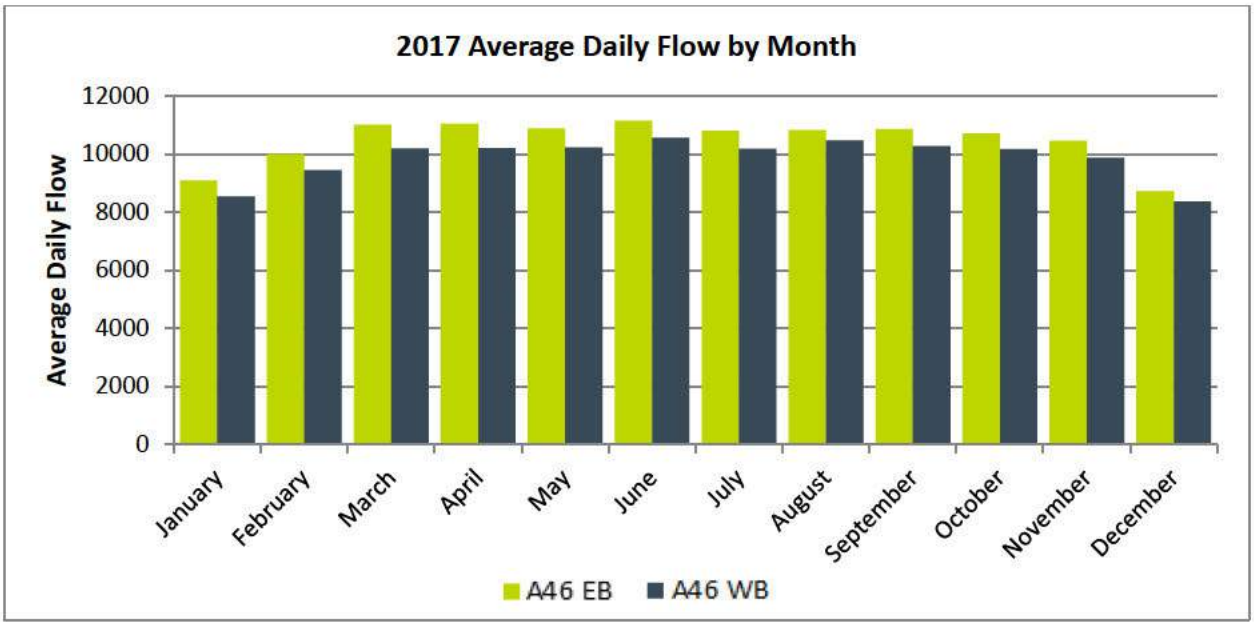
Figure 8: Day of week profile for the A46



Monthly Traffic Flows

The average A46 traffic flows by each month is presented in Figure 9. It should be noted that this data includes all the days in the month with complete flows.

Figure 9: Monthly A46 Traffic Flows



The graph shows that traffic volumes are relatively similar over the course of the year, with little evidence of seasonal variation. Traffic levels remain around 9,000 to 11,000. However, data for several of the winter months is missing, which may provide more insight into this. Traffic levels appear to decline slightly towards the end of the year, which is in line with typical patterns. Flows are slightly higher in the eastbound direction, although traffic for both directions follows a similar pattern. June has slightly higher flows than the other months, and there is a decrease in flows on the A46 in July and August.

- Flows on the M5 are higher during the AM peak, reflecting that the majority of travel to work trips are made from Ashchurch and Tewkesbury towards Gloucester and Cheltenham.
- Flows on the A46 are slightly higher in the eastbound direction.
- The highest traffic flows on the A46 are in June, with a decrease in flows in July and August.

4.3 HGV Composition

The Department for Transport counts record the number of HGVs. The sites of these counts are shown in

Figure 10.

Figure 10: DfT Count Site Locations

HGV proportions fluctuate significantly on the M5 and the A46, however, in overall terms both show a decline in the HGV proportion on the route.

There are no suitable alternative routes for HGVs through Ashchurch, meaning long diversionary routes, which may reflect the declining HGV numbers.

When compared to other sections of the A46 between Tewkesbury and Evesham, the A46 between M5 Junction 9 and Teddington Hands roundabout, has a higher proportion of HGVs. In 2016, 10% of all vehicles travelling through Ashchurch were HGVs. This is greater than on the A46 east of Teddington Hands (8%), and the A438 west of M5 Junction 9 (4%).

Figure 11: Percentage HGVs on the M5

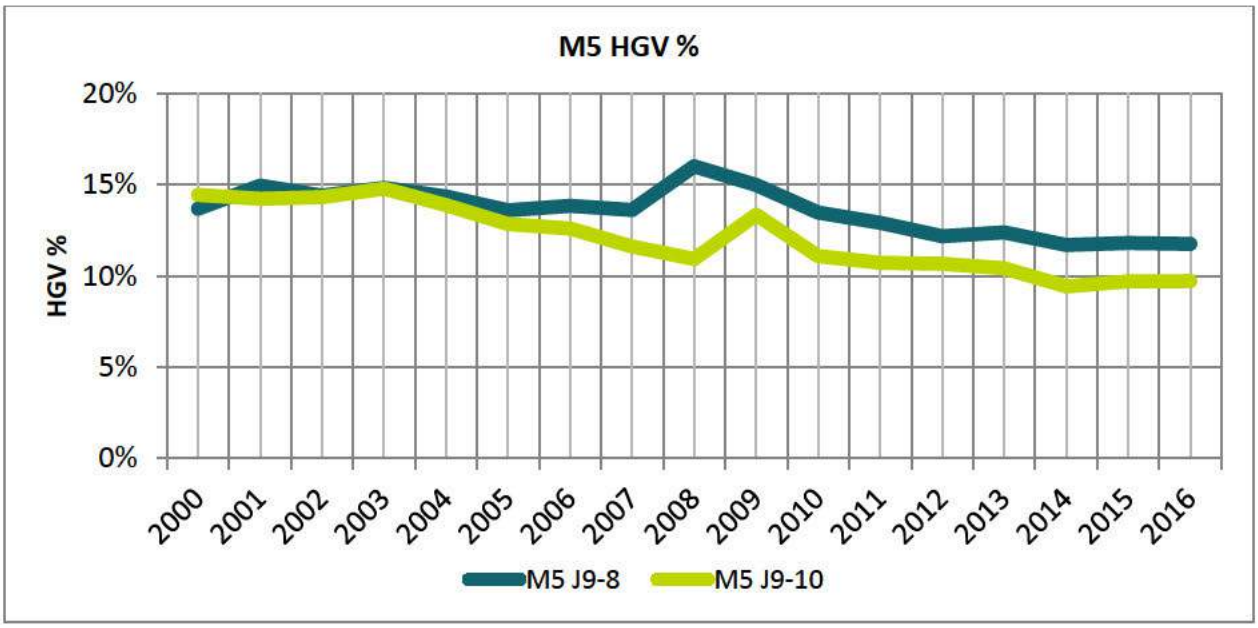
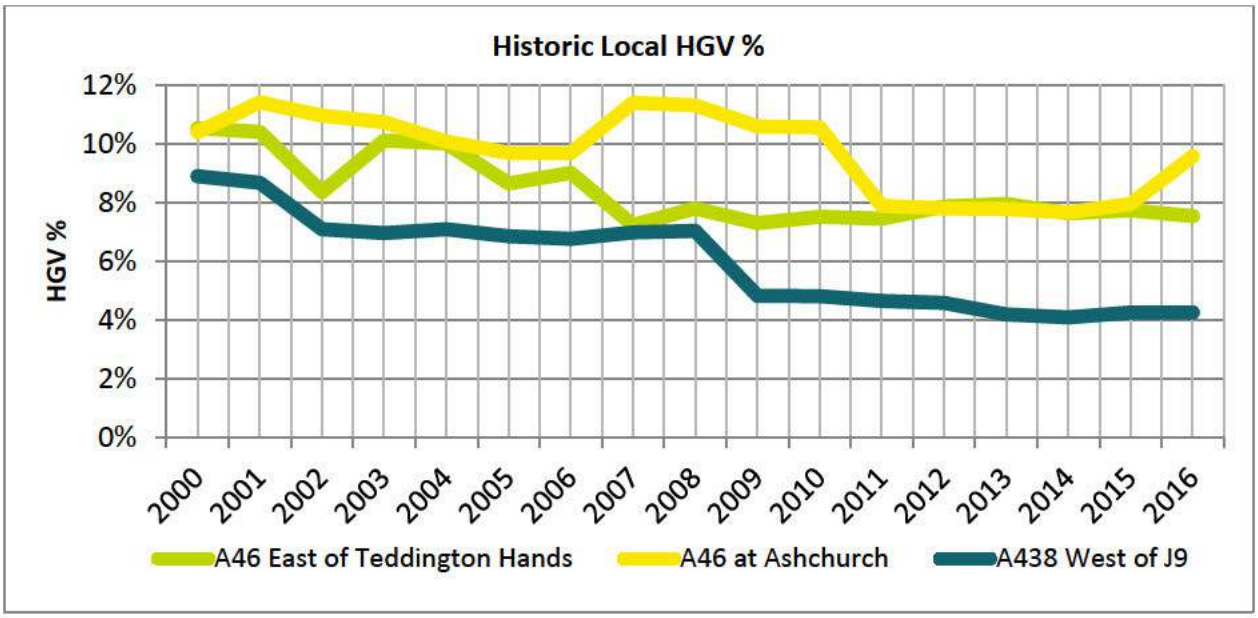


Figure 12: Percentage HGVs on the A46



- HGV proportions fluctuate significantly on the M5 and the A46 however overall both seem to show a decline in the HGV proportion on the route.
- In 2016, 10% of all vehicles travelling through Ashchurch were HGVs. This is greater than on the A46 east of Teddington Hands (8%), and the A438 west of M5 Junction 9 (4%).

4.4 Capacity

The capacity values for each link were based on a 7.3m wide carriageway for all 'blue dot' sites, using the values provided in the DMRB TA 79/99.

The link stress of a particular road is the ratio of the AADT to the Congestion Reference Flow (CRF). When this exceeds 1.0 and the AADT is higher than the CRF value, it indicates that the road link is likely to suffer from congestion during certain periods. In addition, stress level ratios between 0.85 and 1.0 could result in flow breakdown during peak periods.

Calculations for the A46 were calculated based on flows taken from WebTRIS sites 7005/1 and 7005/2, the locations of which are shown in Figure 3.

The stress factors for the A46 are shown in Table 1 below. These results show that the A46 is near capacity in both directions, and is likely to suffer congestion during certain periods.

Table 1: A46 between Junction 9 and Aston Cross stress factors

Stress Factor		
EB	WB	Both
0.94	0.89	0.91

4.5 Historic Traffic Growth

Data has been obtained from the DfT for three sites within the vicinity of the scheme. Figure 13 shows the AADT for the period from 2000 to 2016 on the A46 and A435. Figure 14 shows the AADT for the same period on the M5.

