highways england

A27
Arundel Bypass
Scheme Assessment Report

Volume 1.0

May 2018

TABLE OF CONTENTS

TABLES

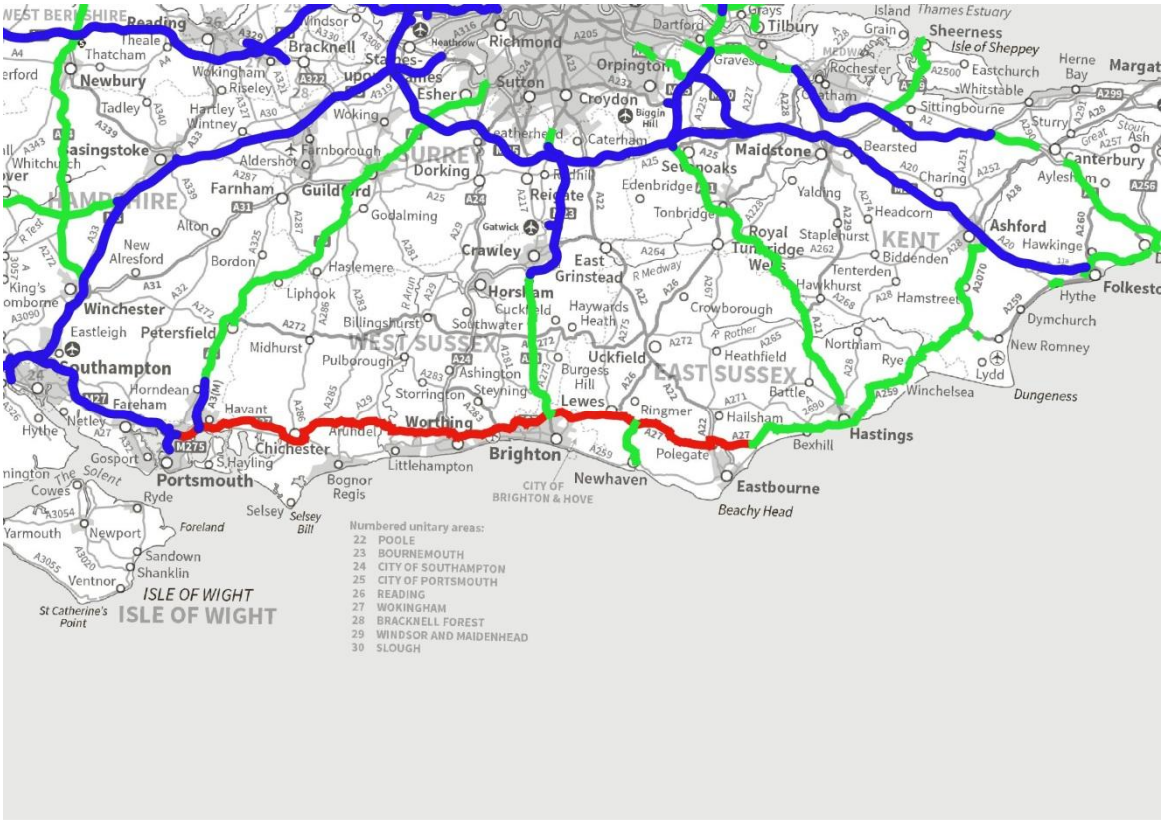
FIGURES

1 INTRODUCTION

1.1 SCHEME CONTEXT

1.1.1 The A27 forms part of the Strategic Road Network (SRN) running from Pevensey in East Sussex in the east to Portsmouth in the west as illustrated in Figure 1-1. It is the only east-west trunk road south of the M25 resulting in it serving as both part of the SRN and as a local distributor, with short trips and long-distance heavy traffic causing substantial interaction at junctions. It links key coastal urban areas between Eastbourne and Portsmouth with the rest of the strategic road network. Over three quarters of a million people are concentrated in this urbanised coastal area. The route also runs along and across the South Downs National Park (SDNP).

Figure 1-1 Strategic Road Network in the South East of England



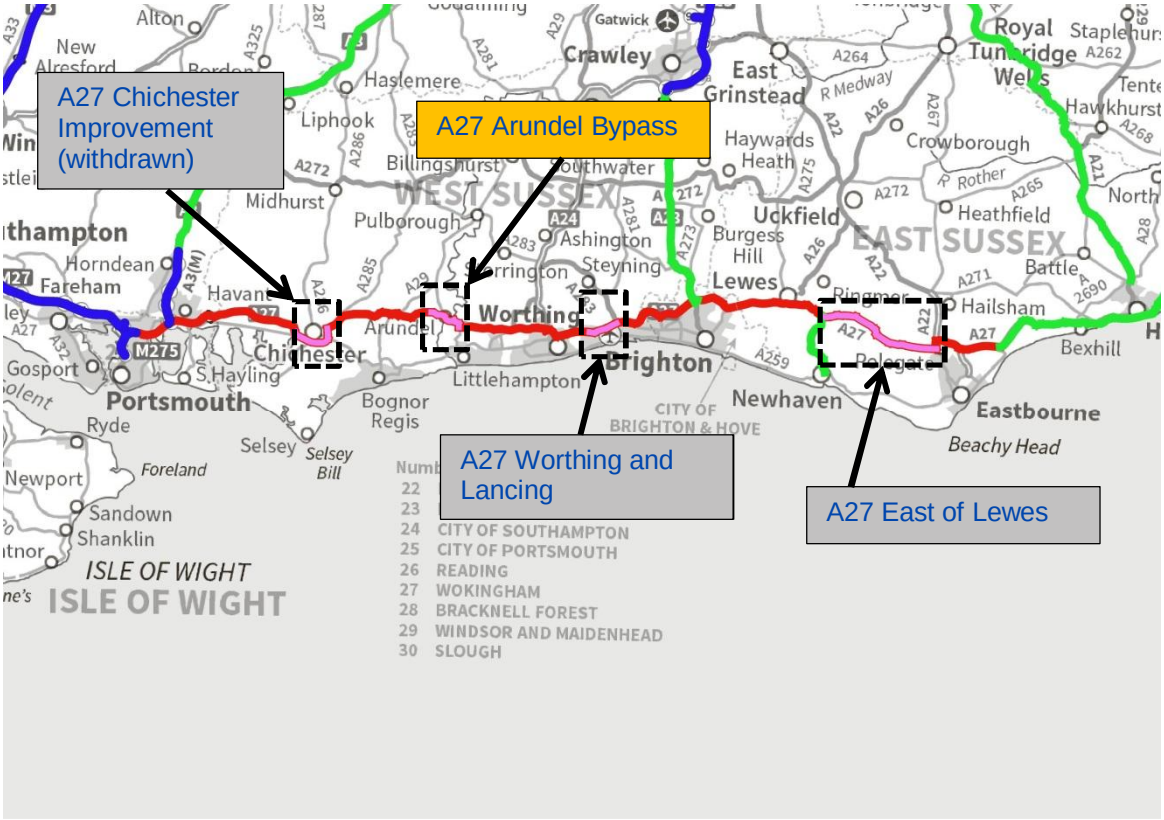
1.1.2 Over 60% of the 67 mile length of road is dual carriageway, while four stretches of the road remain single carriageway at Arundel, Worthing and two sections east of Lewes. Such sections of road tend to experience peak hour congestion and poor time reliability. The 2015 A27 Corridor Feasibility Study found that, at Arundel, the A27 is already operating at 100%-150% capacity. Due to population growth and increased economic activity in the region there will be more traffic using the A27 through Arundel in the future. Without improvement, the congestion and delay on the A27 through Arundel will increase in the future. The single carriageway section is further constrained by congestion resulting from limited capacity at at-grade junctions at Ford Road Roundabout and Crossbush Junction.

1.1.3 Provision of a new dual carriageway bypass of the A27 at Arundel was announced in the Road Investment Strategy: for the 2015/16 – 2019/20 Road Period (Department for Transport, December 2014, update March 2015) to ensure it can deliver the performance needed to support the nation in the 21st century. The scheme is currently in the option selection stage.

1.1.4 Within the Highways England Road Investment Strategy (RIS), four major improvements were prioritised and committed to start before the end of the first RIS period (2015/16 to 2019/20) on the A27 corridor and as illustrated in Figure 1-2:

- A27 Arundel Bypass - replacement of the existing single carriageway road with a dual carriageway bypass, linking together the two existing dual carriageway sections of the road;
- A27 Chichester improvement - Upgrading four junctions on the A27 Chichester bypass;
- A27 East of Lewis - package of proposals to improve capacity along the A27 between Lewes and Polegate; and
- A27 Worthing and Lancing - improvements to the capacity of the road and junctions along the stretch of single carriageway in Worthing and narrow lane dual carriageway in Lancing.

Figure 1-2 A27 Corridor RIS schemes



1.1.5 The A27 Chichester Improvement was removed from the RIS following a public consultation in 2016, when support from local councils for the options presented was withdrawn resulting in a critical lack of consensus.

1.1.6 This sets the wider context for the current A27 Arundel Bypass Scheme which has an extensive history in the search for an affordable and acceptable solution.

1.2 SCHEME HISTORY

1.2.1 Proposals for the improvement of the A27 at Arundel have been the subject of extensive study and consultation since 1987. The main events providing background context to the current scheme are as follows:

Table 1-1 Scheme History

TIME LINE	DESCRIPTION
1987	First public consultation on three routes termed the orange, red and purple routes illustrated in Figure 1-3. A modified orange route was proposed during the consultation.
1989	Orange route was selected as the Preferred Route.
1991	Second public consultation on the orange route with alternative route at the eastern end called the blue route and alternative route at the western end termed the brown route as illustrated in Figure 1-4. The pink route was proposed during the consultation as an alternative to brown route.
1993	During further consultation three alternative routes for the western end were proposed. These were termed the green routes and are illustrated in Figure 1-5.
1993	Pink Blue route selected as preferred option following a comparison with the green routes. Pink route identified as least environmentally damaging option.
1995 – 2000	A series of Government reviews of the roads programme and transport strategy resulted in the scheme been placed in long term category.
2002 – 2003	The South Coast Multi Modal Study (SoCoMMS) carried out for the Government as part of a review of transport provision recommended a new bypass at Arundel. The recommendation was rejected by the Secretary of State for Transport due to its environmental impact and further investigation of less environmentally damaging options was requested.
2005 – 2006	Further investigation of options was carried out by the Highways Agency focusing on less environmentally damaging solutions.
2014 – 2015	The A27 Feasibility Study considered 7 route options developed as part of the further investigations undertaken after SoCoMMS and 3 non highway options. Following a sifting of options two dual carriageway bypass options to the south of the existing A27 were evaluated and concluded that an investment case existed.