Figure 13: Change in A46 traffic over time

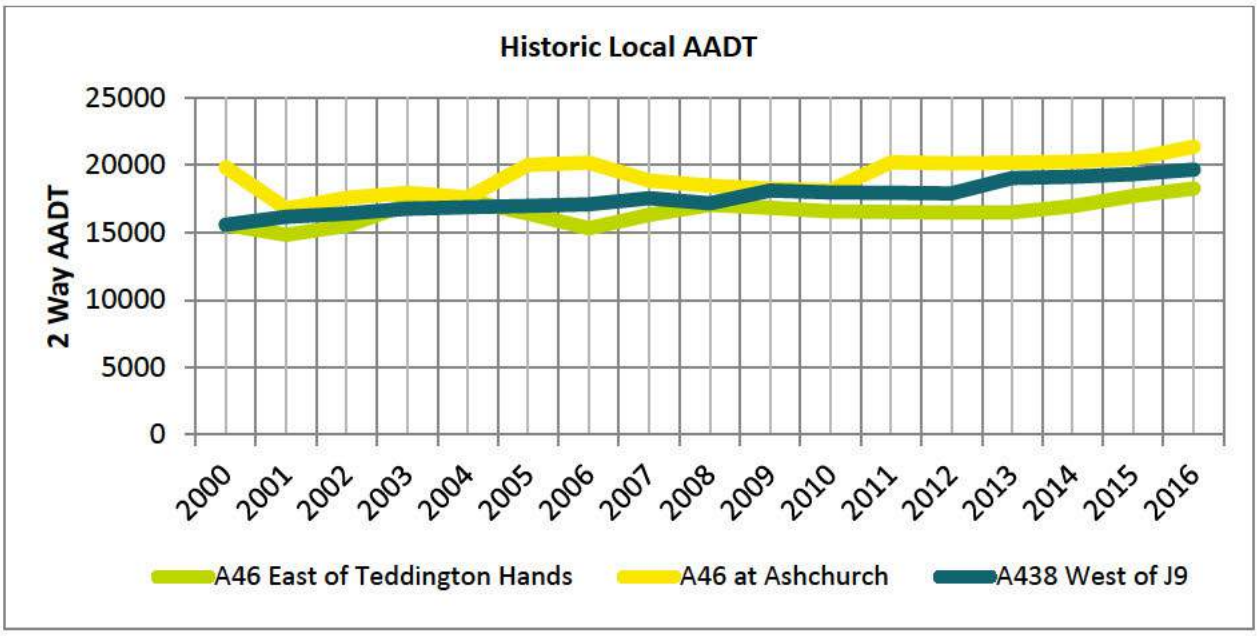
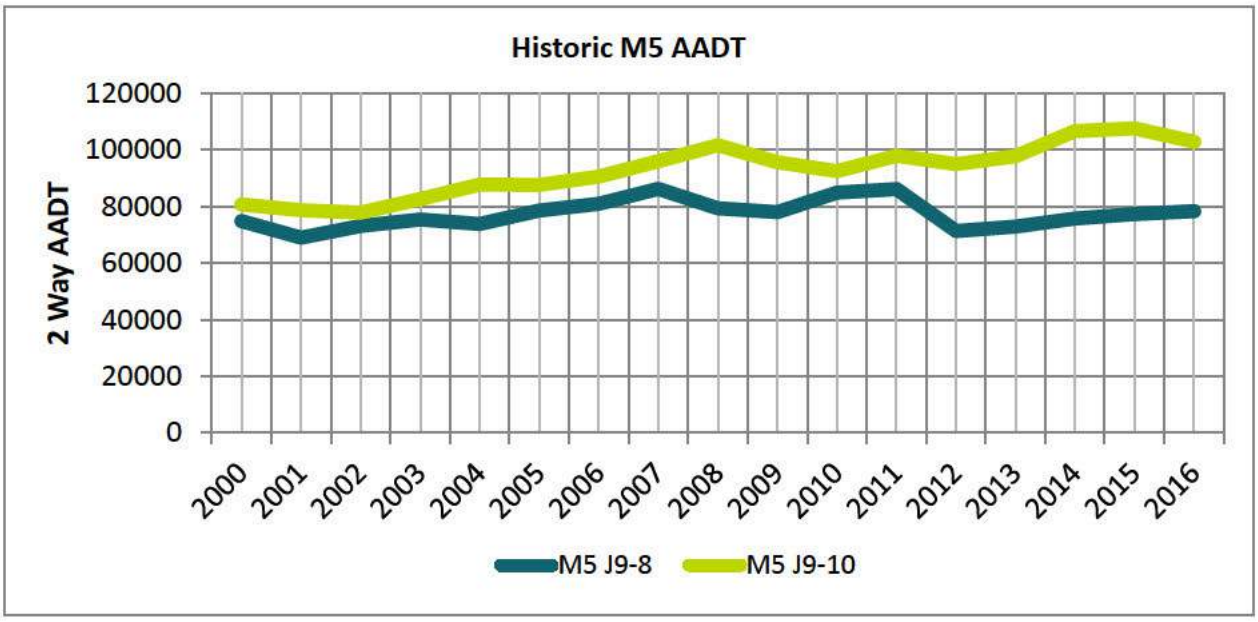


Figure 14: Change in M5 traffic over time



As shown in the graphs, traffic flows have remained relatively similar over time for both the M5 and the A46, with a small increase in more recent years. On a local level, traffic levels are higher through Ashchurch, with lower volumes of traffic recorded east of Teddington Hands and on the A438 west of M5 Junction 9. Interestingly however, there has been a more significant increase in traffic flows in both of those locations, more so than through Ashchurch. This could be due to new housing developments in Tewkesbury and Evesham.

- Two-way historic AADF for the A46 at Ashchurch shows an increase of approximately 2,000 vehicles between 2000 and 2016.
- Two-way historic AADF for the M5 shows the number of vehicles between M5 Junctions 8 and 9 from 2000 to 2016 is relatively constant; however between M5 Junctions 9 and 10 during the same time periods (both directions), there has been an increase of over 20,000 vehicles.

4.6 Journey Time Data

This section considers journey times on the A46 and M5 within the study area. Journey time data has been obtained from the DfT's TrafficMaster dataset. The dataset provides average journey time and speed data relating to links within the NTIS (National Traffic Information Service) Link Network.

Performance specification metrics were provided for the NTIS links within the study area. This information included:

- Profile Flow;
- Average Vehicle Miles;
- Average Delay (Seconds per vehicle per mile);
- Average Speed (Miles per hour); and
- Acceptable Journeys (%).

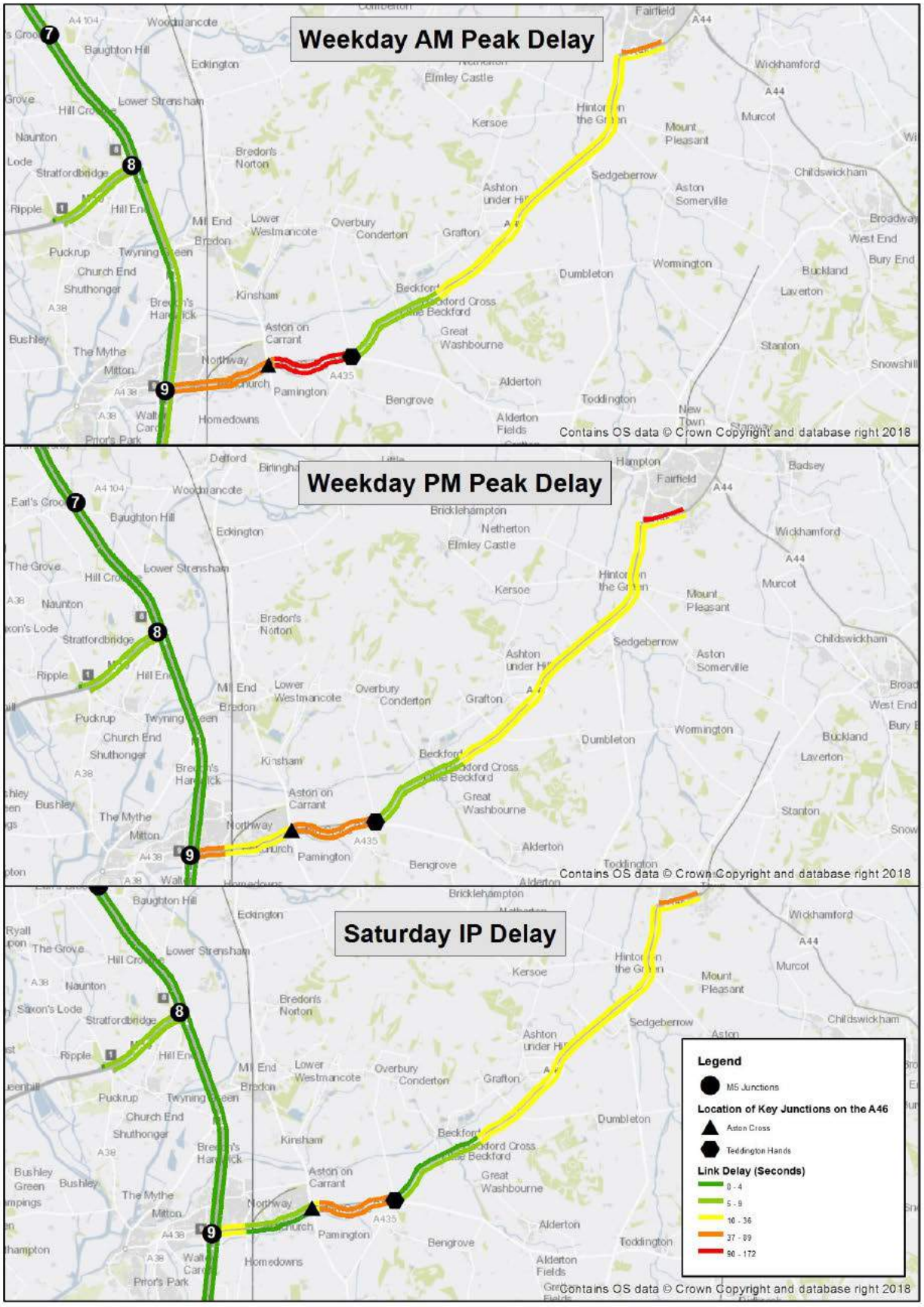
This data was provided as an average across three time periods for November 2017:

- AM Peak (7am to 9:59am);
- Inter-Peak (10am to 3:59pm); and
- PM Peak (4pm to 6:59pm).

This data was plotted for weekday AM and PM peak periods, and for a Saturday inter-peak period, as these are the time periods where maximum delay was experienced.

The results are shown on Figure 15.

Figure 15: Delay on the M5 and the A46 during Peak Periods



The results of this analysis show that there is delay of greater than 40 seconds experienced between Aston Cross and Teddington Hands roundabout, in both directions, during all the time periods studied. This delay is most severe during the AM peak period.

On weekdays there is also delay between Junction 9 and Aston Cross in both time periods; however this delay is minimal during the Saturday inter-peak period. This also reflects the results of the capacity calculation in Section 4.4 above, which showed that the A46 between M5 Junction 9 and Aston Cross is near capacity and is likely to experience congestion during peak periods.

There is also some delay experienced on the A46 between Beckford and Evesham (to the east of Ashchurch), however this delay is less than 36 seconds in all time periods analysed, and is less severe than the delay observed elsewhere on the A46.

According to Google Maps, the average journey time to travel the 3 miles from M5 Junction 9 to Teddington Hands roundabout is between 6 and 8 minutes. During AM and PM peak times on this section of the A46, there are significant delays experienced:

- 10-20 minute average journey time in AM peak – eastbound (worst delay between M5 Junction 9 and Aston Cross eastbound; worst delay between Teddington Hands and Aston Cross westbound);
- 10-24 minute average journey time in PM peak westbound (worst delay between Teddington Hands roundabout and Aston Cross); and
- 10-18 minute average journey time in PM peak eastbound (worst delay between Aston Cross and M5 Junction 9).

- According to Google Maps, the average journey time for the 3 miles from M5 Junction 9 to Teddington Hands roundabout is between 6 and 8 minutes. This can increase to a 24 minute journey during peak times due to congestion.
- Delay on the M5 was minimal during all time periods.

4.7 Accident Data

STATS19 Data

The record of accidents between 2012 and 2016 was obtained from STATS19 data on the DfT road safety website. STATS19 data is the only national source to provide detailed information on accident circumstances, vehicles involved and resulting casualty severity. The data is the most detailed and reliable single source on accidents in England, however it is important to note that it is not a complete record of all injury accidents and resulting casualties due to some accidents not being reported.

Table 2 shows the number of accidents on key routes in the vicinity of the A46 according to STATS19 data. The corresponding key routes are shown on Figure 16.