Figure 1-3 1987 First Public Consultation Route Options – Original Preferred Route

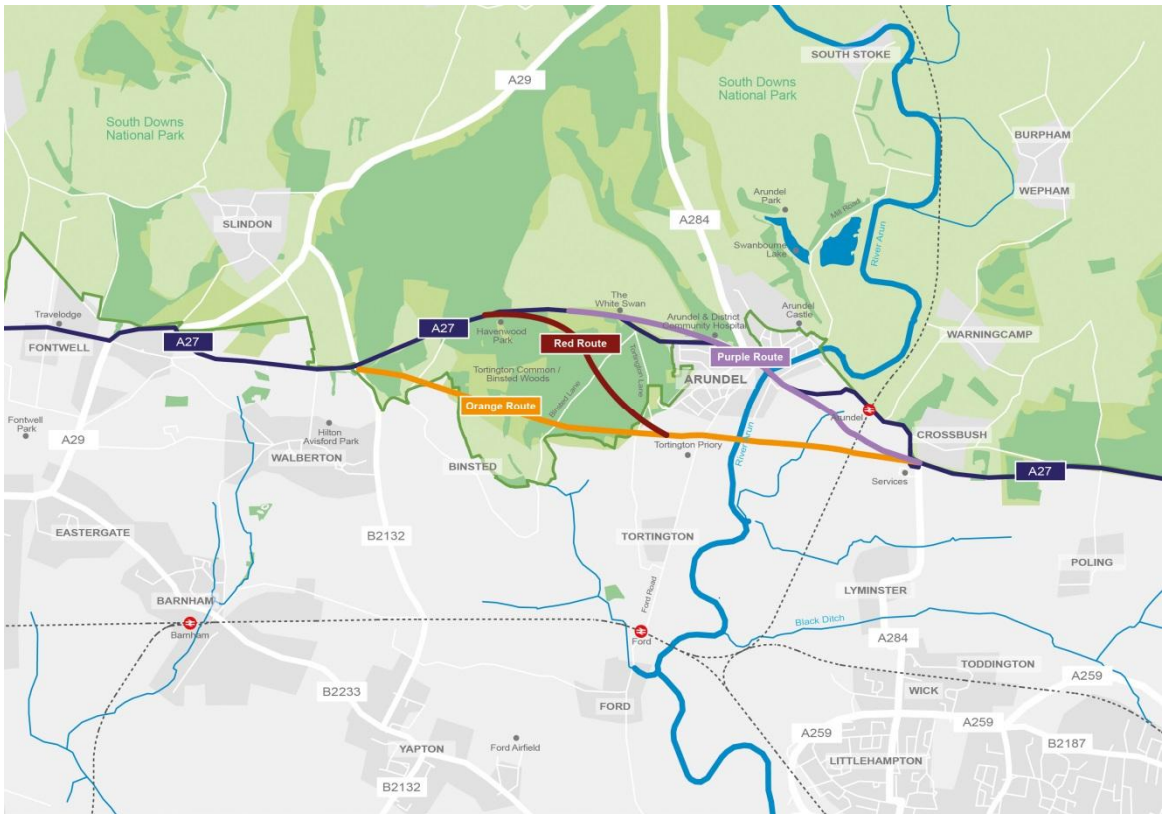


Figure 1-4 1991 Second Public Consultation Route Options

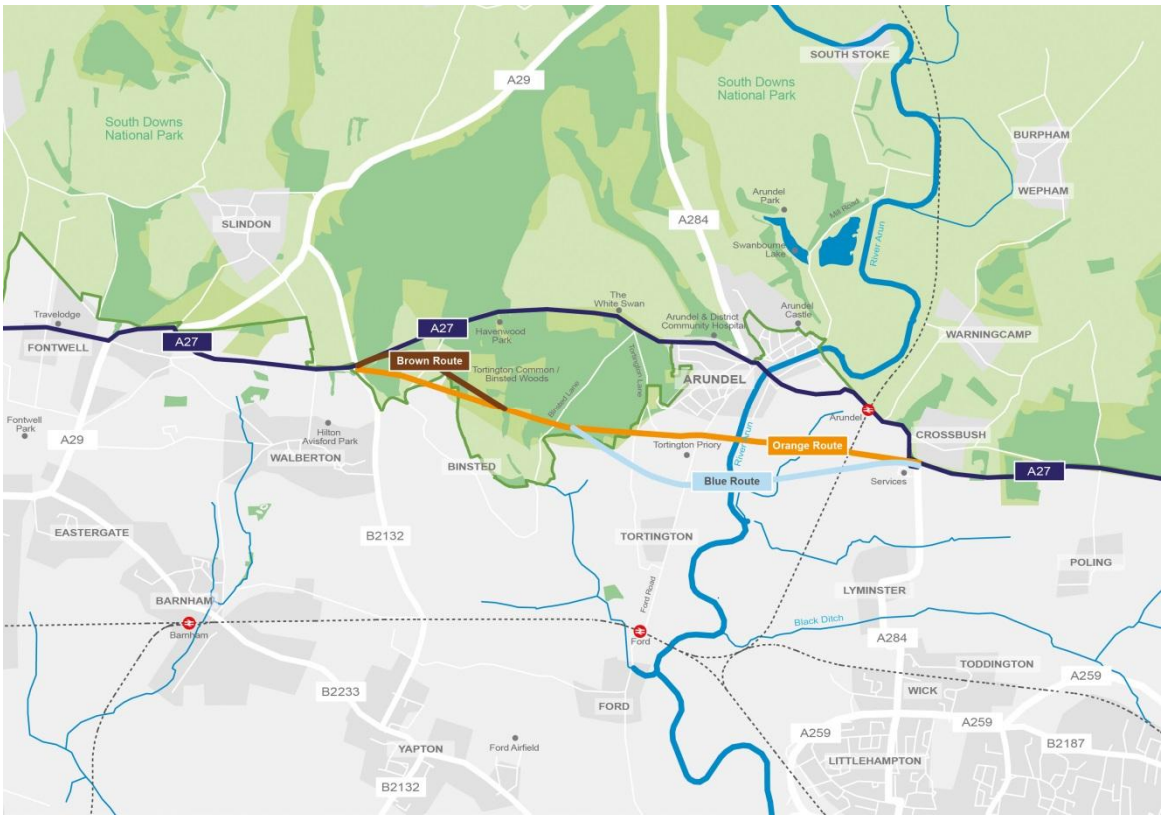
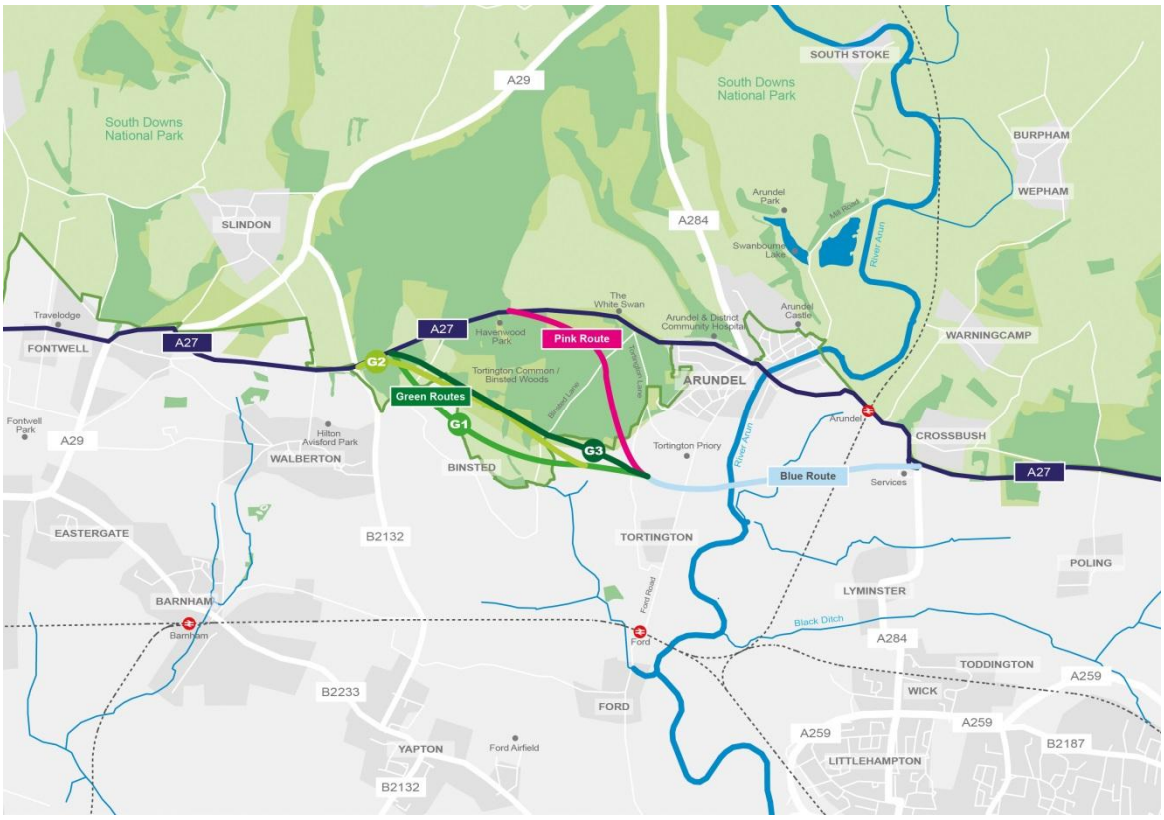


Figure 1-5 1993 Further Consultation Route Options and Preferred Route (Pink – Blue Route)

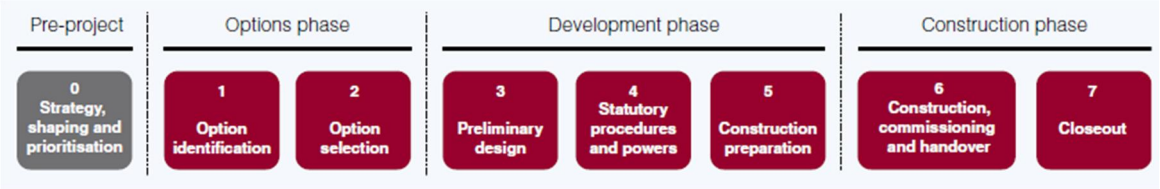


1.2.2 The results of the A27 Feasibility Study informed the RIS, which was published by the Government on 1 December 2014 and included proposals for a new dual carriageway bypass to link together the two existing dual carriageway sections of the road either side of Arundel. The starting point was proposed to be the previous 1993 preferred route, subject to consultation with the National Park Authority (NPA), local government and the public on this and alternative options.

1.2.3 The A27 Feasibility Study also informed the Pre-project Strategy, Shaping and Prioritisation of the A27 Arundel Bypass scheme, as the start of Highways England's Project Control Framework (PCF) illustrated in Figure 1-6 below. The PCF Stage 0 was completed at the end of 2015 by WSP / PB, which recommended consideration of seven options at the start of the Options Phase. These comprised both online options as well as bypass route options. Within the Stage 0 assessment there was insufficient information to discount an on-line option at that stage. Highways England decided, therefore, to continue to consider such an option within Stage 1 (see Chapter 5).

1.2.4 Highways England commissioned WSP / PB in 2016 to undertake the Options Phase for the scheme (PCF Stages 1 and 2). This Scheme Assessment Report (SAR) represents the conclusion of the Stage 2 Options Selection phase, leading into a Preferred Route Announcement and the subsequent Development phase.

Figure 1-6 Highways England Project Control Framework



1.3 SCHEME BRIEF

ROAD INVESTMENT STRATEGY OBJECTIVES

1.3.1 Part 1 chapter 2 of the Road Investment Strategy: for the 2015/16 – 2019/20 Road Period (Department for Transport, March 2015) sets out the Department for Transport's (DfT's) aspiration for the strategic road network to be smoother, smarter and sustainable by 2040. The Department for Transport aims to achieve this by focussing on eight key performance areas as set out in part 3 Chapter 1 of the RIS. These are:

- 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
- Keeping the network in good condition

HIGHWAYS ENGLAND SCHEME OBJECTIVES

1.3.2 The objectives for the A27 Arundel Bypass scheme are set out in the Client Scheme Requirements. These are reproduced below:

HIGH-LEVEL OBJECTIVES

1.3.3 Project objectives were defined in the feasibility study and further refined in a stakeholder workshop in May 2016. Objectives are:

- Improve capacity of the A27 whilst supporting local planning authorities to manage the impact of planned economic growth.
- Reduce congestion, reduce travel time and improve journey time reliability along the A27.
- Improve the safety of travellers along the A27 and consequently the wider local road network.
- Improve accessibility for all users to local services and facilities.
- Deliver a scheme that minimises environmental impact and seeks to protect and enhance the quality of the surrounding environment through its high quality design.
- Respect the South Downs National Park and its special qualities in our decision-making.