Table 2: STATS19 Data Summary

Year	Total Injury Accidents	Severity			Weather						Location									
		Fatal	Serious	Slight	Fine	Rain	Snow	Fine & High Wind	Rain & High Wind	Other	A38	A435	A438	A46	B4079	Gloucester Road	M5 J8/9	M5 J9/10	Northway Residential	Tewkesbury High Street
2012	38	4	4	30	31	6	0	0	1	0	0	7	5	5	1	4	4	6	4	2
2013	19	2	5	12	19	0	0	0	0	0	0	2	3	3	0	0	4	4	2	1
2014	16	2	1	13	10	2	0	0	4	0	2	1	1	1	1	1	1	5	3	0
2015	35	0	5	30	28	4	0	1	1	1	0	6	5	7	1	2	4	6	3	1
2016	42	2	12	28	36	6	0	0	0	0	1	2	4	8	1	2	5	13	2	4
Total	**150**	**10**	**27**	**113**	**124**	**18**	**0**	**1**	**6**	**1**	**3**	**18**	**18**	**24**	**4**	**9**	**18**	**34**	**14**	**8**

Figure 16: Accident Data Links

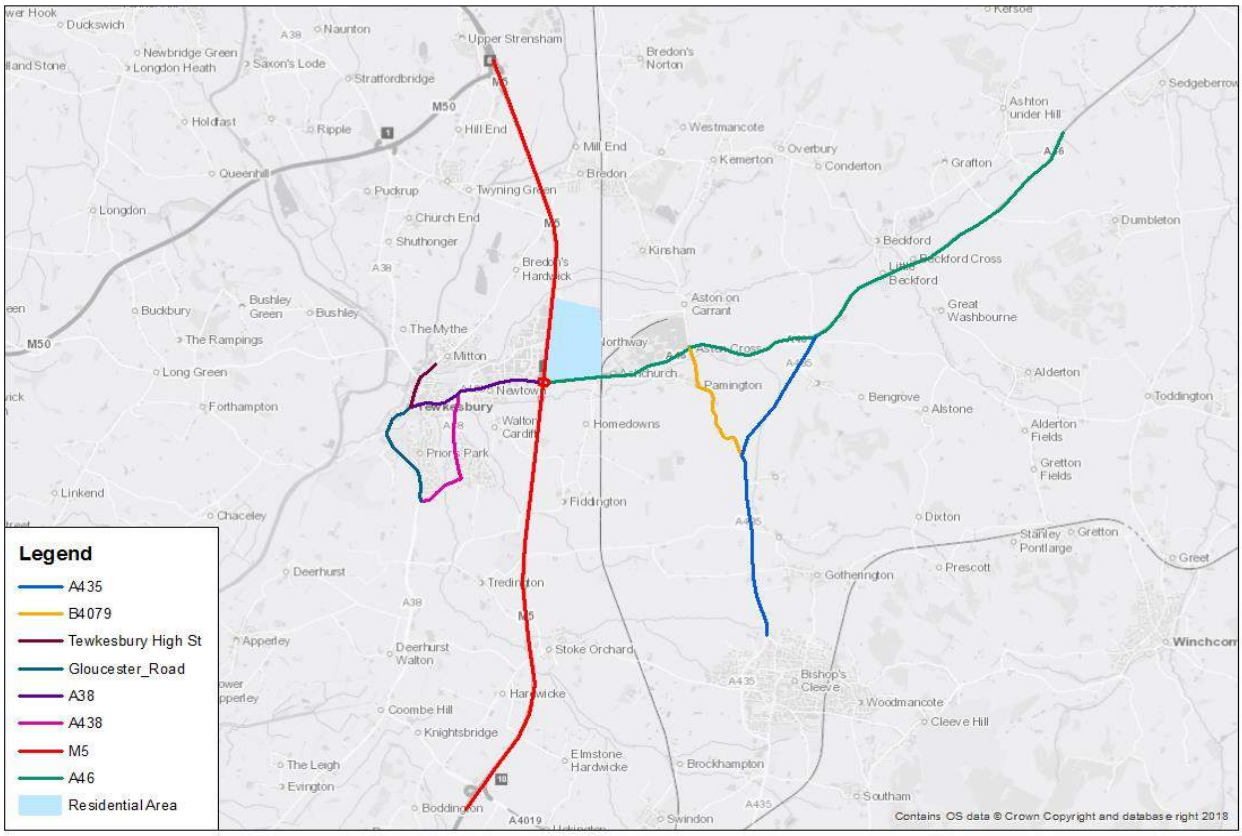


Table 2 shows that the majority of the accidents on the key routes (83%) occurred when the weather was fine. A small proportion occurred during rainy conditions (12%), and rain and high wind conditions (4%).

In total, there were 150 accidents recorded along the major roads in the vicinity of the A46 between 2012 and 2016. It is interesting to note that the A46 has the second highest number of accidents in the area.

Figure 17: Accidents on the A46 between 2012 and 2016

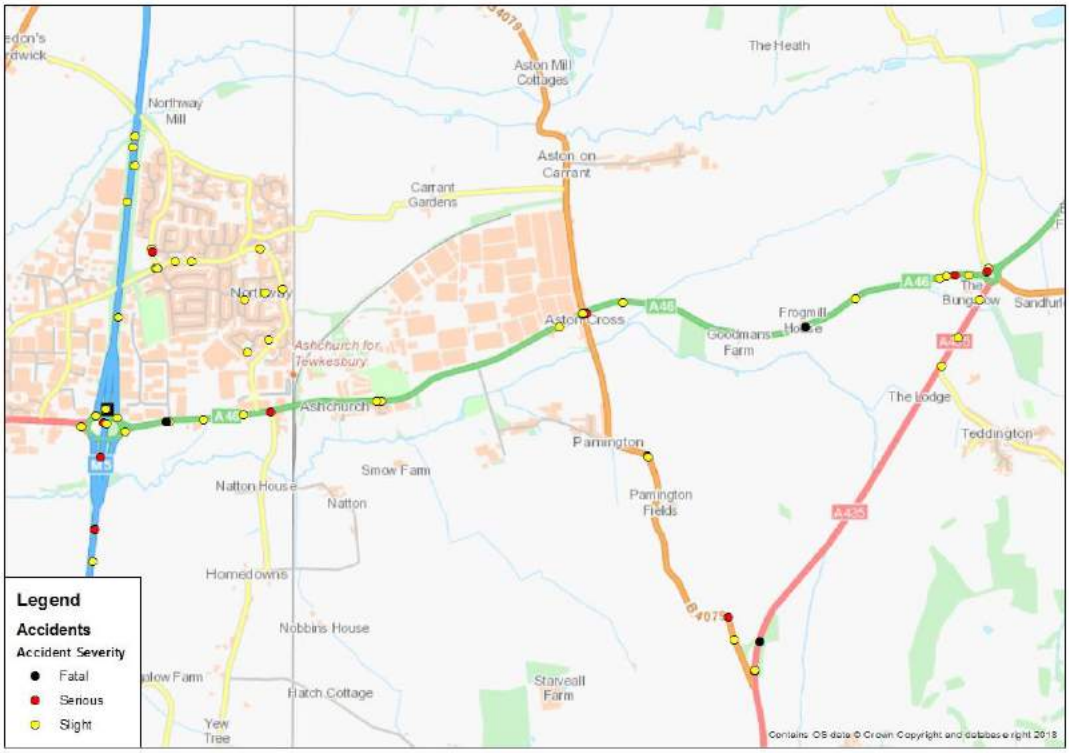


Figure 17 above shows that the majority of accidents on the A46 are focussed around the junctions on the route, particularly M5 Junction 9, Aston Cross and Teddington Hands roundabout. There are also a number of accidents on the A435, particularly around the junction with the B4079. It is also important to note the comparatively large number of accidents in the residential area of Northway, which is likely due to traffic 'rat running' through the area.

Figure 18: Accident Locations throughout the study area

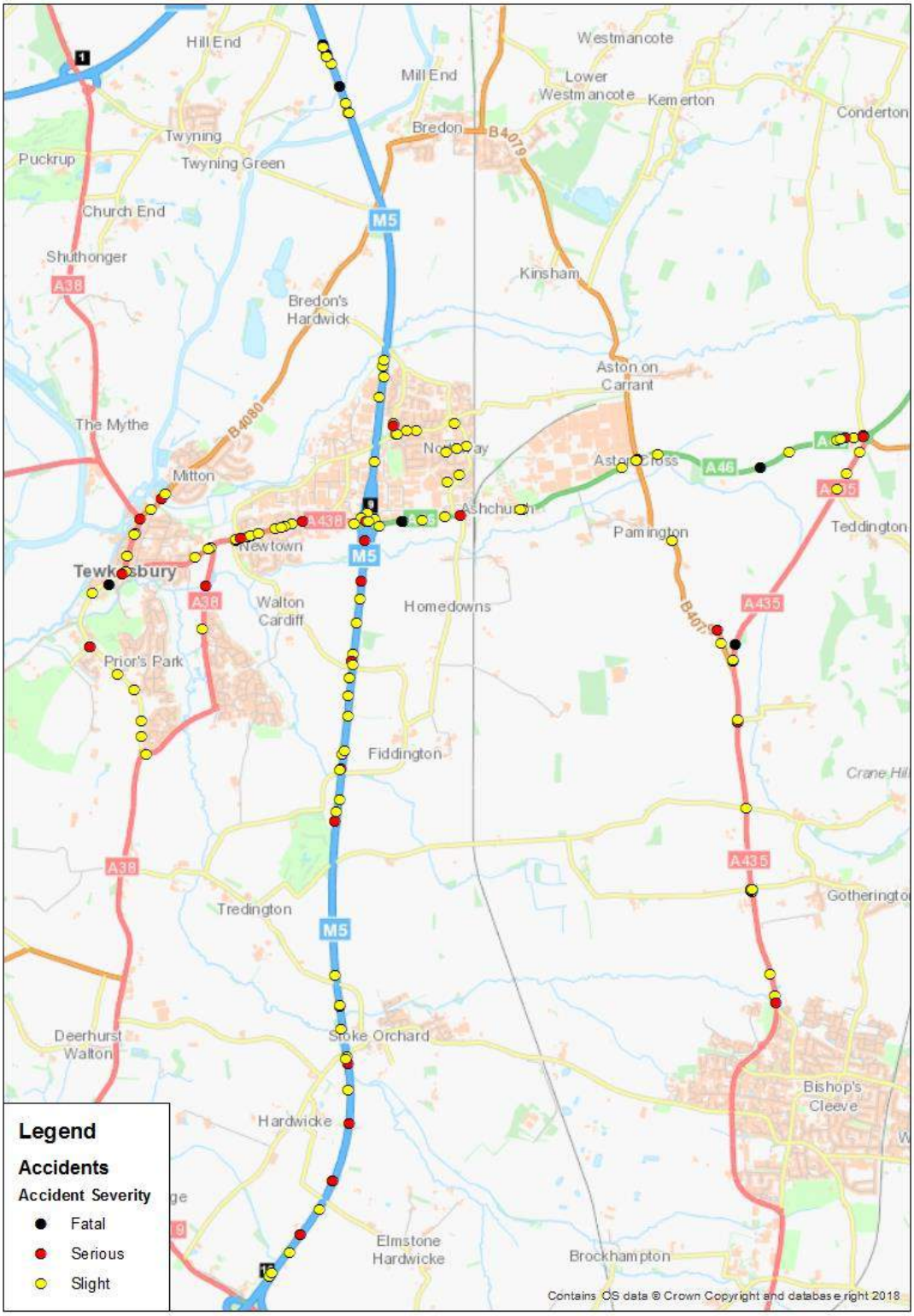


Figure 18 shows the accidents on key links in the wider study area, and shows a number of accidents on the M5. The large numbers of accidents on the A438 through Tewkesbury, Gloucester Road and on Tewkesbury High Street reflect the fact that these roads travel through built-up areas and are congested.

- There were 150 accidents recorded along the major roads in the vicinity of the A46 between 2012 and 2016.
- There are a large number of slight accidents at Northway, likely due to 'rat running' in the area.
- The majority of accidents along the A46 between M5 Junction 9 and Teddington Hands roundabout occur at junctions, and more noticeably at Teddington Hands roundabout itself.

COBALT Analysis of Expected Accident Numbers

Analysis was undertaken to compare the number of observed accidents in the study area against national averages by using the COBALT (Cost and Benefit to Accidents – Light Touch) Manual, which provides national average accident rates. The COBALT user guide provides guidance on accident rate calculation and link type classification and was used to calculate the national equivalent rates for each route section. 2009 rates were uplifted by the appropriate change factors identified in the COBALT WebTAG parameters file, and data from the years 2010-2016 was used.

The study route was divided into four sections as shown in Table 3.

Table 3: Sections for Accident Analysis

ID	Section	Length (m)	Speed Limit (mph)	2016 Total Daily VKM	Road Category	Road Type
1	A46 Junction 9 – Aston Cross	2.56	30/40	54,707	Modern S2 Roads 30/40	4
2	A46 Aston Cross – Teddington Hands	2.27	40	41,688[2]	Modern S2 Roads >40	4
3	M5 Junction 9-10	7.47	70	767,931	D3 Motorway	2
4	M5 Junction 8-9	5.45	70	426,915	D3 Motorway	2

Table 4 shows the number of predicted (based on national rates) and observed accidents occurring on the four sections of road between 2012 and 2016. Where the number of observed accidents is greater than predicted the cell is highlighted in red. Overall the observed total is less than predicted, as is the observed KSI. Only the observed fatal is greater (one more) than the predicted. Looking at each section in turn, the total observed accidents for sections 1 and 3 are greater than predicted.

Table 4: Number of predicted and observed accidents by severity between 2012 and 2016

Section	Number of Predicted Accidents					Number of Observed Accidents				
	Fatal	Serious	Slight	Total	KSI	Fatal	Serious	Slight	Total	KSI
1	0	5	38	43	6	1	2	10	13	3
2	1	3	12	15	3	1	2	6	9	3
3	1	8	66	75	9	3	0	16	19	3
4	1	4	37	42	5	0	9	25	34	9
Total	**3**	**20**	**152**	**175**	**23**	**5**	**13**	**57**	**76**	**18**

- When compared against the national average accident rates, overall the observed total is less than predicted, as is the observed KSI.

[2] AADT data for this section of the route is unavailable, so this value is estimated based on a comparison of model flows for this section with model flows on the 'A46 Junction 9 – Aston Cross' section.

4.8 NILO Incidents and Closures

Data was requested from the NILO (National Information Liaison Office) team regarding the date, location and duration of incidents and closures on the SRN. The data was analysed to extract those relevant to the A46 scheme.