DETAILED OBJECTIVES

1. Improve capacity of the A27 whilst supporting local planning authorities to manage the impact of planned economic growth. These include:
   - improving regional connectivity, taking into account all modes of transport, and the resilience provided by the A27 route within the West Sussex coastal region in order to contribute positively to the economy of the Arun area; and
   - facilitating the delivery of housing allocations within the Local Plans
2. Reduce congestion, reduce travel time and improve journey time reliability along the A27.
3. Improve the safety of travellers along the A27 and consequently the wider local road network:
   - Along the Arundel section of the A27 route. The A27 through Arundel has a higher than average accident rate due to its single carriageway component and multiple junctions. This is outlined further in Section 2.4.
   - On the wider local road network caused by longer distance traffic avoiding congestion on the A27.
4. To reduce the community severance caused by the A27 through Arundel by improving the links between local communities, to provide better access to local services and facilities, particularly for tourism and access to railway stations and bus services.
5. To deliver a design that reflects the quality of the landscape and setting of Arundel that takes advantage of opportunities to minimise the adverse environmental impact of new construction, including habitat loss, and takes into account the following objectives
   - plan for climate change;
   - work in harmony with the environment to conserve natural resources and encourage bio-diversity;
   - protect and enhance the countryside and historic and archaeological environments; and
   - Reduce air and noise pollution.
6. Recognising that any improvement would have a significant impact on the SDNP, have regard to the National Park purposes and the special qualities the SDNP authority is seeking to preserve in designing and evaluating improvement options.

1.4 PURPOSE OF THIS REPORT

1.4.1 The purpose of this PCF Stage 2 Scheme Assessment Report (SAR) is to provide a summary of the technical appraisal of the consultation options allowing the evaluation of options and selection of a preferred route by Highways England.

1.4.2 This report is structured into the following 15 chapters supported by a number of appendixes:

Volume 1 (this document):

1. Introduction
2. Summary of Existing Conditions
3. Summary of Planning Policy
4. Summary of Do Nothing Scenario
5. Summary of Alternative Schemes
6. Summary of Traffic and Economic Appraisal
7. Summary of Environmental Appraisal
8. Summary of Operational and Maintenance Assessment
9. Summary of Public Consultation
10. Summary of Post Consultation Development
11. Appraisal Summary
12. Conclusion and Recommendation

Volume 2

Appendix A	A-1	Environmental Drawings – Cultural Heritage
Appendix A	A-2	Environmental Drawings – Landscape
Appendix A	A-3	Environmental Drawings – Biodiversity
Appendix A	A-4	Environmental Drawings – People and Communities and Water Environment

Volume 3

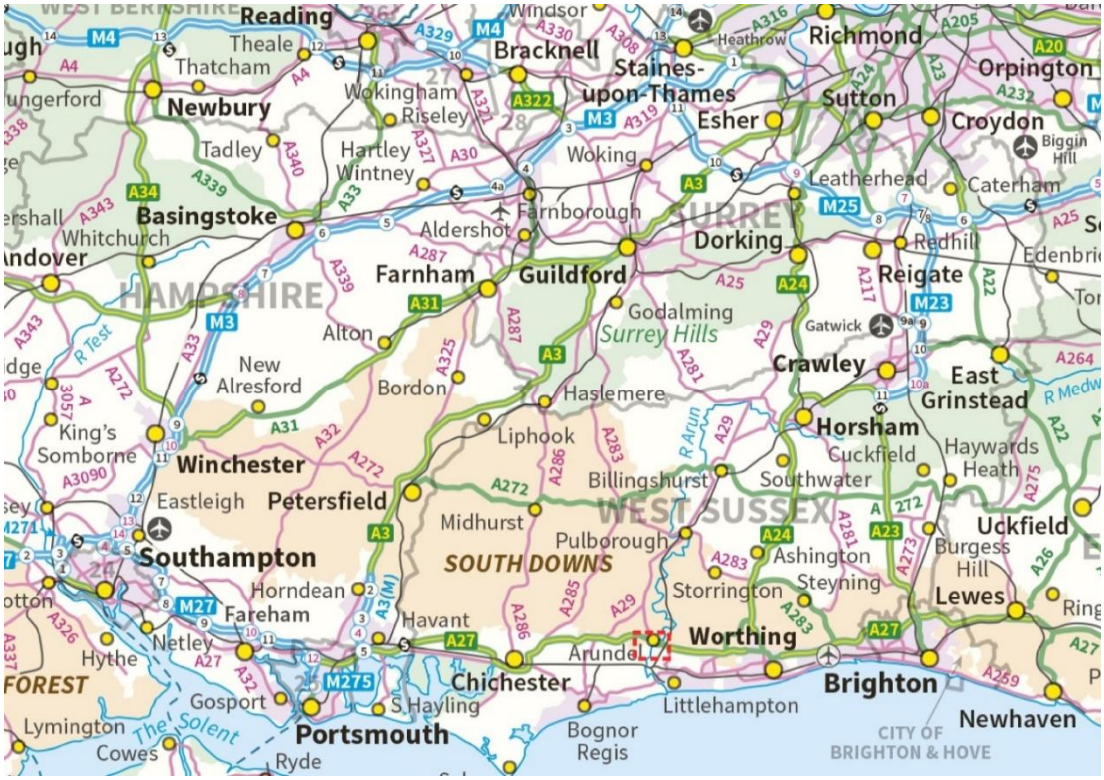
Appendix B	B-1	Scheme Layout Drawings – Option 1
Appendix B	B-2	Scheme Layout Drawings – Option 3
Appendix B	B-3	Scheme Layout Drawings – Option 5A
Appendix C	C-1	Scheme Layout Drawings – Option 1V
Appendix C	C-2	Scheme Layout Drawings – Option 5AV
Appendix D	D-1	Appraisal Summary Table's
Appendix E	E-1	National Networks National Policy Statement Compliance Table

2 SUMMARY OF EXISTING CONDITIONS

2.1 STUDY AREA/ LAND-USE/ LOCALITY

The small historic market town of Arundel is located within the Arun District of West Sussex in the South of England. The town is positioned in a steep valley on the border of the South Downs National Park (SDNP). The national park covers an area of 1600km^2, extending from Winchester in the west to Eastbourne in the east.[1] The location of Arundel in a regional context is presented in Figure 2-1.

Figure 2-1 Regional Location



2.1.1 The largest population centre in the surrounding region is the city of Brighton and Hove, located approximately 29km to the east of Arundel, with a population of over 270,000[2]. Other nearby major urban areas includes Littlehampton to the South, Worthing to the East, Bognor Regis to the South-West and Portsmouth and Chichester to the West.

2.1.2 There are a number of major employment areas within the region, one of which is the Gatwick Diamond, a diamond-shaped geographical area with Gatwick Airport at its centre. Within this area there are 45,000 businesses, many of which are global companies, generating £24 billion GDP. The Gatwick Diamond has strong commuter links to towns along the south coast. Other major employment areas are situated in the cities of Portsmouth and Brighton and Hove for example, as well as the large town of Worthing.

[1] *https://www.southdowns.gov.uk/discover/https://www.southdowns.gov.uk/discover/*
[2] Population figures are sourced from the 2011 Census key statistics *https://www.nomisweb.co.uk/*

2.1.3 Tourism is a key driver of the economic activity in the region, with West Sussex as a county receiving over 17 million visitor days per year. This contributes over £500 million to the local economy[3]. However, it is felt that traffic congestion, particularly on the A27, restricts the areas' economic potential[4].

2.1.4 Pockets of deprivation are found within the county of West Sussex, especially in coastal areas. These areas suffer from a skills shortage and lack of accessibility to higher value employment sectors within the county. Some of the most deprived areas are the wards of River and Ham in Littlehampton, with three Lower Super Output Areas (LSOA's[5]) in these two wards falling within the UK's top 10% most deprived areas. As a result of this, regeneration is underway, not just in Littlehampton, but in Bognor Regis, Shoreham and Newhaven. In Bognor Regis for example, there are proposals to develop a creative/digital hub through the implementation of 108,500m^2 of employment space, generating over 4,000 jobs.

2.1.5 Figure 2-2 presents the extent of the local road network within the A27 Arundel Bypass study area.

Figure 2-2 Scheme Location

2.1.6 Arundel has a population of approximately 3,500 people, with an average age of 47.1 years[6]. The town is a popular tourist destination for its location on the border of the SDNP and for its heritage which includes three scheduled monuments, one of which is Arundel Castle and many listed buildings including Arundel Cathedral.

[3] The GB Day Visitor Statistics 2015, Visit Britain
[4] http://tourisminsights.info/ONLINEPUB/STRATEGY/STRATEGY%20PDFS/Arun%20District%20Council%20(2006),%20Sussex%20by%20the%20Sea%20-%20Visitor%20Strategy%202006-2011,%20ADC,%20Littlehampton.pd
[5] A geographical boundary used in the production of statistics collected via the UK census
[6] Population figures are sourced from the 2011 Census key statistics *https://www.nomisweb.co.uk/*

2.1.7 Employment within Arundel itself is focused on the tourist industry, with restaurants, shops, and a museum featuring alongside the historical attractions. Situated just outside of Arundel are a number of industrial areas. These include Ford Lane, Ford Road and Rudford Industrial Estates all of which are situated adjacent to Ford Road.

2.2 EXISTING NETWORK

2.2.1 This section describes the existing transport network with the wider region and the study area, including the provision for highway, public transport, and Walking, Cycling and Horse Riding (WCHR) users.

HIGHWAY

2.2.2 The A27 is the only east-west trunk road south of the M25. It links many of the towns and cities along the South coast, including Portsmouth, Havant, Chichester, Arundel, Worthing and Lancing, Brighton and Hove, Lewes, and Eastbourne. It serves a population of over 750,000 people as well as a large number of businesses. The A27 also provides access to the wider Strategic Road Network (SRN[7]), and is therefore an important corridor for both longer distance travel (67%) and local traffic (33%)[8].

2.2.3 The A272 provides a predominantly single carriageway parallel route between Winchester and the Haywards Heath area along a similar east – west alignment, to the north of the A27. The A259 provides a predominantly urban route between Chichester and Brighton and Hove and continues to the east. Neither route is considered to offer a genuine alternative to the A27 as a strategic long distance route.

2.2.4 Locally to Arundel there are two east-west routes that are used as alternatives to particular sections of the A27. The first is located to the north, the A29 / B2139 / A283, which passes through the SDNP and the villages of Storrington and Steyning. To the south is the B2233 / A259 which runs through Eastergate, Barnham, Yapton and Climping, north of Littlehampton and then on to Goring by Sea and Worthing.

2.2.5 The existing A27 through the Arundel area is approximately 6 km in length, from the approach to the Crossbush junction to the east of Arundel, to the junction with Yapton Lane to the west. Currently, the A27 bisects the SDNP and the town of Arundel, and passes over the River Arun and the Arun Valley railway line. This can be seen from Figure 2-2.

2.2.6 The A27 at Arundel consists of sections of single carriageway, dual carriageway, and a number of at-grade junctions. The single carriageway section is approximately 3.7km in length and extends from its junction with Long Lane near the Arundel Arboretum to the west of Arundel through to the Crossbush junction to the east. Uncontrolled at-grade roundabouts are present at Ford Road and the Causeway junctions, whilst the Crossbush junction is partially signal controlled.

[7] The Strategic Road Network is made up of motorways and trunk roads.
[8] Based on traffic on the A27 between Crossbush roundabout and Causeway roundabout. Local traffic defined as having an origin or destination within Arundel. Through-traffic has an origin and a destination outside of Arundel. Based on 2015 observed data.

2.2.7 Heading west from Crossbush the single carriageway section of the A27 drops down the steep valley side of the River Arun flood plain on a winding alignment. It passes over the Arun Valley railway line on a humped back bridge. Heading west there are dramatic views of Arundel Castle (scheduled monument) and Cathedral (listed building). From the Causeway roundabout the road crosses the flat River Arun floodplain on a low embankment on a route constructed in the 1970's as a bypass to the south of the historic town centre of Arundel.

2.2.8 The road crosses the River Arun just to the south of the historic town centre on a bridge built as part of the bypass. From the Ford Road Roundabout the road then follows a winding alignment up the steep west valley side of the River Arun before transitioning back to dual carriageway. This section of the A27 is located within the SDNP.

2.2.9 The three major junctions on this section of the A27 are:

- → Crossbush signalised T-junctions with the A284
- → Causeway priority roundabout with Causeway/Queen Street
- → Ford Road priority roundabout with the A284, Ford Road and Maltravers Street

2.2.10 The performance of these links and junctions is described in section 2.4.

2.2.11 The section of the A27 from Crossbush to Ford Road roundabout caters for both east west movements on the A27 and north-south movements on the A284 which links Littlehampton with the A29 near Madehurst and provides a bypass to the historic town and former route of the A27. The town has since grown to the southwest in the corridor between the A27 Chichester Road and the Ford Road and this more modern residential area is severed from the town centre by the high traffic flows on this section of the A27 and by the lack of controlled pedestrian crossing facilities.

2.2.12 Priority junctions with and without right turn facilities give access to land use and routes that include Arundel Station, Arundel District and Community Hospital, Canada Road and Binsted / Tortington Lane. In addition there are a number of private accesses and farm accesses located along this section of the A27. There are also a number of controlled and uncontrolled pedestrian crossing facilities as described in more detail in section 2.3.4.

2.2.13 Other significant roads within the study area include the A29. This intersects with the A27 to the east of Fontwell, at an uncontrolled at-grade roundabout. The A284 connects with the A27 in two locations, at the Ford Road five-arm roundabout and at the Crossbush junction. It is the primary route used for those in Littlehampton, Wick and Lyminster to travel to and from locations to the north. Other local roads include the B2130 to the north of the town and the B2233 to the south.

RAIL

2.2.14 Arundel railway station is located adjacent to the A27 to the southeast of the Causeway Roundabout, approximately a 13 minute walk from Arundel town centre. The station has pay and display car parking, along with two platforms and two entrances. The station is located on the Arun Valley railway line with the Southern Rail service operating between London and Bognor Regis. Trains travel approximately every half an hour to London Victoria and Gatwick Airport, taking between 60 and 90 minutes[9].

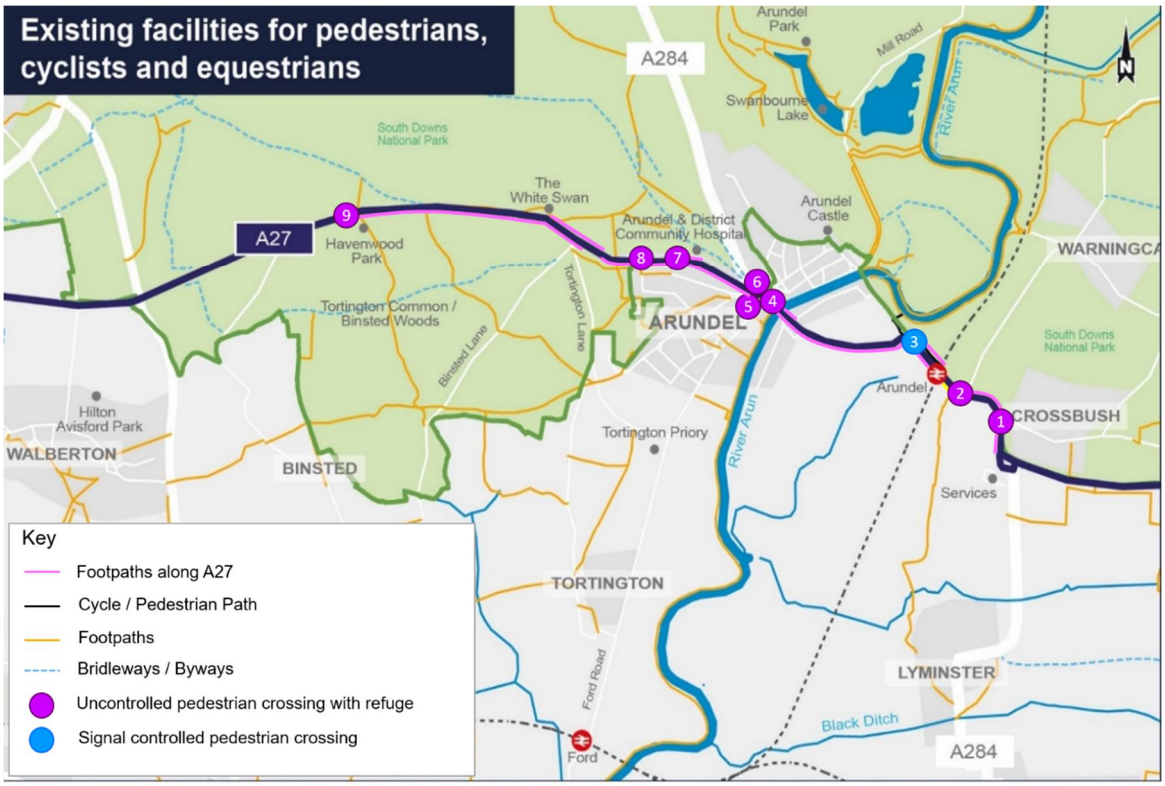
[9] https://www.thetrainline.com/stations/arundel

2.2.15 Other nearby rail stations are in Ford, Barnham, Littlehampton, Amberley and Angmering. Ford and Barnham stations, situated on the West Coast Railway line, are important interchanges for other destinations, including Portsmouth Harbour, Worthing and Brighton, with departures occurring approximately every 20 minutes.

WALKING CYCLING AND HORSE RIDING USERS

2.2.16 The current provision of Walking, Cycling and Horse Riding (WCHR) facilities, including shared cycle and pedestrian paths, footpaths and bridleways/ byways, are highlighted in Figure 2-3.

Figure 2-3 Existing facilities for pedestrians, cyclists and equestrians



2.2.17 The local public rights of way network covers a wide area, with footpaths linking Arundel to the villages of Lyminster, Tortington, Binsted and Walberton. The network also extends into the SDNP and along the River Arun, through a series of footpaths and bridleways / byways. These routes are predominantly used for leisure and recreation purposes rather than commuting, with the exception of the shared cycle and pedestrian paths which connect Arundel to the railway station.

2.2.18 With reference to Figure 2-3, WCHR facilities along and across the A27 comprise of the following:

- Uncontrolled pedestrian crossings with refuge – two locations between Crossbush junction and Arundel station (at points 1 and 2 on Figure 2-3), three at the five arm Ford Road roundabout (4, 5 and 6 on Figure 2-3) – the exception being the Maltravers Street arm and the A27 western arm – two between Ford Road roundabout and the White Swan (7 and 8), and one close to Havenwood Park (9)
- Signal controlled pedestrian crossing - located to the west of Arundel station (3)
- Shared cycle/pedestrian footway – from Arundel station to the west of the Causeway Roundabout. Highlighted as the black line on Figure 2-3.

- Pedestrian footpath – located along the majority of the A27, from Crossbush junction up until Havenwood Park, where immediately to the West of this point there is no provision. This is highlighted as the pink line in Figure 2-3.

2.2.19 The condition of the footpaths along the A27 are variable, and are poorly lit and narrow in places. This, together with the fact that the footpaths are not continually provided along the road, discourages their use.

2.3 EXISTING TRAFFIC CONDITIONS

SOURCE DATA

2.3.1 The data used to describe existing traffic conditions comprises the following sources:

- Census Journey to Work, sourced from NOMIS, the official labour market statistics website[10].
- Traffic count data from WebTRIS, WSCC and other sources
- Journey time data from TrafficMaster surveyed between May and June 2015
- A27 Strategic Traffic Model[11].

2.3.2 The A27 Strategic Traffic Model reflects an average weekday in March 2015, with March classified as a neutral month. The modelled time periods are:

- AM Peak – 07:00 – 10:00
- Inter Peak (IP) – 10:00 – 16:00
- PM Peak – 16:00 -19:00

2.3.3 A further description of the A27 Strategic Traffic Model and how it has been developed further since PCF Stage 1 is provided in Section 11.

JOURNEY PATTERNS

2.3.4 This section summarises the journey patterns within the area as context for the description of traffic flows and conditions in later sections.

2.3.5 Based on Census Journey to Work (2011) data, the car is the most prevalent means of transport in the area, with 45% of Arun District residents (aged 16 to 74) travelling to work by car or van. Walking is the second highest mode of transport at 6%, followed by working from home at 4%, train at 3%, cycling at 2%, bus/minibus/coach at 2%, motorcycle at 1%, other at 0.4%, taxi at 0.2% and lastly underground/metro/light train/tram at 0.1%[12]. 36% of the residents are not in employment.

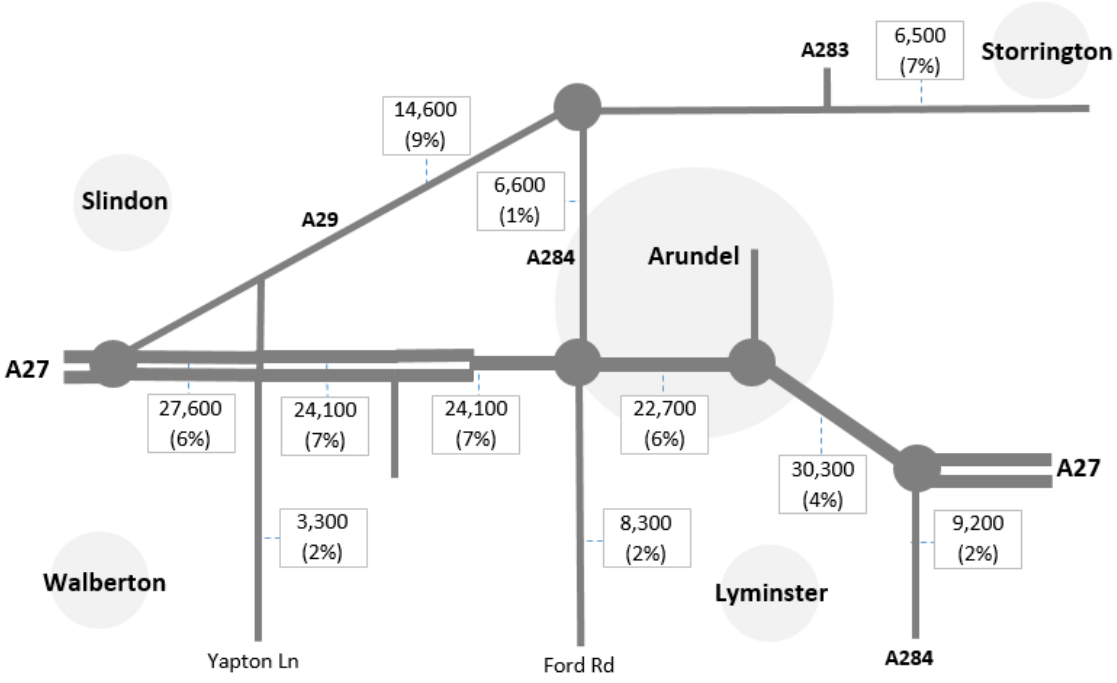
[10] https://www.nomisweb.co.uk/census/2011/qs701ew
[11] HE551523-WSP-GEN-A27A-PCF2-RP-TR-ComMA_P03.03_ISSUE.pdf
[12] Qs701EW Method of travel to work: 2011 Census NOMIS

2.3.6 The majority of travel to work movements are those which are travelling out of the district, at over 27%,[10]. This is compared to nearly 9,000 who travel into the district to work[10]. The major inflows into the Arun District are from the east, with inflows from Worthing accounting for 35% of the total journey to work movements. From the west, 25% of the inflows originate in Chichester and 7% are from Horsham[13]. The highest outflows are for destinations to the west, with 39% of outflows associated with Chichester at 39% and Horsham at 7%. To the east, 21% of outflows travel to Worthing[10]. This illustrates a tidal movement of journey to work trips which is highest in a westbound direction in the morning peak, into and out of Arun, with the reverse pattern of movement in an eastbound direction during the evening peak.