NILO data over the past 5 years indicates that there have been no incidents on the A46 between M5 Junction 9 and Teddington Hands roundabout that reached the criteria for either a NILO Critical or Non-Critical Incident report. Two incidents occurred on the M5 itself, within the vicinity of Junction 9 rather than on the junction roundabout in November 2014 and September 2015, both of which resulted in residual delays of between 40 and 50 minutes. The November 2014 incident also required closure of 2 of the 3 motorway lanes.

- There have been no incidents on the A46 between M5 Junction 9 and Teddington Hands roundabout that reached the criteria for either a NILO Critical or Non-Critical Incident report.

4.9 Opportunities and Constraints

The opportunities are:

- The A46 route is an alternative to the Birmingham Motorway Box (M5/M42/M6), especially during incidents. The resilience of this route is currently questionable with strategic highway movements mixing with farm traffic and local movements through Ashchurch;
- To help facilitate growth in the region by providing additional highway capacity on the SRN;
- To take better account of the needs of communities and non-motorised users by improving access along the existing A46 and reducing the current levels of congestion; and
- Improve the interface between the local and strategic road networks to provide a more efficient route for commuters and industries, and decrease the frequency and severity of accidents.

The main issues and constraints for a proposed scheme in the study area are as follows:

- Businesses within Ashchurch and the surrounding region may not support the realignment of the A46 to carry through traffic away from the existing route, citing it may impact on their livelihoods;
- Significant development in and around Cheltenham and Gloucester will put additional pressure on the M5, particularly Junctions 9 and 11. This will put additional traffic onto the local and strategic road networks, including the A46 through Ashchurch;
- Number of key planning consents already granted and additional sites awaiting consent will further impact on the existing, already congested SRN;
- There are five Noise Important Areas (NIAs) within the study area. Three of these are on the highway, with others at Northway and Newton (to the west);
- Loss or severance of agricultural land will be a medium or high risk to the programme;
- The study area is crossed by a number of Public Rights of Way (PROW). The Gloucestershire Way crosses east-west, with a pedestrian bridge over the M5 to the east of Walton Cardiff;
- Flood risk is a major issue within the Tewkesbury area which sits at the meeting point of the Rivers Severn and Avon. There are large floodplains of the Rivers Severn, Avon and for the several significant tributaries including the River Swilgate, Tirle Brook and Carrant Brook;
- Gas pipeline - Two major high pressure gas pipelines have been identified, which are part of the National Transmission System (NTS) network of gas pipelines that take gas from the import source to the user. These are large diameter pipes and have significant exclusion zones to protect their integrity. The routes pass to the south of the Ashchurch and Tewkesbury area on a north-east / south-west axis. The two pipes pass close to Teddington Hands roundabout;
- Electricity Pylons - A 132kv electricity over-head power line approach Tewkesbury from the south and terminates in the Northway employment area. The route of the power line has pylons located very close to the M5 to the immediate south west of Junction 9; and
- The schemes should offer at least 'Medium' value for money, i.e. BCR>1.5.

4.10 Summary

This section provides a summary of traffic flow, journey time, accident and incident / closure data presented in this chapter.

Traffic flows from the counters in the study area show:

- The A46 is near capacity between M5 Junction 9 and Aston Cross, with a stress factor of 0.94 in the eastbound direction, and 0.89 in the westbound direction. This is likely to cause congestion during peak periods;
- There is little evidence of tidal patterns at any of the sites;
- There is little evidence of seasonality in the area; and
- There is a high proportion of HGVs on both the M5 and A46 in the area, although this proportion appears to be falling over time.

Accidents from STATS19 show:

- In total, there were 150 accidents recorded along the major roads within the vicinity of the A46 between 2012 and 2016;
- Overall the number of accidents is fewer than predicted although there were more fatal accidents than predicted on the A46 between Junction 9 and Aston Cross, and on the M5 between Junction 9 and 10;
- Accident clusters were identified at Teddington Hands roundabout, M5 Junction 9, on the westerly end of the A46 through Ashchurch, and through residential areas around Northway; and
- A higher proportion of accidents than is typical occurred at at-grade junctions.

Journey Times from 2015 TrafficMaster data show:

- There is delay of greater than 40 seconds experienced between Aston Cross and Teddington Hands roundabout, in both directions, during all the time periods studied; and
- On weekdays there is also delay between Junction 9 and Aston Cross in both time periods; however this delay is minimal during the Saturday Inter-Peak period.

Google Maps show:

- The average journey time for the 3 miles from M5 Junction 9 to Teddington Hands roundabout is between 6 and 8 minutes, however during AM and PM peak times these can be:
    - 10-20 minute average journey time in AM peak eastbound;
    - 10-24 minute average journey time in PM peak westbound; and
    - 10-18 minute average journey time in PM peak eastbound;

Road closures from NILO data shows:

- NILO data over the past 5 years indicates that there were no incidents on the A46 between M5 Junction 9 and Teddington Hands roundabout that reached the criteria for either a NILO Critical or Non-Critical Incident report; and
- Two incidents occurred on the M5 itself, within the vicinity of Junction 9 rather than on the junction roundabout in November 2014 and September 2015, both of which resulted in residual delays of between 40 and 50 minutes. The November 2014 incident also required closure of 2 of the 3 motorway lanes.

5 Understanding the Future Situation

5.1 Overview

Following on from the 'understanding of the current situation' the next step is to understand the future situation and in doing so ensure that the scheme not only provides a solution to the existing problems, but that it also meets those of the future situation.

5.2 Future changes to the transport system

Future strategic schemes by Highways England

The RIS sets out a long term programme for motorways and major roads. In RIS1, there was one planned highway improvement scheme located within the wider study area, as shown in Figure 2:

- A417 'Missing link' at Air Balloon (construction expected after 2021) – south of Cheltenham.

Future local highways schemes

There are no committed local highway schemes within the study area.

5.3 Future land-use developments

The following economic opportunities and priorities for land use development have been identified:

- Significant future growth in the JCS region proposing significant sites near the A46 and in Tewkesbury;
- Proposed retail outlet and application for approximately 900 houses close to M5 Junction 9 on the southern side of the A46, in Ashchurch;
- Upgrade to the railway bridge in north Ashchurch is likely to increase housing numbers in the area as access to the area improves;
- Proposed development of 250 homes, south of A46 at Ashchurch;
- Proposed development for mixed housing/employment, which could see up to 21,000 homes and 3,300 jobs, north of Ashchurch;
- In and around Tewkesbury, 2,500 houses are proposed;
- Initial release of the Ashchurch Minister of Defence (MoD) site for housing, with substantial future releases likely; and
- Around 6,000 homes and 56 hectares of high-quality employment land including the nationally-significant Cyber Park) is allocated through the JCS in northern and western Cheltenham.

The scheme will directly support these developments.

5.4 Road Traffic Forecasts

The Road Traffic Forecasts (RTF) published by the DfT have been analysed to see the extent of growth that is predicted in the study area of the road network. Due to the uncertainty surrounding future economic and demographic trends, RTF data is available for a range of scenarios which focus on three critical uncertainties. These are:

- People's propensity to travel (i.e. trip rates);
- The cost of travel and people's ability to pay for it (reflected in fuel costs and income growth); and
- The extent to which rising incomes lead to higher rates of car ownership and car use.

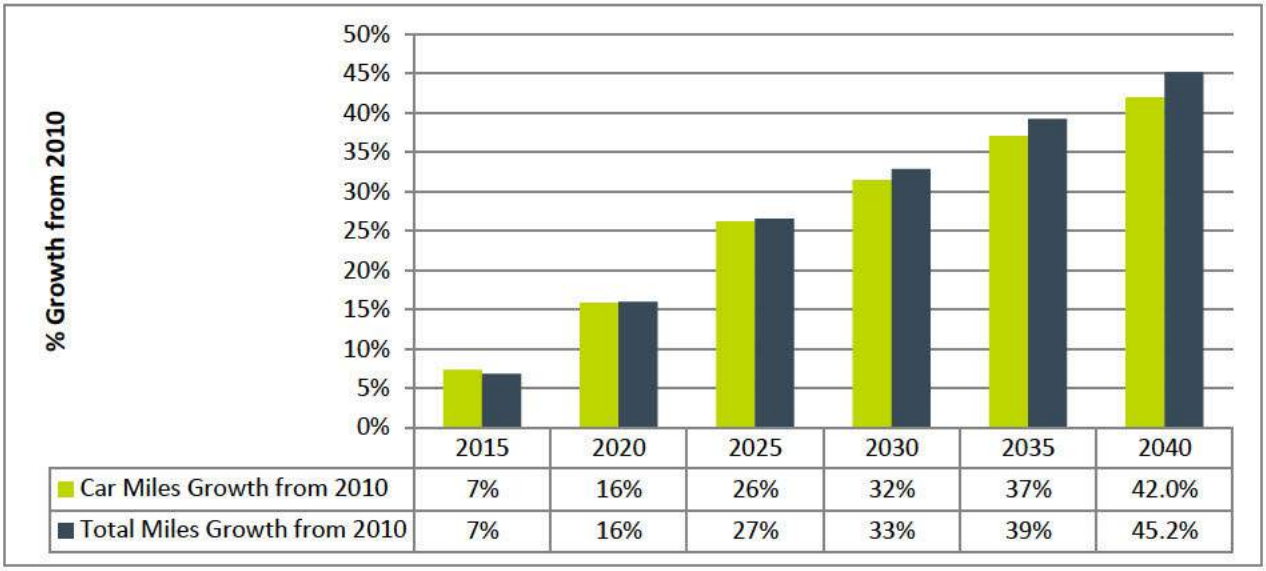
For the purpose of this assessment, Scenario 1 has been chosen to reflect future traffic on the A46 through Ashchurch. This makes the following assumptions:

- Same assumptions compared with Road Traffic Forecasts 2013 (RTF13);
- The number of trips remains constant at the historic average;
- Incomes and costs affect travel choices in the same way as previously modelled; and

- Office for Budget Responsibility (OBR) and Department of Energy and Climate Change (DECC) central forecasts for future changes in incomes and fuel prices.

Figure 19 shows the total miles and car only miles growth rates for the South West region SRN. Growth rates are given for a five-year period beginning with growth between 2010 – 2015, in addition to the compound annual growth rate (CAGR) for each year within all five-year periods between 2010 and 2040. The CAGR is given as a single percentage for each year within any five-year period and is labelled above the data series for car only growth and below for total growth.

Figure 19: Road traffic growth estimates (2015) for South West SRN



	2015	2020	2025	2030	2035	2040
Car Miles Growth from 2010	7%	16%	26%	32%	37%	42.0%
Total Miles Growth from 2010	7%	16%	27%	33%	39%	45.2%

Figure 19 shows that car miles and total miles growth from 2010 is predicted to increase across every five-year period. Road traffic growth from 2015 to 2040 is expected to be 42.0% for cars and 45.2% for all vehicles for the trunk road network in South West England.

6 Establishing the Need for Intervention

This chapter summarises the findings of the assessment presented in Chapters 3 and 4 to explain the need for intervention within the study area. The assessment validates the high-level findings contained within the Route OAR and indicates that an intervention would provide benefits within the study area.

6.1 Existing Situation

The traffic assessment work undertaken has concluded that traffic flows eastbound and westbound are close to exceeding theoretical road capacity.

Analysis of TrafficMaster data shows that there is varying levels of delay on the A46 between M5 Junction 9 and Teddington Hands roundabout during weekday peak periods. There is less delay between Junction 9 and Aston Cross during a Saturday inter-peak period, however there is still delay between Aston Cross and Teddington Hands. Delay is observed to be minimal on the M5 during all time periods.

With regards to safety, accident clusters were identified across the study area. Over the five-year period 2012 to 2016, there were 150 reported accidents (113 slight, 27 serious and 10 fatal) resulting in 158 casualties. In terms of the predicted and observed number of accidents occurring on the route between 2012 and 2016, overall the observed total is less than predicted, as is the observed KSI. Only the observed fatal is greater (2 more) than the predicted.

6.2 Future Situation

Table 5 presents the traffic growth on the M5 (Junctions 8 to 10) and A46 between the base year 2013 and the model forecast year, 2031. It should be noted that there are a number of issues with the JCS model, and while his method is appropriate for this PCF Stage 0 feasibility assessment, more detailed modelling with a local calibrated and validated model will need to be undertaken if this scheme is to progress further. More detail on this is included in the Transport Model Package (TMP) for the scheme.

The traffic growth is for all vehicle types, and does not include variable demand effects.

Table 5: Traffic growth between base year 2013 and model forecast year 2031

Time Period	Location		
	A46 Ashchurch	M5 Junction 8-9	M5 Junction 9-10
AM Peak	32%	5%	5%
PM Peak	13%	6%	11%

Table 5 shows that despite the delays and congestion currently experienced, traffic is expected to rise due to national trends:

- The growth in population;
- The growth in economy; and
- Local traffic is expected to be generated by a number of local developments, as described in Section 5.3.

Forecast traffic growth in the area will result in increased congestion on the A46 between M5 Junction 9 and Teddington Hands roundabout.

7 Identifying Objectives

7.1 Strategic Objectives

This report has highlighted the potential issues, such as increased congestion and poor journey time reliability, which will arise if the A46 is not improved. Based on these existing problems, Highways England's Strategic Vision for the SRN, and the outputs from the Value Management Workshop, the following strategic objectives have been identified:

- To support economic growth within the study area and wider A46 corridor;
- To provide a safe network at M5 Junction 9 (including slip roads) and along the A46;
- To improve the flow of traffic on the A46 corridor to enable reliable journey times and reduce congestion;
- To enhance the resilience of the M5/M6/M42 corridor; and
- To reduce severance and improve integration for non-motorised users within Ashchurch.

The objectives are aligned to SMART goals, being: **Specific** (well-defined and clear to anyone that has a basic knowledge of the scheme), **Measurable** (know if the goal is obtainable, how far away completion is and identify when the goal is to be achieved), **Achievable** (agreement with the stakeholders what the goals should be and that they are able to be achieved), **Realistic** (within the availability of resources, knowledge and time) and **Time-bound** (enough time to achieve the goal, but not too much time, which can affect project performance).

7.2 Specific or Intermediate Objectives

In order to achieve the strategic objectives outlined above, the following specific objectives have been identified:

- To improve capacity and enable the smooth flow of traffic between M5 Junction 9 and Teddington Hands roundabout through Ashchurch;
- Enable economic growth in the region, and particularly in Ashchurch;
- Make the network safer in the wider study area;
- Improve user satisfaction for those using the A46; and
- Identify and record efficiency savings during the PCF Stage process.

8 Generating Options

8.1 Options Identification

The identification of options was informed by those identified within the original Route OARs that offered the most economic benefits.

8.2 Initial Options & Sifting

A range of options was considered as part of the Route OAR. The options that fall along the 3-mile section of the A46 between M5 Junction 9 and Teddington Hands roundabout of this OAR are shown in

Table 6: Options Identified in Route Strategies and Route OAR
. These were reviewed against the findings of the assessment work to determine if the correct options had been identified in the Route OAR and to validate the sifting process.

8.3 Stakeholder Engagement

Stakeholder views were taken into account throughout the initial assessment work to understand the existing and potential future problems. This included views identified during the Route Strategy process from external stakeholders which have fed into this study. The key stakeholders were identified as Highways England's Operations Directorate (OD) and Highways England's Transport Planning Group (TPG) as they possess the local detailed knowledge to enable the study to be better understood. Also, they are aware of previous studies and other useful assessment work. Their input was formalised using the format of a Value Management Workshop.

The Workshop was held to discuss the study area, set out the assessment work that had been undertaken and present any conclusions to OD and the project team. The Workshop initiated constructive discussions around the underlying causes of the problems in the area and how these might change in the future. The discussions resulted in a better understanding of the key issues, constraints and risks within the study area.

Table 6: Options Identified in Route Strategies and Route OAR

Route OAR Reference	Name	Highways England Objectives	Description
MID16_01	M5 Junction 9 Improvements	Economic growth, free flow of traffic, safety, user satisfaction.	Improve conditions at M5 Junction 9 through one or a combination of the following schemes: • Fully signalise M5 Junction 9; • Widen circulatory carriageway from 2 to 3 lanes; • Extend Junction 9 south and realign A46 to south of Natton, re-joining existing alignment by Teddington Hands junction (A435); • Extend south facing slip at Junction 9 of M5, and realign A46; and • Dedicated left turn slip road from the A46 westbound to the M5 southbound at Junction 9.
MID16_15	A46 Offline Improvement M5 Junction 9 to Teddington Hands Roundabout	Free flow of traffic, economic growth.	In order to maintain the current level of service for journeys along the A46 between Teddington Hands roundabout and M5 Junction 9, an off-line improvement to the A46 would become necessary prior to 2026 even if it is assumed that a significant online improvement was already in place.
MID16_17	A46 Online Upgrade	Economic growth, free of flow of traffic,	Online A46 dualling (M5 Junction 9 to M40 Junction 15). Upgrade existing infrastructure where possible. Dualling along sections of the route where widening is

		safety	possible.

For this RIS2 process, the previously identified options (outlined above) were analysed, in addition to using information gathered during previous studies, and discussions with Highways England and AECOM – to develop three new options (Options 1, 2 and 3). These options are a variation of MID 16_15 and are listed in Section 8.4, and their locations shown on Figure 20.

It should be noted that Scheme MID16_01 (listed on Table 6) could be delivered as part of Options 2 and 3; however, MID16_17 is not considered at this stage, as previous studies showed that an online solution was not possible given current road capacity constraints. In addition, an online option is not considered to be a long-term solution to solving the problems at this location.

8.4 Options to Carry Forward

The following options were taken forward for assessment within this PCF Stage 0 study. All options would address local congestion and deliver network free flow benefits, as well as improve network resilience. It would also support the planned economic growth (housing and employment) in the region and address wider issues across the study area. The options are attached at Appendix A – Scheme Drawings.

Option 1 – South-facing slips – a new single lane carriageway and junction on the M5 with south-facing slips

This option would involve the construction of a new highway comprising a single lane in either direction between the A435 to the north-west of Oxenton and a new junction along the M5 between Junctions 9 and 10. The new junction would comprise only southbound on and northbound off-slips.

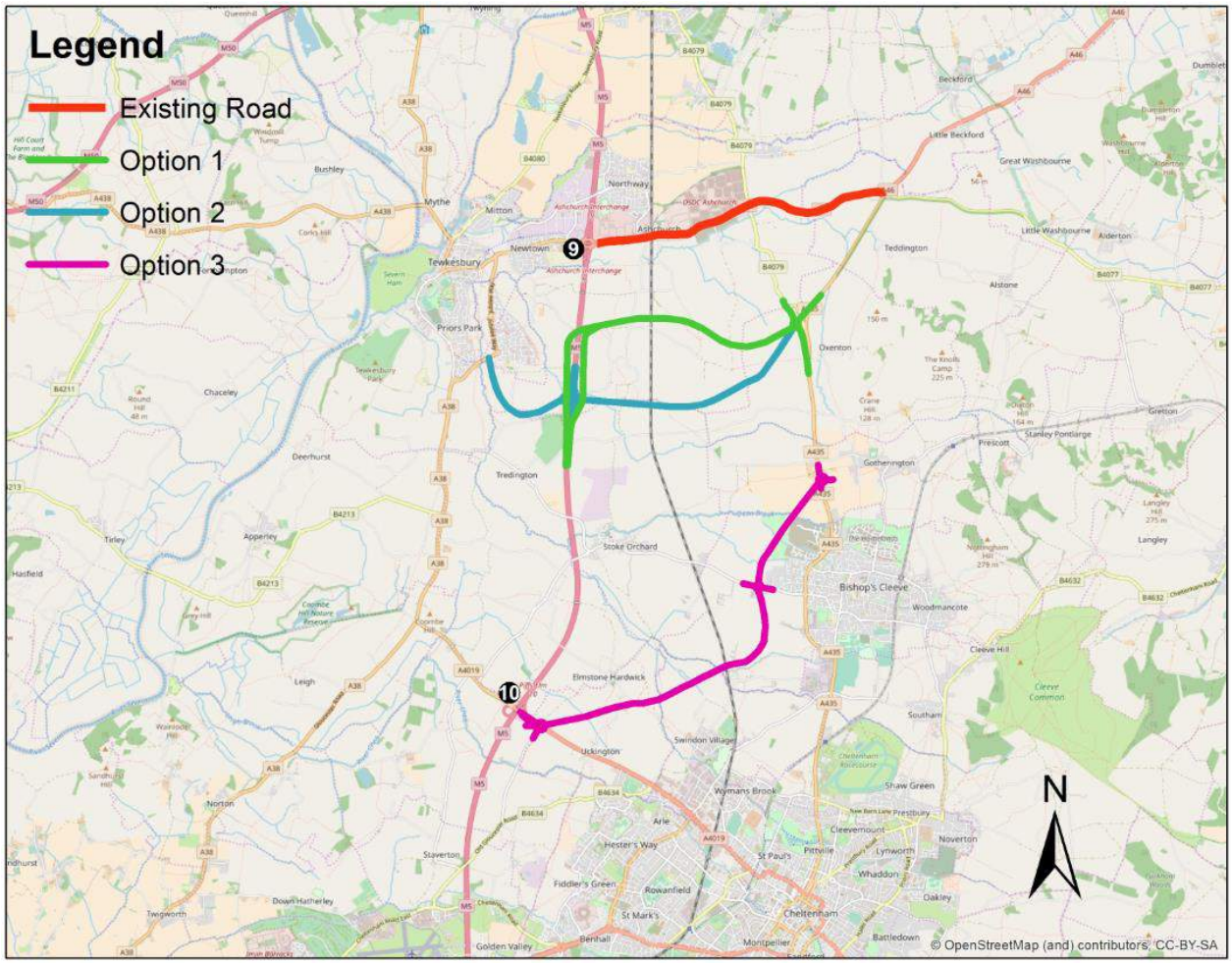
Option 2 – New Junction 9 – a new single lane carriageway and an all movements junction on the M5

This option would involve the construction of a new highway comprising a single lane in either direction between the A435 to the north-west of Oxenton and a new junction along the M5 between Junctions 9 and 10. The new junction would be an all movements junction. This option will also include a link leading west from the M5 to Tewkesbury. Existing Junction 9 slip roads would be closed.

Option 3 – Southern Link – a new single lane carriageway to join the M5 Junction 10

This option would involve the construction of a new single lane carriageway in both directions between the A435 near Bishops Cleeve and a new roundabout at M5 Junction 10 (new roundabout to be constructed as part of the RIS 2 scheme for upgrade of M5 Junction 10). This option will cover an area of 26.6 hectares.

Figure 20: Location of proposed scheme options



8.5 Alternative modes

Previous studies on the scheme have identified that there are no other low cost options that could provide a solution to the issues identified. In addition, an alternative mode assessment has been developed which considers if the problem could be solved by an alternative mode of transport. The report concluded that improved rail, bus and/or walking and cycling infrastructure cannot provide an attractive alternative to private car for the majority of journeys travelling on this route.

The Alternative Mode Assessment is attached at Appendix B – Alternative Mode Assessment.

9 Design

9.1 Highways

The highways options have only been developed to schematic level, therefore this section focuses on high-level engineering and design principles affecting the proposed options and discusses the issues that will need to be considered in more detail as the design is developed. The options drawings are shown in Appendix A – Scheme Drawings.

9.2 Option 1

Option 1 – South-facing slips – a new single lane carriageway and junction on the M5 with south facing slips.

Table 7: Design Summary

Segment No. (Ref. Design)	Approx. Length	Design Proposal
1	1,620m	NB Diverge
2	1,640m	SB Merge Slip
3	3,400m	New Link Road
4	1,286m	Oxenton Roundabout with North - South Link
5	592m	Oxenton Roundabout East Link

Scheme overview:

- New 8.5km single lane carriageway and junction on the M5 with south-facing slips;
- New south-facing slips will provide direct access to a new A46, south of the existing Junction 9 on the M5. This will support the increased traffic flows with the elevated carriageway with hard shoulder arcing over the M5, providing a free flow to A435; and
- Anticipated to reduce strain on existing Junction 9 and on the existing A46.

9.3 Option 2

Option 2 – New Junction 9 – a new single lane carriageway and new all movements junction on the M5.

Table 8: Design Summary

Segment No. (Ref. Design)	Approx. Length	Design Proposal
1	1,761m	West Link
2	3,872m	East Link
3	793m	New Gyratory
4	645m	NB Merge Slip
5	630m	SB Diverge Slip
6	930m	NB Diverge Slip
7	1,601m	SB Merge Slip
8	1,286m	Oxenton Roundabout With North - South Link
9	592m	Oxenton Roundabout East Link

Scheme overview:

- New 12.1km single lane carriageway and new fully functioning junction on the M5; and
- Option 2 is a variation of Option 1, with the construction of a full junction to the south of the existing M5 Junction 9. This would see the closure of the existing junction slip roads, but the link between Ashchurch and Tewkesbury (existing A46 and A438) would remain.

9.4 Option 3

Option 3 – Southern Link – a new single lane carriageway to join the M5 Junction 10.