2.4 TRAFFIC FLOWS

2.4.1 Figure 2-4 presents the current Average Annual Daily Traffic (AADT) two-way flows within the study area for year 2015. The figures presented in this report are an approximation of AADT which is the total volume of vehicle traffic on a section of road over a full year divided by 365 days.

Figure 2-4 Base Year (2015) two-way AADT)



2.4.2 Within the study area, current traffic volumes are highest along the A27, particularly on the single carriageway section to the West of Crossbush where there is a volume of over 30,000 vehicles per day. AADT remains high on the A27 as it bisects Arundel, with 20,000 to 28,000 vehicles per day using these sections of road. The A29 experiences flows of almost 15,000 vehicles per day. The lower order roads in the study area, such as Yapton Lane, Ford Road and the A284, have lower AADT flows.

[13] ONS, Census WU03UK – Location of usual residence and place of work by method of travel to work. https://www.nomisweb.co.uk/census/2011/WU03UK/chart/1132462325

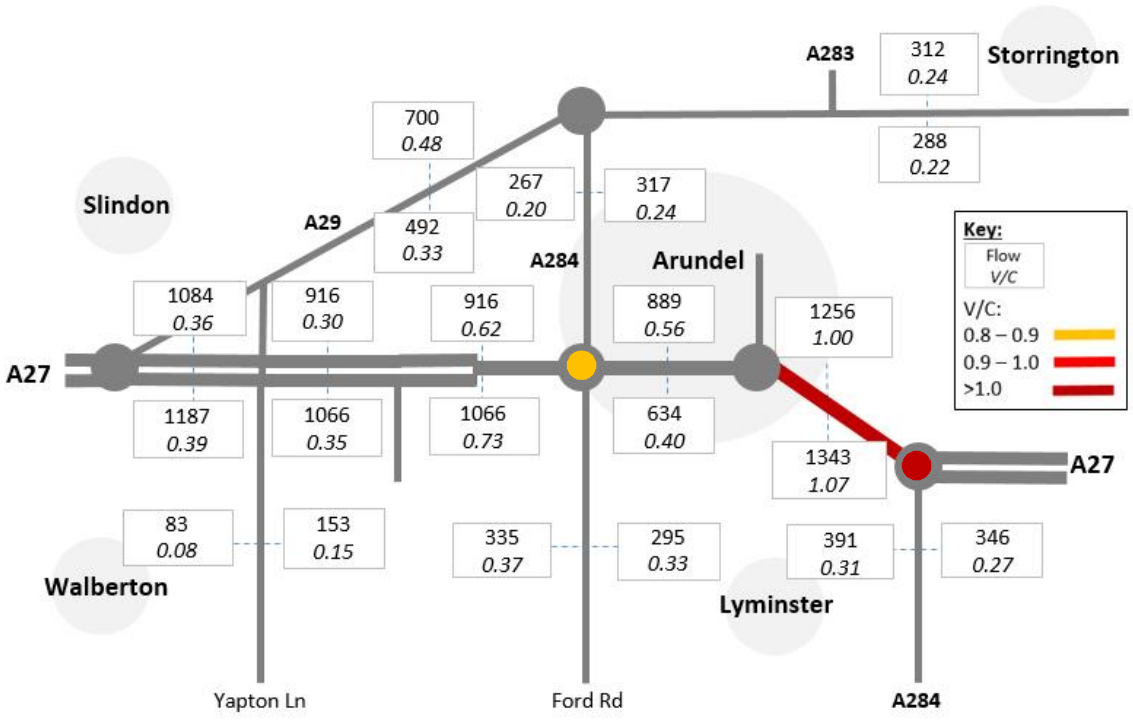
2.4.3 Along the A27, the proportion of HGVs is highest to the west of Arundel, with a high of 7% of total vehicles on the dual carriageway section between Yapton Lane and Ford Road roundabout. To the east of this roundabout, HGV numbers decrease as a number have destinations within Arundel or along Ford Road. The percentage of HGVs along the A29 is high relative to other routes, at 9%.

2.4.4 The dual carriageway on either side of Arundel has the capacity to carry existing traffic flows and accommodate future traffic growth. However, the single carriageway sections are not able to accommodate the demand during peak periods, resulting in congestion. The main congestion points are observed at the Ford Road roundabout, the section between the Causeway roundabout and Crossbush, and the approaches to Crossbush junction.

Figure 2-5 and Figure 2-6 summarise the AM and PM peak flows and capacity, measured in number of vehicles, along the same sections of road as presented in Figure 2-4. Capacity is defined in TA 79/99 as the maximum sustainable flow of traffic passing in one hour, under favourable road and traffic conditions and is measured in one-way hourly flow in each direction[14].

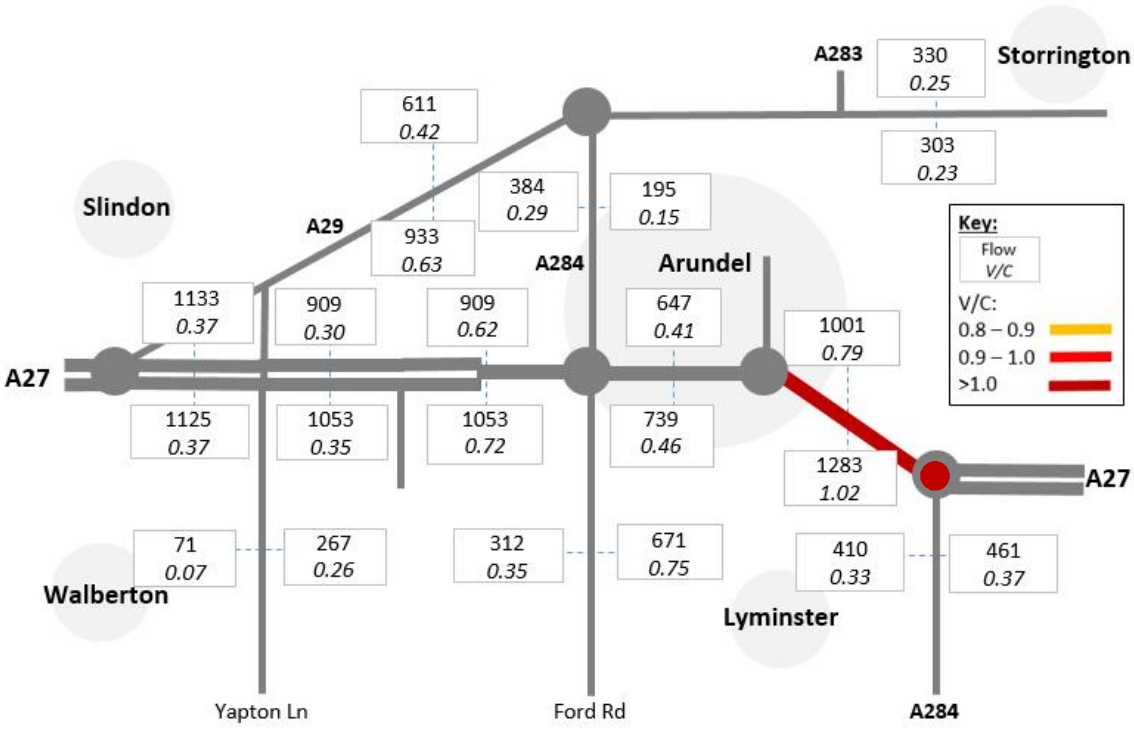
2.4.5 A Volume / Capacity (V/C) figure is presented for each link. Peak V/C compares traffic volume with the capacity of the road. The higher the value, the closer the road is to capacity, and therefore the more prevalent congestion is likely to be. In addition, where maximum junction Ratio Flow to Capacity (RFC) or Degree of Saturation (DoS) exceeds 0.8, 0.9 or 1.0, this is indicated on the figures with the corresponding colour for the Ford Road and Crossbush junctions. These junctions have been identified during earlier PCF stages as having a significant impact on the performance of the A27. The junction modelling results are presented later in this section.

Figure 2-5 Base Year peak period flow and V/C (AM)



[14] TA79/99 Amendment No 1. Traffic Capacity of Urban Roads (February 1999)

Figure 2-6 Base Year peak period flow and V/C (PM)



2.4.6 The capacity of the A27 within the study area varies and is lowest in the single carriageway section between Causeway roundabout and Crossbush junction past Arundel railway station where the carriageway narrows and gradient increases. This section also has a number of side road junctions along the route which are a factor in the capacity of the link. The signal controlled pedestrian crossing just east of Causeway roundabout interrupts the flow of traffic. To the west of this section, the road capacity increases between Causeway and Ford Road roundabout as the standard of road improves. The capacity then significantly increases to over 3,000 vehicles per hour where it becomes dual carriageway. Other local routes have lower capacities, commensurate with the standard of the road.

2.4.7 Peak flows are generally highest in the AM peak and travelling westbound, which reflects the dominant tidal commuting pattern to destinations to the west of Arundel including Chichester. The highest average hourly flows are between Causeway roundabout and Crossbush junction, past Arundel Station. As this is a single carriageway section, congestion here is a significant problem and V/C's indicate the link is operating at capacity.

2.4.8 Elsewhere on the A27 within the study area, flows typically range from 900 to 1,200 vehicles per peak period in each direction. The only exception is on the link between Causeway roundabout and Ford Road roundabout, where flows are in the order of 700 vehicles per hour. This is because those who have destinations within Arundel or to areas to the north or south will exit the A27 at either one of these two roundabouts.

2.4.9 Away from the A27, the highest average flows are found on the A29. This indicates that this is the predominant route into the area from the north, with high AM southbound and PM northbound flows. Other routes within the locality see lower peak flows, although various lower order roads within the study area can be considered sensitive to traffic volumes due to their residential or rural nature and can be affected by 'rat-running' traffic which can utilise local roads in the event of congestion or incidents on the SRN. These roads include Ford Road and Yapton Lane.

2.4.10 Table 2-1and Table 2-2 summarise the operational modelling results of Ford Road roundabout and Crossbush junction for 2015, in both the AM and PM peak periods. The tables illustrate that the Ford Road roundabout is approaching capacity, and Crossbush junction is over capacity in the base year.

Table 2-1 Ford Road Base Results (2015 AM and PM Peak)

JUNCTION ARM		2015 AM PEAK PERIOD			2015 PM PEAK PERIOD		
		RFC	Queue (Veh)	Delay (s/Veh)	RFC	Queue (Veh)	Delay (s/Veh)
A	A284	0.27	0.36	5.43	0.31	0.44	5.46
B	Maltravers Street	0.63	1.69	12.47	0.54	1.14	10
C	A27 East (Arundel Bypass)	0.59	1.41	7.35	0.71	2.39	10.77
D	Ford Road	0.53	1.12	11.13	0.47	0.88	9.34
E	A27 West (Chichester Road)	0.84	5.11	19.04	0.76	3.15	11.59

Table 2-2 Crossbush Junction Base Results (2015 AM and PM Peak)

JUNCTION ARM / LANE(S)		2015 AM PEAK PERIOD			2015 PM PEAK PERIOD		
Arm / Movement	Lane(s)	DoS (%)	MMQ (PCUs)	Delay (s/PCU)	DoS (%)	MMQ (PCUs)	Delay (s/PCU)
A27 Westbound Left Turn	1/1	5	1	7	29	4	10
A27 Westbound Ahead	1/2	101	61	87	94	37	40
A27 WB Circulatory	2/1	80	12	68	34	5	44
A284 Northbound	3/1+3/2	98	19	126	95	18	99
A284 N/B Circulatory Right Turn	4/1	79	2	6	74	2	5
N/B Circulatory Give-way Right	5/1	38	5	22	25	4	10
Total Delay (PCUhr)		50.51			27.36		
Practical Reserve Capacity (%)		-12.7			-5.5		

2.5 JOURNEY TIME

2.5.1 The average peak period journey times on the A27 between the junctions of Mill Road / Tye Lane to the west of Yapton Lane, and Blakehurst Lane/ Polling Street to the east of Crossbush, extending 5.3 miles, are presented in Table 2-3. This data illustrates the typical peak period traffic conditions along the A27 within the study area, and compares it to free flow conditions (based on the lowest inter-peak journey time in either direction).