Table 9: Design Summary

Segment No. (Ref. Design)	Approx. Length	Design Proposal
1	6,766m	Southern Link

Scheme overview:

- New 6.8km single lane carriageway to join the M5 at Junction 10;
- The new carriageway would run between the A435 near Bishops Cleeve and a new roundabout at M5 Junction 10 (new roundabout to be constructed as part of the RIS 2 scheme for upgrade of M5 Junction 10); and
- Existing M5 Junction 9 would remain in its current form however there are also opportunities to incorporate some junction improvements.

10 Development and Assessment of Potential Options

10.1 Introduction

The Transport Model Package (August 2018) described the process to develop and calibrate the 2013 CSV model.

This section of report describes the updates that have been made to the model to appraise the schemes in the proposed opening year and design year of the scheme. Further detail is available in the Transport Forecast Package (May 2018).

10.2 Traffic Modelling

Looking at the October weekday daily flow profiles for the M5 in the southbound and northbound directions respectively, flows are lower during the inter-peak period between these times.

Each scheme option has been assessed for the following year:

- 2031 – Design Year (assumed). This is the single forecast year modelled in the JCS model representing the end of the Local Plan period.

It is expected that the scheme may be delivered earlier than 2031, or an incremental approach to delivery may be adopted. However, given that 2031 forecasts were readily available from the JCS model, it was agreed that this would be a suitable opening year to give an indication of the performance of the schemes.

10.3 Future Year Schemes

The following scheme options have been assessed:

- Option 1 – The location and configuration of the B4079/A435 priority junction was changed to a roundabout and additional detail on the alignment of this roundabout is shown in the plan for the scheme, attached as Appendix A – Scheme Drawings of this report. A new, single carriageway link with an assumed 50mph speed limit was coded to provide access to the new motorway junction, with south facing slips only;
- Option 2 – The B4079/A435 priority junction was modified in the same way as in Option 1, with the exception of the arm, which connected this new roundabout to the new location of Junction 9 – assumed to be a dual carriageway with a 50mph speed limit. The new Junction 9 was coded with 3 lanes on the circulatory of the gyratory, and two lane entries and exits. It was not coded as a signalised junction, as this was not built into the costs for the scheme. An additional link was also coded into the west of this junction, connecting it to the A38, south of Tewkesbury; and
- Option 3 – For this option, roundabouts were added to the network on the A435 north of Bishop's Cleeve, and on Stoke Road east of Bishop's Cleeve, to accommodate the single carriageway link between the A435 and the roundabout east of M5 Junction 10. The speed limit of this route was again assumed to be 50mph.

Drawings of each option are shown in Appendix A – Scheme Drawings.

10.4 Model Results

This section presents a summary of the modelled results. For the detailed analysis see the Transport Forecasting Package.

10.5 Summary

In summary, the assessment of options concluded that:

- Based on the results of the economic assessment undertaken for each of the scheme options, outlined in the EAP, Option 1 provides the best economic justification. This option offers the best value for money and also the highest Present Value of Benefit (PVB); and
- All three options produce benefits for transport users. The three options increase capacity on the SRN and remove traffic from roads through towns and villages. As such, disbenefits arising due to re-routeing traffic are minimal. However, as a result of the improvements included in Option 3, there is a small increase in delay around M5 Junction 10.

10.6 Transport Economic Efficiency (TEE) Benefits

Whilst there are many different methodologies available for undertaking economic appraisals of highway schemes, the most common methodology is through the use of Transport User Benefit Appraisal (TUBA). The use of TUBA is WebTAG compliant and acts as the DfT's appraisal software for calculating benefits to transport users and providers.

Inputs of travel distance, travel time and demand for the Do Minimum and Do Something scenarios are entered, and the economic value of the scheme over a defined period is calculated by comparing the user benefits and costs incurred in the proposed Do Something scenario with that of the Do Minimum. The comparison is carried out with regard to link transit times, vehicle operating costs and wider public finances. This benefit is then offset against the cost of the scheme to determine its value for money via a benefit to cost ratio (BCR).

For each of the three scheme options an economic assessment with TUBA 1.9.11 has been undertaken. The results of this assessment are shown in Table 10.

Table 10: TUBA TEE Results (£000s)

		Option 1	Option 2	Option 3
Vehicle Hours Saved (2031)	AM	132	134	122
	PM	159	112	255
2031 TEE Benefits		2,131	1,293	590
Total Journey Time Benefit across 60-year appraisal period		84,532	71,048	24,066
Total Vehicle Operating Cost benefit across 60-year appraisal period		14,640	-18,780	2,760
Present Value of TEE Benefit across 60-year appraisal period: Journey Time Benefits Discounted to 2010		99,172	52,268	26,826

Overall, while all three options result in a benefit, the number of vehicle hours saved is greatest for Option 3, while the vehicle operating cost benefit is highest for Option 1. Option 1 provides the greatest overall benefit.

10.7 Accident Analysis Results

An estimate of the likely accident benefits can be made from the development of simple COBALT networks which consider:

- Forecast opening and design year flows;
- The change in road layout between 'Do Minimum' and 'Do Something'; and
- The different accident rates that may apply to different link and junction type.

The COBALT network includes the A46 from Junction 9 to Evesham, the M5 between Junction 11 and 8 and the key minor roads which link Ashchurch, Tewkesbury and Cheltenham. M5 Junction 10 itself has been excluded from the COBALT analysis for this scheme.

The 'Do Minimum' and 'Do Something' accident numbers are shown in Table 11.

Table 11: 'Do Minimum' and 'Do Something' accident numbers

	Do Minimum	Option 1	Saving	Option 2	Saving	Option 3	Saving
2026	79	67	12	66	14	76	3
2041	72	73	-2	75	-4	74	-3
Total (60 years)	**4,350**	**4,385**	**-35**	**4,469**	**-119**	**4,490**	**-140**

There is an increase in total personal injury accidents (PIAs) as a result of all of the possible scheme options. This is because all three schemes result in trips transferring from the M5 onto the new road, which has a higher accident rate.

The largest accident disbenefit comes from Option 3, which is likely due to the length of the new road (not including junctions and slip roads) being longer than the other two options.

Table 12 below shows the total (60-year) casualty numbers associated with the 'Do Minimum' and 'Do Something' scenarios, and the associated economic cost of casualties.

Table 12: Total (60 year) casualty numbers and costs

Casualties	Do Minimum	Option 1	Saving	Option 2	Saving	Option 3	Saving
Fatal	71	75	-5	77	-6	79	-9
Serious	601	621	-20	629	-29	641	-40
Slight	5,731	5,788	-57	5,881	-149	5,938	-207
Casualty Cost (£000s)	**201,757**	**205,529**	**-3,772**	**208,829**	**-7,072**	**212,954**	**-11,197**

All of the schemes result in an increase in the number of casualties within the scheme area. The largest increase is as a result of Option 3, which is likely to be due to the new road linking to M5 Junction 10 being longer than those proposed in the other options.

The accidents have only been assessed in the immediate area of the scheme, and the change in flow, and associated accidents on the surrounding road network has not been considered and would require further study in future PCF stages.

10.8 Order of Magnitude Estimate

Scheme costs have been produced by Highways England in the form of 'Order of Magnitude Costs'. These estimates are provided as a range estimate which considers a price range around the expected cost estimate. Therefore, the estimates provided in the table are the Minimum Plausible Outcome (P10) and the Maximum Plausible Outcome (P90), with the Expected Value (P50). This range represents the confidence in the quantities allocated to the items. The scheme option costs are shown on Table 13.

Highways England has developed the range estimate process to improve the predictability of cost, and therefore overcome optimism bias, meaning the methodology described in 'WebTAG Unit A1-2: The Estimation and Treatment of Scheme Costs' for factoring base costs by an optimism bias uplift, has not been followed.

Table 13: Scheme option costs (£ million)

Option	Range Estimate (Q1 2016)			Present Value of Costs (2010 Prices) (PVC) (P50)
	Minimum (P10)	Most Likely (P50)	Maximum (P90)	
Option 1 – New 'Junction 9A' with south facing slips	100	169	318	83
Option 2 – New Junction 9 with closure of current Junction 9	181	299	565	143
Option 3 – Southern Link into Junction 10	97	164	311	80

10.9 Analysis of Monetised Cost and Benefit

Of the three options, Option 1 provides the best value for money, with a BCR of 1.13 providing low value for money. The other two options both provide a benefit less than the cost of the scheme, resulting in poor value for money with BCRs below 1.0.

It is expected that, due to the methodology applied to the calculation of the economic benefit of the schemes, the monetised benefits shown in Table 14 are underestimates, and that further analysis at a later PCF stage would result in more benefits and a greater BCR.

Table 14: Analysis of Monetised Costs and Benefits 2010 Prices (£000's)

	Option 1	Option 2	Option 3
Noise	N/A	N/A	N/A
Local Air Quality	N/A	N/A	N/A
Greenhouse Gases	N/A	N/A	N/A
Journey Quality	N/A	N/A	N/A
Physical Activity	N/A	N/A	N/A
Accidents	N/A	N/A	N/A
Economic Efficiency: Consumer Users (Commuting)	63,710	34,081	14,733
Economic Efficiency: Consumer Users (Other)			
Economic Efficiency: Business Users and Providers	35,461	18,187	12,093
Wider Public Finances (Indirect Taxation Revenues)	-5,100	-6,420	660
Travel Time Reliability	N/A	N/A	N/A
Total Present Value of Benefit (PVB)	94,072	45,848	27,486
Present Value of Cost (PVC)	**83,124**	**143,404**	**80,170**
Present Value of Benefit (PVB)	**94,072**	**45,848**	**27,486**
Net Present Value (NPV)	**10,948**	**-97,556**	**-52,684**
Benefit Cost Ratio (BCR)	**1.13**	**0.32**	**0.34**

10.10 Environment

As part of the assessment of the A46, a Preliminary Environmental Risk Assessment (PERA) has been prepared. The purpose of the PERA is to identify the initial environmental constraints, risks and opportunities for the study corridor and to establish any barriers to delivery in respect of scope, programme and budget to the project. High level environmental constraints maps for the corridor are included in Appendix C – Environmental Constraints Maps. At this stage in the project, the key constraints and opportunities from the PERA are identified in Table 15.

Table 15: Key Environmental Constraints

Key Constraints	Potential Implications
Air Quality and Greenhouse Gases: There is an AQMA within the 1km study areas of Option 1 and 2. Option 3 runs through Cheltenham AQMA.	• Recent monitoring data of the Tewkesbury town centre AQMA has shown that concentrations are below the objective, with the highest measured concentration of 37 µg/m3 on the High Street within the AQMA; • Measured concentrations are above the annual mean objective at monitoring sites within the AQMA, but not within 1km of the scheme; • There are Defra compliance links within 500 m of the scheme, but these are not predicted to exceed the NO2 EU Limit Value; and • The nearest compliance link that exceeds the limit value is 8km south of Cheltenham on the A40 and is due to be compliant in 2019. • *Opportunity: The proposed road alignment in Option 1 and 3 are further from residential properties in Tewkesbury than Option 2, so the impact on air quality may be lower.*
Cultural Heritage: There are 44 listed buildings within the study area.	• The nearest listed buildings are the Teddington Hands Guide Post and the Tibblestone, both of which are Grade II listed, which are located just south of the Teddington Hands roundabout; • The majority of other listed buildings are Grade II however there are 4 Grade II* listed buildings and one Grade I listed building. The Grade I listing relates to the Church of St Nicholas at Teddington, approximately 930m to the south of the Teddington roundabout; and • There is one scheduled monument within the study area – the deserted medieval village at Walton Cardiff, approximately 1.1km to the south west of the M5 J9. • *Opportunity: Archaeological status (i.e. buried, unrecorded finds) of the area would also need to be considered.*
Noise and Vibration: Each option would be likely to result in adverse noise impacts at a number of residential receptors, and for Option 3 potentially the Noise Important Areas (NIA) at the southern end of the scheme.	• During construction, nearby sensitive receptors are likely to experience some level of temporary noise (and possibly vibration) effects; • There is potential for localised noise impacts at receptors in close proximity to each of the options, Option 3 passes close to the greatest number of residential properties due to its proximity to Bishops Cleeve and Gotherington; • There is the potential for adverse operational noise effects to result at a number of residential properties and any other noise sensitive receptors, including the NIAs at the southern end of Option 3, which may require additional land purchase for bunds and inclusion of noise barriers; and • Some properties could qualify for insulation under the Noise Insulation Regulations depending on the predicted noise levels. • *Opportunity: Localised beneficial effects could potentially be realised on roads from which traffic transfers onto the new scheme, such as the A46 through Ashchurch.*
Road Drainage and the Water Environment: Flood zones and flood risk are key considerations.	• A Flood Risk Assessment (FRA) will be required due to the potential for development to affect fluvial Flood Zone 2 and 3 (and potentially other sources of flood risk); • River and brook crossings will need to be of a suitable design so as not to affect flows. Areas for flood storage and attenuation may be required which could affect the programme and budget for the project; • Option 1 has potentially less interaction with fluvial flood zones compared with Option 2. Option 3 crosses areas of fluvial flood risk associated with three main rivers; and • New development should be directed towards areas of lower flood risk where possible. Any loss of flood storage capacity must be compensated for by providing equivalent flood storage capacity on a 'like for like' and 'level for level' basis. • *Opportunity: Areas set aside for new flood water storage present an opportunity to provide areas of biodiversity enhancement.*