Table 2-3 Base year (2015) A27 journey times (mm:ss)

ROUTE		AM	IP	PM
A27 EB	Journey time	9:46	9:01	15:46
	Increase relative to free flow	+0:45	-	+6:45
A27 WB	Journey time	10:07	9:50	9:01
	Increase relative to free flow	+1:06	+0:49	0:00

2.5.2 The free flow time to travel this route is in the order of 9 minutes. Travelling along the A27 eastbound during the PM peak period is the longest journey duration of all the time periods, taking up to 6 minutes longer than in the AM and IP periods. Much of this delay is associated with the link capacity constraints in the vicinity of Arundel Station which result in traffic queuing back through Causeway junction and to Ford Rd roundabout.

2.5.3 During the AM peak, the route is less affected by congestion, as the journey only takes an extra 45 seconds eastbound. In the westbound direction, it is the AM peak which takes the longest of journeys for this direction, with delays of over 1 minute.

2.5.4 Journey time reliability is one of the main issues associated with the Arundel section of the A27. The current congestion and delays impact upon the efficient and safe movement of people and goods within the area.

2.6 PUBLIC UTILITIES

2.6.1 During Stage 1 of this scheme, enquiries were undertaken in accordance with Appendix C2 of the Code of Practice Measures Necessary where Apparatus is affected by Major Works (Diversionary Works) (Department for Transport, June 1992) to determine the location of public utilities within the scheme area.

2.6.2 Several statutory undertakers were found to have equipment in the area that may require protection or diversion depending on the scheme option chosen. These included

- BT
- Network Rail
- Portsmouth Water
- Scottish and Southern Energy
- Southern Gas Network
- Southern Water
- Street Lighting Area 4
- Virgin Media

2.6.3 Most of the existing public utilities that may be affected by the scheme are alongside or across the existing A27.

2.7 EXISTING ACCIDENT RECORD

2.7.1 Collision data for the section of the A27 between Crossbush Junction and Yapton Lane has been obtained from the Sussex Safer Roads Partnership for the five year period from 01/06/2010 to 21/05/2015. A summary of the accident numbers is shown in Table 2-4.

Table 2-4 Summary of Accident Numbers

	Accident Number	Percentage
Fatal	2	2.9%
Serious	12	17.6%
Sight	54	79.4%
Total	68	100%

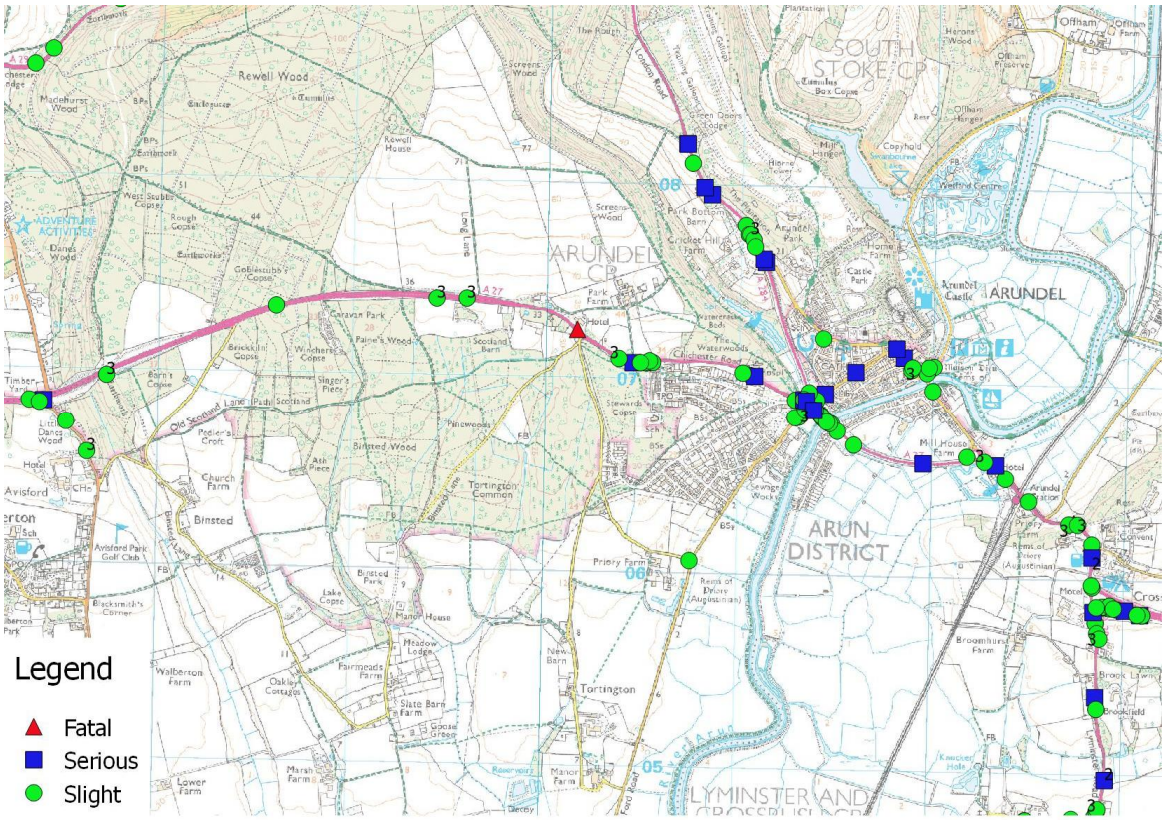
2.7.2 The collisions are mainly focussed at junctions, with the largest clusters at Ford Road Roundabout and Crossbush Junction. Figure 2-7 shows the locations of the collision data and Table 2-5 provides a summary of the collisions recorded.

Table 2-5 Summary of Collision Records

Location	Junction / Link	Number of collisions	Collision summary
Yapton Lane / A27 / Shellbridge Rd	junction	3	2 out of 3 collisions involved vehicles entering / exiting the A27 onto B2132
A27 from Yapton Lane to Binsted Lane (east)	Link	5	3 out of 5 collisions involved single vehicles and 4 out of 5 involved loss of control.
Binsted Lane (east) to Jarvis Road	link	6	5 out of 6 were westbound shunts in slow moving traffic or vehicles turning into side roads / private drives. These shunts all involved multiple cars and goods vehicles (3 or more). Remaining collision was a result of a medical condition.
A27 junction with hospital	Junction	3	2 out of 3 collisions were shunts, (1 eastbound 1 westbound involving a right turn into the hospital.) Remaining collision was two cars in opposing directions caused by careless / reckless in a hurry.
Ford Road Roundabout	Junction	13	2 collisions occurred on eastbound approach, 3 within the circulatory carriageway, 1 northbound approach on Ford Road, 1 southbound approach on A284 Arundel Bypass and 6 on the northwest bound approach. The 6 vehicles on the northwest bound approach all involved multiple vehicles
A27 between Ford Road roundabout and The Causeway junction	Link	6	4 out of the 6 collisions were shunts. 3 involved eastbound vehicles and 1 westbound vehicle. An additional collision occurred where a westbound vehicle stopped in a queue towards Ford Rd roundabout u-turned into the path of an overtaking P2W. The remaining collision occurred when an eastbound driver drifted into the westbound carriageway,
Causeway junction	Junction	2	1x eastbound shunt, 1 x circulatory side swipe
A27 between Causeway junction and Crossbush Lane (north)	Link	4	2 out of 4 of the collisions involved pedal cycles being passed too close. The remaining 2 collisions involved northbound shunts.
A27 between Crossbush Lane (north) and Crossbush Lane (south)	Junction	4	All 4 collisions were located within approximately 100m radius, close to a section of the A27 that has both vertical and horizontal alignment changes. There is a 50% KSI ratio at this location. 3 out of 4 collisions were single vehicle collisions, 2

LOCATION	JUNCTION / LINK	NUMBER OF COLLISIONS	COLLISION SUMMARY
			of 4 involved loss of control, 1 involved travelling too fast for prevailing conditions and the final involved a passenger falling from a rear door of a minibus.
A27 between Crossbush Lane (south) and Crossbush junction	Link	2	1x turning into the pub 1 x 3 car shunt northbound
Crossbush Lane junction	Junction	11	9 of the 11 collisions occurred within the circulatory carriageway, 6 of these were shunts. An additional 2 collisions were attributed to traffic light failure and contravention.
A27 westbound off slip approach to Crossbush Lane junction	Link	7	3 out of the 7 collisions involved westbound shunts. The remaining collisions involved lane changes, standing water, travelling too close to a cyclist and an animal in the carriageway.
A284 approach to Crossbush Lane junction	Link	2	1x pedestrian 1x right turn to / from service road

Figure 2-7 Location of Collision



2.7.3 The accident rate for the existing single carriageway section has been calculated from the data obtained and is presented in Table 2-6. It shows that the accident rate is higher than the national rate for rural A roads.

Table 2-6 Accident Rate Compared to National Average

LOCATION	OBSERVED ACCIDENT RATE PER BILLION VEHICLE-KM TRAVELLED	NATIONAL DATE RURAL A ROADS* ACCIDENT RATE PER BILLION VEHICLE-KM TRAVELLED
Existing single carriageway section of A27	269	162

*National Data – Reported Road Casualties Great Britain Annual Report 2015 (RRCGB 2015) Table RAS 10002

2.8 ENVIRONMENTAL OVERVIEW

2.8.1 The following section outlines existing baseline environmental conditions for the A27 Arundel Bypass Scheme. The route options described in this section relate to the options described in Chapter 6.

2.8.2 The overall study area of all options is very complex and contains environmental features of significant importance including:

- South Downs National Park (a Category V protected area as defined by the International Union for Conservation of Nature);
- South Coast Plain and South Downs National Character Areas;
- Numerous cultural heritage assets including Scheduled Monuments, Grade I, Grade II* and Grade II Listed Buildings;
- Nineteen different habitat types including Ancient Woodland, Wood Pasture and Parkland Habitats of Principal Importance (HPI), Coastal and Floodplain Grazing Marsh HPI, and Coastal Saltmarsh HPI;
- Various species of national and European importance (including bats);
- Arundel flood plains between Crossbush Junction and Ford Road roundabout (see Volume 2, Appendix A, A-4 Figure 13.1C).

2.8.3 For a plan of existing known and potential environmental constraints in the vicinity, please refer to the Environmental Constraints Maps in A-1 to A-5, Appendix A, Volumes 2.

2.9 AIR QUALITY

2.9.1 The following section outlines the baseline conditions for air quality. This information has been extracted from Chapter 5 of the PCF Stage 2 A27 Arundel Bypass Environmental Assessment Report (EAR).

2.9.2 A review of the current air quality information in the vicinity of the local affected road network (ARN) was undertaken to establish the baseline situation. The local ARN extends across five local authority jurisdictions.

2.9.3 The following local authorities have declared air quality management areas:

- Adur District Council;
- Chichester District Council;
- Horsham District Council; and,
- Worthing Borough Council.

2.9.4 The nearest detected air quality management area is at Storrington, in Horsham District, approximately 10.5km to the north east of Arundel.

2.9.5 Arun District Council, which encompasses the scheme options, does not contain any declared air quality management areas. The latest local air quality management report produced by this local authority concluded that the national air quality objectives for all pollutants would be met.