Key Constraints	Potential Implications
Biodiversity: A number of SSSI's and other designated areas are present within the study area	• There would be no direct effects on International / European sites. However, there is potential for indirect effects upon the bat populations supported by the Wye Valley & Forest of Dean Bat Sites SAC and also potential for hydrological links to the Severn Estuary SAC / SPA; • No direct effects on national and local statutory designated sites are anticipated, however there is potential for indirect effects upon Severn Ham, Tewkesbury SSSI as a result of potential hydrological links; • There is the potential for localised direct or indirect effects on woodland and grassland which is of biodiversity value (i.e. Priority / Natural Environment and Rural Communities (NERC Act) habitat; and • Standard mitigation measures would be implemented which may involve the adoption of best working practices to maintain water supply and quality. • *Opportunity: Potential for considerate ecological mitigation and compensation design to realise beneficial effects, potentially achieving a net gain in biodiversity.*
Landscape: The Cotswolds Area of Natural Beauty (AONB) is located within 1km of all three options. Option 3 passes through a large area of Green Belt.	• Loss of trees and hedgerows has the potential to lead to a reduction on the functionality and effectiveness of green infrastructure; • In relation to visual impact and amenity, Options 1 and 2 would be in close proximity to Sherdons Golf Course, Priors Park and Tewkesbury Cemetery Registered Park and Garden and overlooked by residential properties which could experience visual change during construction and operation of the proposed scheme; • Users of the Gloucestershire Way and local Public Rights of Way (PRoW) will also experience some change in their views as a result of the scheme; and • Option 3 would be in close proximity to Swindon Recreational Ground, Home Farm Equestrian Centre, Cheltenham and District Clay Club, Cheltenham North Rugby Club and overlooked by residential properties which could experience visual change during construction and operation of the proposed scheme. • *Opportunity: Potential for considerate landscape design to replace vegetation lost during the construction phase and to provide visual screening. Site specific planting could also help strengthen existing field boundaries, riparian woodland and existing woodland copses.*
Geology, soils and materials: Options 1, 2 and 3 would all result in the loss and severance of agricultural land.	• Potential to encounter waste and contaminated soils during site investigations/construction leading to remediation and/or higher disposal costs and impacts on the construction programme; • It will be a requirement that the works are undertaken in a manner that employs best practice construction methods such that risk associated with land contamination and ground stability will be appropriately managed in accordance with national legislative requirements; and • It is not anticipated that any of the options within the scheme development would result in any significant impacts as related to geology and soils.

11 Conclusion

11.1 Existing and Future Problems

The traffic assessment undertaken has identified the following problems on the A46:

- **Congestion and Delay.** There is delay on the A46 between M5 Junction 9 and Teddington Hands roundabout during peak periods. According to Google Maps, the average journey time for the 3 miles from M5 Junction 9 to Teddington Hands roundabout is between 6 and 8 minutes. This can increase to a 24 minute journey during peak times.
- **Resilience.** Lack of appropriate alternative routes (especially for HGVs) when the A46 is closed e.g. accidents / incidents / maintenance. The A46 route is an alternative to the Birmingham Motorway Box (M5/M42/M6), especially during incidents.
- **Safety.** There were 150 accidents recorded along the major roads in the vicinity of the A46 between 2012 and 2016. There are a large number of slight accidents at Northway, likely due to 'rat running' in the area. The majority of accidents along the A46 between M5 Junction 9 and Teddington Hands roundabout occur at junctions, and more noticeably at Teddington Hands roundabout itself.
- **Economic growth**. There is significant future growth in the JCS region proposing significant sites near the A46 and in Tewkesbury:
    - Proposed retail outlet and application for approximately 900 houses close to M5 Junction 9 on the southern side of the A46, in Ashchurch;
    - Upgrade to the railway bridge in north Ashchurch is likely to increase housing numbers in the area as access to the area improves;
    - Proposed development of 250 homes, south of A46 at Ashchurch;
    - Proposed development for mixed housing/employment, which could see up to 21,000 homes and 3,300 jobs, north of Ashchurch;
    - In and around Tewkesbury, 2,500 houses are proposed;
    - Initial release of the Ashchurch MoD site for housing, with substantial future releases likely; and
    - Around 6,000 homes and 56 hectares of high-quality employment land including the nationally-significant Cyber Park) is allocated through the JCS in northern and western Cheltenham.
- **Traffic growth.** Road traffic growth estimates (2015) for south west SRN show that car miles and total miles growth from 2010 is predicted to increase every five year period. Road Traffic Growth from 2015 to 2040 is expected to be 42.0% for cars and 45.2% for all vehicles for the trunk road network in South West England.

The underlying causes of the above issues are attributed to the following key factors:

- Single carriageway through Ashchurch, with strategic highway movements mixing with farm traffic and local movements through Ashchurch;
- Large number of junctions on the A46;
- 10% of all vehicles travelling through Ashchurch were HGVs. This is greater than on the A46 east of Teddington Hands (8%) and the A438 west of M5 Junction 9 (4%);
- The commencement of planned development will increase the number of vehicles using the A46 through Ashchurch and M5 Junction 9;
- Lack of appropriate strategic alternative routes to the A46; and
- Lack of safe crossing facilities for NMUs leading to severance of local communities and leisure routes.

11.2 Scheme Objectives

This report has highlighted the potential issues, such as increased congestion and poor journey time reliability that will arise if the A46 between M5 Junction 9 and Teddington Hands roundabout is not improved. Based on these existing problems, Highways England's Strategic Vision for the SRN, and the outputs from the Value Management Workshop, the strategic objectives have been identified, as listed below:

- To support economic growth within the study area and wider A46 corridor;
- To provide a safe network at M5 Junction 9 (including slip roads) and along the A46;
- To improve the flow of traffic on the A46 corridor to enable reliable journey times and reduce congestion;
- To enhance the resilience of the M5/M6/M42 corridor;
- To reduce severance and improve integration for non-motorised users within Ashchurch; and
- Identify and record efficiency savings during the PCF Stage process.

11.3 Proposed Options

Three options were developed within the study area to address the scheme objectives. The development of these options was based upon the considerable volume of previous work and the assessment work undertaken within this study. The three options are summarised below.

- Option 1 - New single lane carriageway and junction on the M5 with south facing slips;
- Option 2 - New single lane carriageway and new all movements junction on the M5; and
- Option 3 - New single lane carriageway to join the M5 Junction 10 (6.8km).

The proposed options vary in their technical complexity, but all have significant engineering and environmental constraints. Identify and record efficiency savings during the PCF Stage process.

11.4 Traffic Assessment

All three options for improvement to the SRN in the area have been tested using the JCS model. The result is a reduction in flows on the A46 through Ashchurch, and an increase in flows on the A435 south of Teddington Hands, due to trips transferring to the new road. These changes were the largest in Option 2, which is due to the closure of M5 Junction 9 as part of this option. This is because this option forces any trips travelling through Ashchurch to use the M5 via Junction 9 to re-route to the new road and relocated Junction 9. This results in a significant reduction in the number of trips using the A46 in Ashchurch, as only local traffic uses the road, with strategic traffic diverting onto the new bypass.

In Options 1 and 3, strategic trips using the M5 northbound must still use the A46 through Ashchurch to access the motorway via Junction 9. Changes in traffic flow on the B4079 were minimal in all options.

All three options result in a significant reduction in journey time and delay from the 'Do Minimum' option on the key routes through Ashchurch, and on the M5. The largest improvements on the strategic network can be seen in Option 2.

11.5 Economic Assessment

Table 16 shows the overall TUBA benefits, including PVB and PVC for each scheme option and the resulting BCR.

Table 16: Analysis of Monetised Costs and Benefits 2010 Prices (£000's)

	Option 1	Option 2	Option 3
Present Value of Cost (PVC)	83,124	143,404	80,170
Present Value of Benefit (PVB)	94,072	45,848	27,486
Net Present Value (NPV)	10,948	-97,556	-52,684
Benefit Cost Ratio (BCR)	1.13	0.32	0.34

Of the three options, Option 1 provides the best value for money, with a BCR of 1.13 providing low value for money. The other two options both provide a benefit less than the cost of the scheme, resulting in poor value for money with BCRs below 1.0.

It is expected that, due to the methodology applied to the calculation of the economic benefit of the schemes, the monetised benefits shown in Table 16 are underestimates, and that further analysis at a later PCF stage would result in more benefits and a greater BCR.

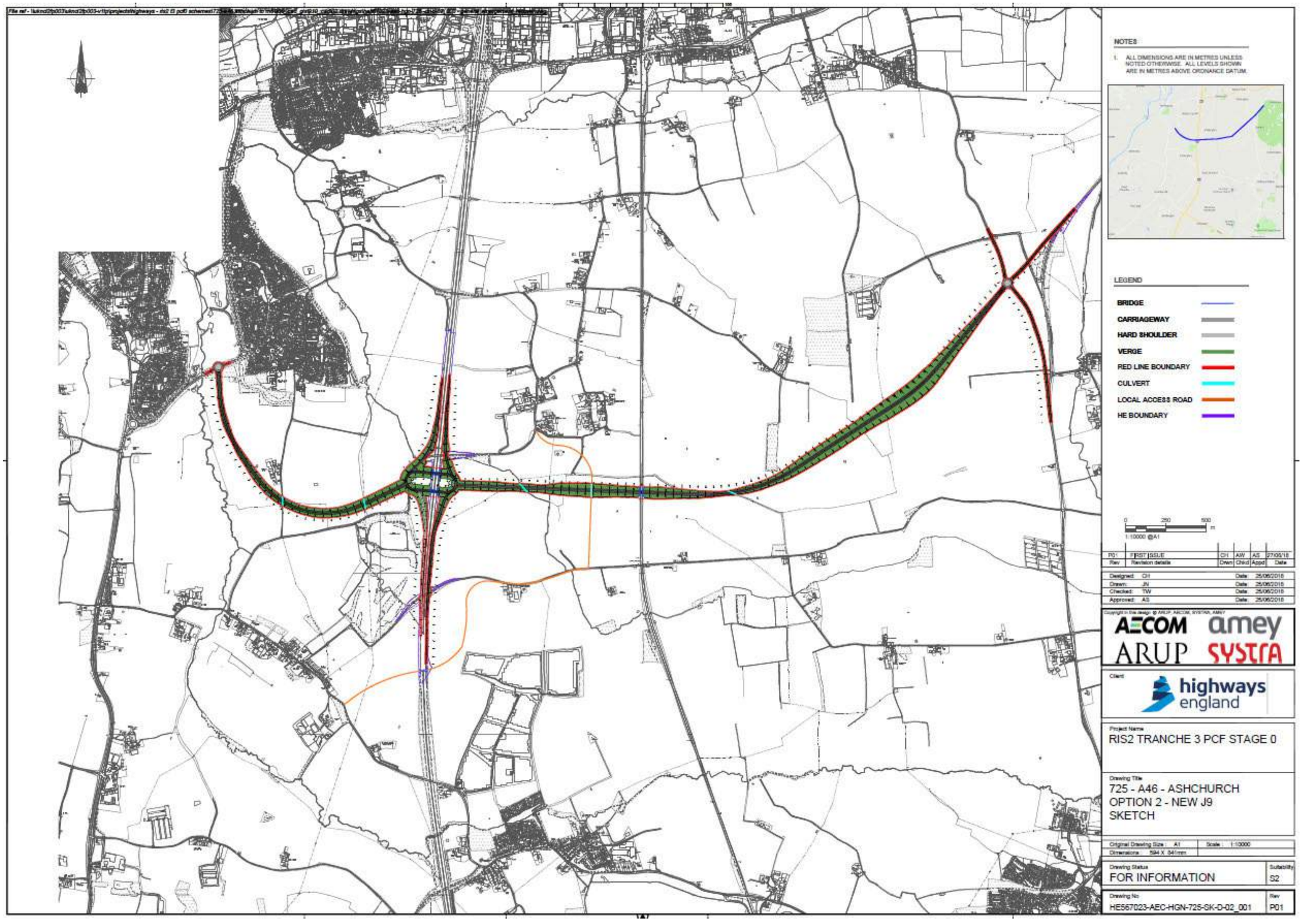
Glossary and abbreviations

AADT	Average Annual Daily Traffic
AAWT	Average Annual Weekday Traffic
ANPR	Automatic Number Plate Recognition
ARR	Analytical Requirements Report
ASR	Appraisal Specification Report
AST	Appraisal Summary Tables
ATC	Automatic Traffic Count
COBA	Cost Benefit Analysis
COBALT	Cost Benefit Analysis – Light Touch
ComMA	Combined Modelling and Appraisal Report
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
ENVIS	Environmental Information System
GIS	Geographic Information Systems
HGV	Heavy Goods Vehicle
ITN	Integrated Transport Network
JTW	Journey to Work
LGV	Light Goods Vehicle
NILO	National Information Liaison Office
NTEM	National Trip End Model
NTM	National Transport Model
OAR	Options Assessment Report
OS	Ordnance Survey
PCF	Project Control Framework
PERA	Preliminary Environmental Risk Assessment
RIS	Road Investment Strategy
RTM	Regional Transport Model
SAR	Scheme Appraisal Report
SRN	Strategic Road Network
TAG	Transport Analysis Guidance
TAP	Traffic Assessment Project
TOID	Topographic Identifier
TPG	Transport Planning Group
TUBA	Transport User Benefit Appraisal

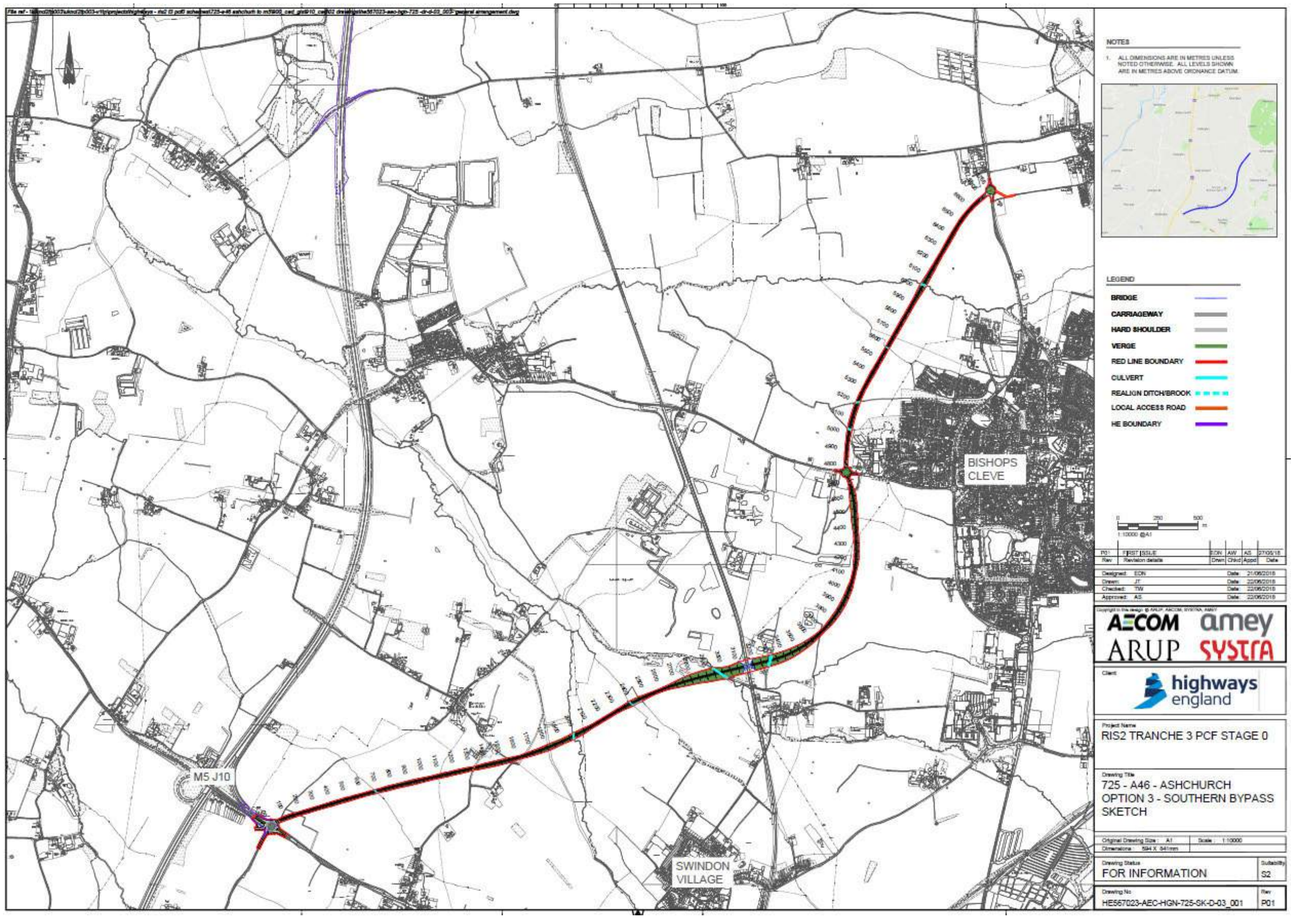
Appendix A – Scheme Drawings

Option 1 – South-facing slips

Option 2 – New Junction 9



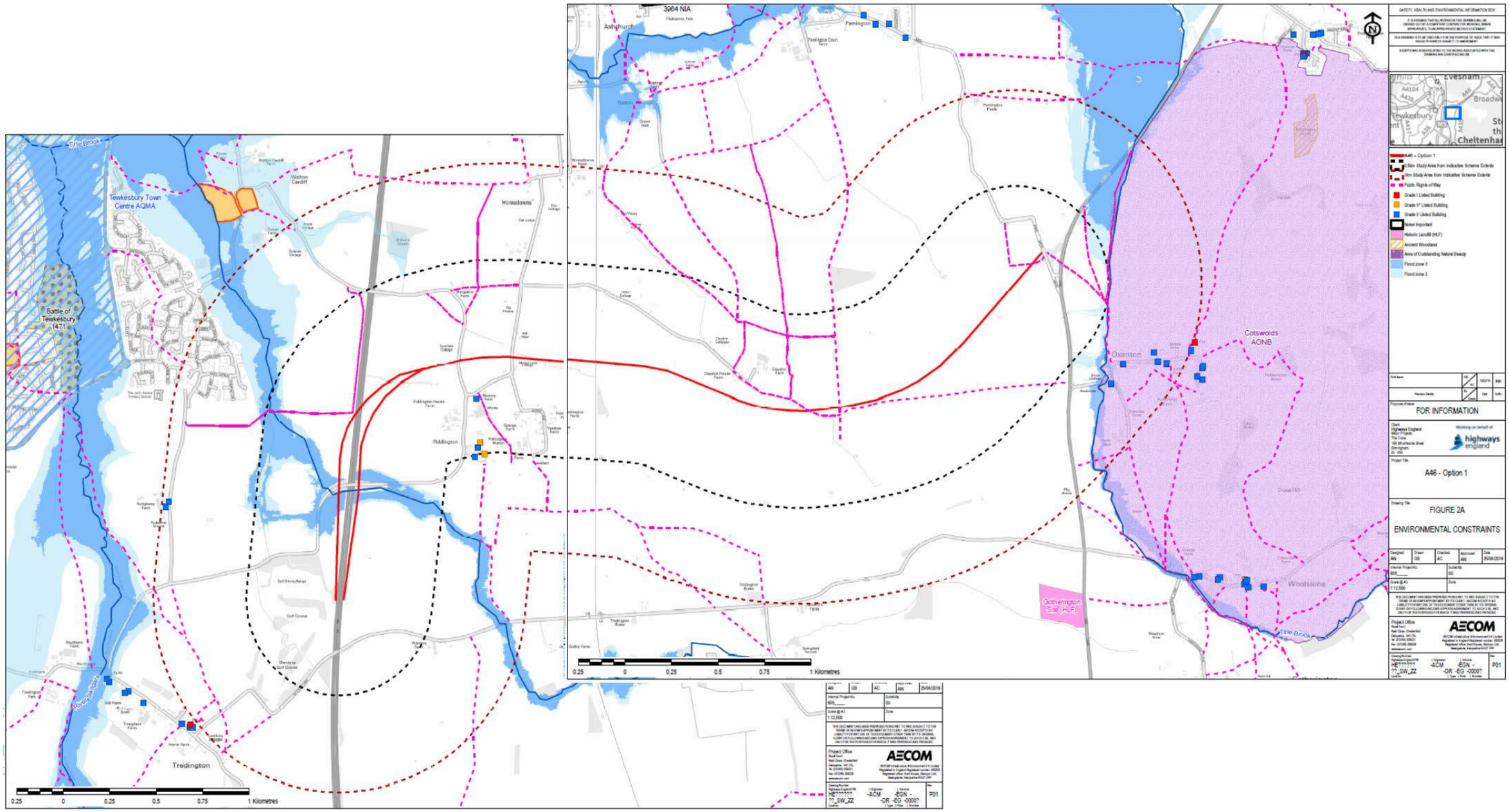
Option 3 – Southern Bypass



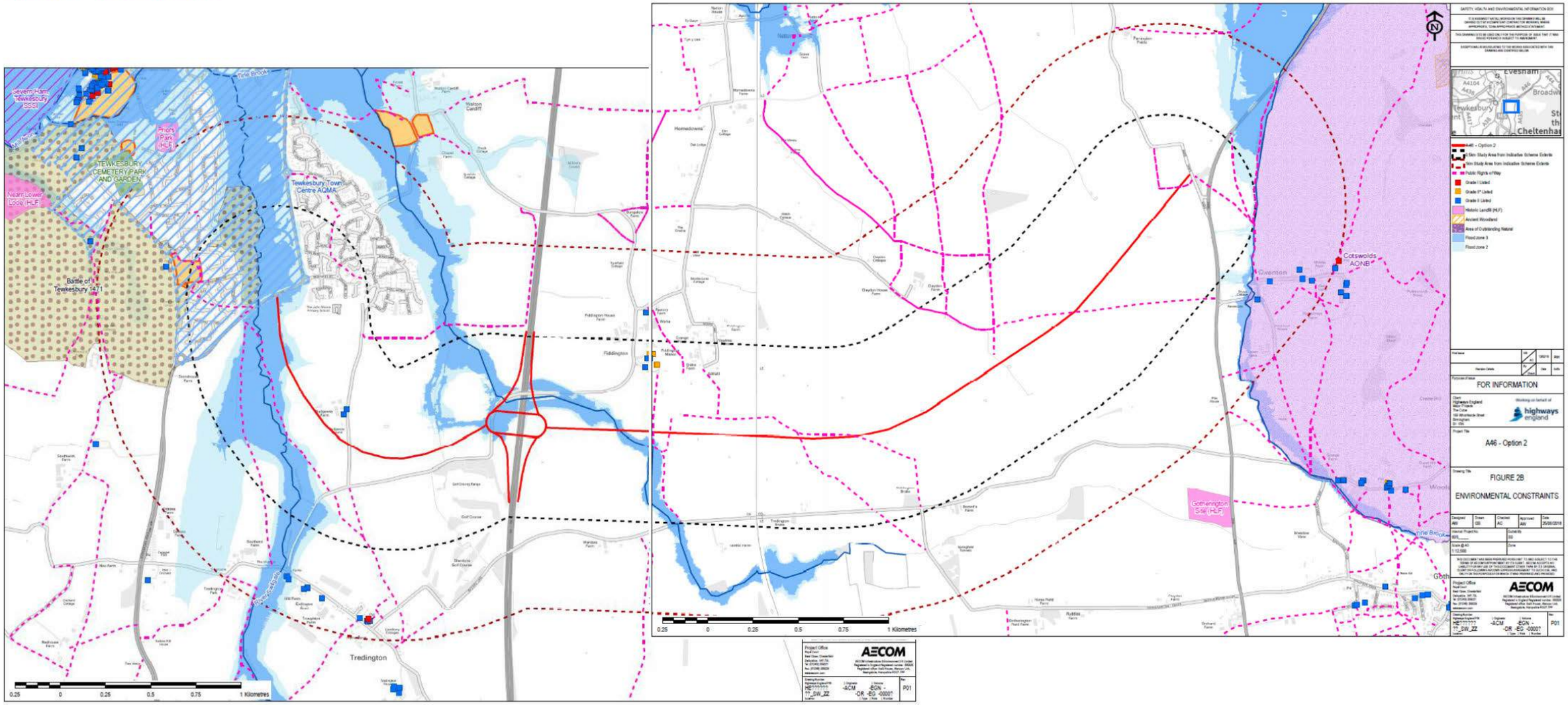
Appendix B – Alternative Mode Assessment

Appendix C – Environmental Constraints Maps

Option 1 – South-facing slips



Option 2 – New Junction 9



Option 3 – Southern Bypass