2.9.6 Several stretches of the A27, including The Causeway, Arundel by-pass (A284) and Chichester Road / Arundel Road are included as part of the local ARN. Other sections of the local ARN include Grevatts Lane A259 and A259 Rowan Way between Littlehampton and Bognor Regis within Arun District.

2.9.7 Passive diffusion monitoring undertaken in the Arun District Council area indicated that the annual mean NO2 (nitrogen dioxide) concentrations did not exceed the UK air quality objectives in the period between 2012 and 2016. The highest recorded annual mean NO2 concentration of 23.7 µg/m3 was found at the Arun06 / A27 Causeway, which is situated along the existing A27 corridor. This is below the NO2 air quality objective of 40 µg/m3.

2.9.8 A scheme specific NO2 monitoring programme was undertaken between January 2016 and January 2017 using diffusion tubes at 22 sites to establish baseline conditions around the proposed Scheme. The data were used to facilitate verification of the DMRB modelling undertaken for the assessment. This data informed the air quality baseline and modelling.

2.9.9 The results gained from the monitoring survey show the annual mean NO2 concentrations ranged from 9.5 µg/m3 to 41.4 µg/m3.

2.9.10 Two monitoring locations ('A27 Arun 8' and 'A27 Arun 16') show concentrations above the annual mean objective for 2016. The highest concentration was 41.4 µg/m^3 at 'A27 Arun 16' which was situated at the Brown's Lane and Manley's Hill A283 junction in Storrington (Horsham district). The nearest relevant human exposure is approximately 10 metres distance from this location and 1 metre distance from the road.

2.9.1 The 'A27 Arun 8' monitoring location, where the concentration was 41.2 µg/m^3 was situated at the central reservation of the Ford Road roundabout. The nearest relevant human exposure is approximately 30 metres distance from this location and 1 metre distance from the kerb.

2.9.2 NO_2 passive diffusion tube monitoring data was obtained from the Highways England National Air Quality Monitoring Network to further inform baseline conditions. There were 33 monitoring locations considered as part of the 'A27 Arundel' section, where a six month programme began in January 2016 and ended in July 2016.

2.9.3 The monitoring location with the maximum concentration observed from the monitoring survey (Site Number A27Ar_023_0116) is situated at Arundel & District Community Hospital, north of the A27 with an annualised 2016 NO_2 concentration of 54.9 µg/m^3 (Annualisation involves adjustment of the data to be representative of the whole calendar year). The diffusion tube is located within 10 metres of the local ARN.

2.10 CULTURAL HERITAGE

2.10.1 The following section outlines the baseline condition for cultural heritage. This information has been extracted from Chapter 6 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR. An inner study area 200 metres from the outer limits of the Scheme options was applied for all types of heritage assets. An outer 1 kilometre study area was applied for statutory designated assets and their settings.

2.10.2 All of the statutory designated cultural heritage assets are of national importance (Scheduled monuments, Grade 1, Grade II* listed buildings) or regional importance (Grade II listed building). The presence, degree of preservation, extent and significance of archaeological remains cannot be determined prior to investigation, which is programmed for PFC Stage 3. It is likely that the sensitivity of the archaeological remains will range from Low (local) to Medium (regional).

2.10.3 A total of 229 heritage assets have been recorded within the outer study area for Option 1. Of these 214 are statutory designated:

- Five Scheduled Monuments:
  - Maison Dieu (1005865);
  - Goblestubbs Copse Earthworks (1005895);
  - Ringwork 400m NNW of Batworthpark House (1012177);
  - Arundel Castle (1012500); and
  - Tortington Augustinian Priory and ponds (1021459);
- Four Grade I, six Grade II* and 198 Grade II Listed Buildings, one Registered Park and Garden and two conservation areas within the outer study area (1 kilometre) (see Volume 2, Appendix A, A-1 Figure 6.1); and
- Three Archaeological Notification Areas, one historic landscape and nine non-designated assets lie within the inner study area. Records show that two of these lie in the Option 1 footprint, and comprise site of Brickyard near the Gas Works on Ford Road (MWS6506) and a WWII Loopholed Wall (MWS7583). However, these assets are likely to have been removed by construction works for the existing A27 (see Volume 2, Appendix A, A-1 Figure 6.2 for non-designated heritage assets for Option 1).

2.10.4 A total of 48 heritage assets have been recorded within the outer study area for Option 3. Of these assets, 28 are statutory designated and include:

- Four Scheduled Monuments:
  - Goblestubbs Copse Earthworks (1005895);
  - Ringwork 400m NNW of Batworthpark House (1012177);
  - Arundel Castle (1012500); and
  - Tortington Augustinian Priory and ponds (1021459).
- Two Grade II* Listed Buildings; 22 Grade II Listed Buildings; one Registered Park and Garden; and two conservation areas (located within 1km) (see Volume 2, Appendix A, A-1 Figure 6.3)
- Four Archaeological Notification Areas and nine non-designated assets within 200 metres of Option 3 (see Volume 2, Appendix A, A-1 Figure 6.4). Two non-designated assets are located within, or extend into, the footprint of Option 3. These have been identified as: the site of a brick kiln along Arundel Road (MWS4693); and the potential site of Romano-British road, between Arundel and Chichester.
- Four historic landscapes including Brooks Innings (HWS2476), Cohesive Assart (HWS24819) and Assart Woodlands (HWS24801 and HWS250881).

2.10.5 A total of 61 heritage assets are present within the outer study area for Option 5A (see Volume 2, Appendix A, A-1 Figure 6.5). 28 of these are statutory designated, including:

- Five Scheduled Monuments:
  - Wood earthworks (1003736) Goblestubbs Copse Earthworks (1005895), Ringwork 400m NNW of Batworthpark House (1012177), Arundel Castle (1012500) and Tortington Augustinian Priory and ponds (1021459)
- Two Grade II* Listed Buildings, 30 Grade II Listed Buildings, one Registered Park and Garden and three conservation areas (located within 1km)
- Seven Archaeological Notification Areas
- Eleven non-designated assets have been identified within 200 metres of Option 5A (see Volume 2, Appendix A, A-1 Figure 6.6)
- Two non-designated assets are located within, or extend into, the footprint of Option 5A. These have been identified as: the site of the historic park of Binsted (MWS2354); and the potential site of Romano-British road between Arundel and Chichester.
- Two historic landscapes; Brooks Innings (HWS24767), a fresh water marsh, and Cohesive Assarts (HWS24819).

2.10.6 Potential hitherto unknown below-ground heritage assets exist within all three Scheme extents:

- For Option 1, the potential for below-ground archaeological and earthwork remains have been identified between Crossbush Junction and Ford Road Roundabout, associated with use of the flood plains from the Early Medieval through to the Industrial period
- Option 3 traverses the Brooks Innings (Arun) floodplain between Crossbush Junction and Ford Road. The potential for archaeological below-ground and earthwork remains for this section and will be similar in nature to Option 1. The west part of Option 3 follows a course through the South Downs National Park and Ancient Woodland (HWS24801 and HWS24881), which have the potential for below-ground archaeological and earthwork features associated with historical agricultural stock and woodland management and possibly including the remains of stock pens, lapsed coppice, cut ditches or raised banks. In addition, Option 3 intersects the projected line of the Chichester to Brighton Roman road that has been recently identified by LiDAR surveys. The longest stretch of the road is recorded on LiDAR images and shows a raised causeway through the eastern end of Paine's Wood, where it is now followed by the course of a woodland track.[15]
- Option 5A traverses the Brooks Innings flood plain and across land south of Tortington Priory Scheduled Monument (SM1021459), therefore the potential for archaeological below-ground and earthworks remains for this section are as described for Option 3.
- From Tortington Lane to Yapton Lane, Option 5A traverses agricultural land and swaths of Ancient Woodland both within and on the border of the South Downs National Park. Here, the landscape is largely characterised by the cohesive assarts (HWS24819) as described above for Option 3. This landscape has been subject to little change over time and ancient field boundaries are likely to survive with a good degree of preservation. At the location of the former Binsted Park (MWS2354) there is potential that below ground remains associated with landscaping (for example remnants of tree lines) survive below ground, however such remains are likely to be disturbed by subsequent ploughing. Given the undeveloped nature of the land, there is also potential for archaeological remains associated with the Prehistoric period onwards to survive within the Scheme footprint of Option 5A. Further to this, this study

[15] SDNPA A27 improvements: Arundel By-Pass and Land North of Worthing: Preliminary Desk-based Assessment, 2017

area contains raised storm beach deposits, river terrace and alluvial deposit which may potentially be (Palaeolithic) artefact-bearing.

2.10.7 At Paine's Wood, Option 5A intersects the projected line of the Chichester to Brighton Roman road that has been recently identified by LiDAR surveys. The longest stretch of the road is recorded on LiDAR images and shows a raised causeway through the eastern end of Paine's Wood, where it is now followed by the course of a woodland track.[16]The area of Binsted, which lies partly in the South Downs National Park, through which Options 3 and 5A follow a course, holds significant social and spiritual value to local communities. Historic England considers spiritual value to be associated with places sanctified by longstanding veneration or worship, or wild places with few obvious signs of modern life. Their value is generally dependent on the perceived survival of the historic fabric or character of the place, and can be extremely sensitive to modest changes to that character, particularly to the activities that happen there[17]. During the 2017 Public Consultation process it was highlighted by multiple members of the public that a religious group known as the Wiccans (Pagan Witches) practice in the woodland of Binsted, which is considered by the group to be a place of worship.

2.11 LANDSCAPE

2.11.1 The following section outlines the baseline conditions for landscape. This information has been extracted from Chapter 7 of the PCF Stage 2 A27 Arundel Bypass EAR.

2.11.2 The proposed Scheme Options will fall within the following Local Character Areas (LCAs) (see Volume 2, Appendix A, A-2 Figure 7.2):

- Landscape character area 1 – Western Downs, an extensive area of rolling chalk upland;
- Landscape character area 2 – Fontwell Upper Coastal Plain, an undulating farmland forming transition between coastal plain and South Downs;
- Landscape character area 4 – Lower Arun Valley, an extensive stretch of drained floodplain surrounding meandering River Arun;
- Landscape character area 5 – Arundel, a small town alongside the River Arun at the edge of the South Downs that dates back to the 11th century; and
- Landscape character area 9 – Angmering Upper Coastal Plain, composed of wooded chalk uplands and enclosed valleys with a steep and wooded escarpment forming the northern boundary.

2.11.3 The South Downs National Character Area comprises a 'whale-backed' spine of chalk stretching from the Hampshire Downs in the west to the coastal cliffs of Beachy Head in East Sussex. The majority of the South Downs area falls within the South Downs National Park, a recognition of its natural beauty and importance for access and recreation. It is an extremely diverse and complex landscape with considerable local variation representing physical, historical and economic influences; much of it has been formed and maintained by human activity, in particular; agriculture and forestry.

2.11.4 The distinctive profile of Arundel Castle, located in a prominent position above the town, contributes to the rich and varied local landscape. It is visible within many views to/from the various scheme options including views experienced by users of the right of way that runs parallel with the River Arun. Thirty representative viewpoints have been selected to asses visual amenity, see Volume 2, Appendix A, A-1 Figure 7.6 and 7.7.

[16] SDNPA A27 improvements: Arundel By-Pass and Land North of Worthing: Preliminary Desk-based Assessment, 2017
[17] Historic England 2015: 32

2.11.5 All of the various scheme options require a crossing of the River Arun floodplain and therefore many of the viewpoints assessed have clear or intermittent views of the open River Arun floodplain which extends eastwards. However, it should be noted that Option 1 will cross the River Arun at the same crossing location as the existing A27.

2.12 BIODIVERSITY

2.12.1 The following section outlines the baseline condition for biodiversity including designated sites, habitats and species. This information has been extracted from Chapter 8 of the PCF Stage 2 A27 Arundel Bypass EAR. The field study area comprised the scheme footprint and a 50metre buffer zone. The desk study area comprised:

- 10kilometre (up to 30km for Special Areas of Conservation designated for bats) from the outer edge of the scheme footprint for international statutory designated sites;
- 2kilometre from the outer edge of the scheme footprint for national statutory and non-statutory designated sites; and
- 2kilometre for protected and notable species.

2.12.2 The methods for desk study and field survey are defined in Chapter 8 of the PCF Stage 2 A27 Arundel Bypass EAR.

2.12.3 All statutory and non-statutory designated sites, Natural England priority habitat inventory areas, Natural England Ancient Woodland Inventory woodland and Phase 1 habitat survey types are listed below (see Volume 2, Appendix A, A-3 Figures 8.1 to 8.6).

DESIGNATED SITES

2.12.4 Table 2-7 lists each of the designated sites in the Desk Study Area including their proximity to the three Scheme Options.

Table 2-7 Designated sites

Site Designation	Statutory / Non - Statutory	Site Name	Approx. Distance (Km) and Direction from Scheme Options			Key Habitat Type
			1	3	5A	
SAC	Statutory	Singleton and Cocking Tunnels	14.1 km north-west	13 km north-west	12.4 km north-west	Man-made structure
SAC	Statutory	The Mens	14.5 km north	14.5 km north	15.4 km north	Woodland / wood pasture
SAC	Statutory	Ebernoe Common	18.1 km north	18 km north	18.3 km north	Woodland / wood pasture
Ramsar site, SAC & SPA	Statutory	Arun Valley	6.4 km north	6.6 km north	7.3 km north	Inland water bodies, wetland and humid grassland.
SAC	Statutory	Duncton to Bignor Escarpment	5.8 km north	5.8 km north	5.8 km north	Broadleaved woodland on calcareous soils.
SSSI	Statutory	Arundel Park	0.4 km north	1.4 km south	1.4 km south	Chalk grassland and variety of woodland.
SSSI	Statutory	Fairmile Bottom	2 km north west	1.5 km north	1.5 km north	Yew woodland, yew scrub and chalk grassland.
LWS	Non-Statutory	Binsted Wood Complex	The northern edge of this LWS crossed by Option 1	Crossed by this Option	The southern edge of this LWS is crossed by Option 5A	Mixture of Ancient Woodland and recent woodland.

Site Designation	Statutory / Non -	Site Name	Approx. Distance (Km) And Direction From Scheme Options			Key Habitat Type
LWS	Non-Statutory	Poling Copse	0.6 km east	0.6 km east	0.6 km east	A large block of Ancient Woodland.
LWS	Non-Statutory	Warning camp Hill and New Down	1.8 km north east	1.8 km north east	1.8 km north east	Herb-rich chalk grassland and a small area of ancient, semi-natural woodland.
LWS	Non-Statutory	Rewell Wood Complex	The southern edge of this LWS is in Option 1	Immediately adjacent to Option 3	The southern edge of the LWS is in Option 5A	Diversity of habitats including ancient semi-natural woodland, worked Sweet Chestnut coppice, confer plantation, beech plantation and species-rich chalk grassland.
LWS	Non-Statutory	Arun Valley, Watersfield to Arundel (includes Arundel Wetland Centre)	0.4 km north east	0.4 km north	0.4 km north	Extensive tract of wetland, wet grassland, network of ditches and unimproved meadows.
LWS	Non-Statutory	Slindon Bottom	>3 km	> 3 km	1.85 km west	An area of Ancient Woodland with a rich higher plant flora.
Notable Road Verge	Non-statutory	A27 Avisford 'site A' A27 Avisford 'site B' A27 Avisford 'site C'	0.3 km east	The east edge of the road verge is in the Option 3 footprint	The west of the road verge is in the Option 5A footprint	No citation information provided by Sussex Biodiversity Records Centre – assumed to be a species-rich neutral or calcareous grassland
SAC – Special Area of Conservation SPA – Special Protection Areas SSSI – Site of Special Scientific Interest LWS – Local Wildlife Site						

2.12.5 The following biological SSSIs are within 0.2 kilometres of a road which may be subject to chances in traffic flows as a result of the Scheme operation. In general, changes in traffic flow may alter the road traffic-derived nitrogen deposition at nearby SSSIs. Only Fairmile Bottom SSSI is also within 2 km from the boundary of the footprint of a Scheme Option, the other SSSIs are greater than 2 km from the Scheme Options:

- Adur Estuary SSSI which is 13 m from an affected road;
- Amberley Mount to Sullington Hill SSSI which is 170 m from an affected road;
- Arundel Park SSSI is 90 m from an affected road;
- Beeding Hill to Newtimber Hill SSSI which is 72 m from an affected road;
- Chantry Mill SSSI which is 50 m from an affected road;
- Fairmile Bottom SSSI which is directly adjacent to an affected road; and
- Sullington Warren SSSI which is 114 m from an affected road.

NON-DESIGNATED SITES

2.12.6 Six non-statutory designated sites were identified within 2 kilometres of Options 1, 3 and 5A. A summary of the features underpinning the designation of these Local Wildlife Sites is provided in Appendix B of the PCF Stage 2 A27 Arundel Bypass EAR, Table 8.2. Non-statutory designated sites are mapped in Figure 8.3, (see Volume 2, Appendix A, A-3).

HABITATS

2.12.7 Nineteen different habitat types have been identified in the Desk Study Area which are either mapped on Natural England's Ancient Woodland Inventory or Priority Habitat Inventory, and confirmed by the Mid Arun Valley Environmental Survey[18] studies or confirmed by Highways England's Phase 1 Habitat Survey.

Table 2-8 Habitats in Desk Study Area

Phase 1 Habitat Type	Corresponding HPI Type	Scheme Option		
		1	3	5A
WOODLAND				
Semi-natural Broadleaved Woodland (not Ancient Woodland)	Lowland Mixed Deciduous Woodland HPI (partly) Wet Woodland HPI (partly)	✓	✓ (includes wet woodland)	✓ (includes wet woodland)
Semi-natural Broadleaved Woodland (Ancient Semi-Natural Woodland)	Lowland Mixed Deciduous Woodland HPI Wet Woodland HPI (partly)	✓	✓ includes wet woodland)	✓ i
Mixed Plantation Woodland (Plantation on an Ancient Woodland Site)	None.	x	✓	x
Scattered Broadleaved Trees (Ancient/Veteran Trees)	Wood Pasture and Parkland HPI (partly)	✓	✓	✓
Scattered Broadleaved Trees (younger trees)	None.	✓	✓	✓
WETLAND				
Swamp	Lowland Fen HPI (partly) Reebed HPI (partly) Coastal and Floodplain Grazing Marsh HPI (partly)	✓	✓	✓
Flood Plain Mire	Lowland Fen HPI	x	x (but some is present downstream of the Field Survey Area)	x (but some is present downstream of the Field Survey Area)
Standing Water	Pond HPI (partly)	✓	✓	✓
Running Water	River HPI (partly)	✓	✓	✓
Saltmarsh – Scattered Plants	Saltmarsh HPI	x	✓	✓
GRASSLAND				
Unimproved neutral grassland	Lowland Meadow HPI	x	x	x
Poor Semi-improved Grassland	Coastal and Floodplain Grazing Marsh HPI (partly)	✓	✓	✓
Semi-improved neutral	Coastal and Floodplain	✓	✓	✓

[18] Thompson, J. (October, 2017). *The Mid Arun Valley 2015 – 2017 A27 Arundel bypass Road Options 1, 3 and 5A Ecological Impact Report (using current data)* Wildlife Splash on behalf of the Mid-Arun Environmental Survey.

grassland	Grazing Marsh HPI (partly)			
Marshy grassland	Coastal and Floodplain Grazing Marsh HPI (partly)	x	x	x (but some is present downstream of the Field Survey Area)
OTHER				
Dry dwarf shrub heath (Lowland Heathland HPI)	Lowland Heath HPI	x	✓ (part of Binsted Wood Complex LWS)	x
Dense Continuous Scrub / Scattered Scrub	None.	✓	✓	✓
Intact species-poor hedge, defunct species-poor hedge and species-poor hedge and trees	Hedgerow HPI (mostly)	✓	✓	✓
Arable	Arable Field Margin HPI (part)	x✓	✓	✓
Buildings and hard-standing	None.	✓	✓	✓

2.12.8 Habitat suitable to support 13 protected and/or notable species/species groups was identified in the Field Survey Area as follows.

SPECIES	HABITAT
Amphibians	Ponds, small lakes and some ditches in the Field Survey Area are suitable to support great crested newt (*Triturus cristatus*) which is a protected species and a Species of Principal Importance (SPI) and common toad (*Bufo bufo*) which is a SPI was identified in the field survey area.
Badger	Woodland, farmland, hedgerow and grassland habitats throughout the Field Survey Area are suitable to support badger (*Meles meles*). Desk study evidence suggests that a number of main setts/clan territories are present.
Bat	The desk study identified 35 confirmed or likely bat roosts within the Desk Study Area. These were common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), brown long-eared bat (*Plecotus auritus*), serotine (*Eptesicus serotinus*) and barbastelle (*Barbastella barbastellus*). Preliminary findings of 2017 Highways England preliminary roost assessment surveys indicate that woodland edge and farmland in the Field Survey Area contain approximately 150 trees which are of high and moderate suitability for roosting bats. Such features may support roosts of rare tree-roosting bat species such as barbastelle and the Bechstein's bat. The Mid-Arun Valley Environmental Survey bat surveys have confirmed maternity colonies of Becshtein's bat, Alcathoe bat and occasional roosts for a range of other bat species in Binsted Wood Complex LWS. Preliminary findings from 2017 bat trapping and radio-tracking surveys undertaken by Highways England support the general conclusions of the Mid-Arun Valley Environmental Survey studies. A total of nine bat species have been captured foraging or commuting within the Survey Area. Bechstein's bat, Alcathoe bat and brown long-eared bat are using roosts within the Binsted Wood Complex LWS for breeding. Barbastelle has been recorded foraging in Binsted Wood Complex LWS but no roosts were identified by Highways England relating to this species.

SPECIES	HABITAT
Birds	Farmland, wetland and woodland habitats across the survey may support populations of Birds of Conservation Concern Red List and Amber List species.
Fish	There are desk study records of bullhead and European eel (among other species) which are both listed under Annex II of the Habitat and Species Directive. Other species are also listed as a SPI, and/or recorded on the International Union for the Conservation of Nature (IUCN) Red List. Preliminary survey findings from 2017 suggest that the watercourses are only likely to support small freshwater fish, such as stickleback and minnow, as well as populations of European eel. Typically, the watercourses observed were slow flowing, silted and poorly oxygenated.
Hazel dormouse	Woodland, hedgerow and scrub habitats across the Field Survey Area have potential to support hazel dormouse.
Terrestrial invertebrates	The desk study identified over 1,000 invertebrate records comprised of 405 species within the Desk Study Area. These records included four beetle species, 122 moth species, 272 butterfly species, two true fly species and five hymenopteran species. Three records of invertebrate species listed under Schedule 5 of the Wildlife and Countryside Act 1981 were within the Desk Study Area. These were brown hairstreak (*Thecla betulae*), stag beetle and pearl-bordered fritillary. A large number of records of the latter species came from within Rewell Wood Complex LWS. Ancient woodland, hedgerow and wetland habitats throughout the Field Survey Area may all support notable invertebrate species.
Otter	Watercourses, ditches and streams throughout the Field Survey Area have potential to support otter. Although there are few desk study records relating to this species.
Plants	Ancient woodland, arable and wetland habitats throughout the Field Survey Area have potential to support notable plant species. The desk study identified 13 notable species (either England Red Data Book above Least Concern and/or Sussex Rare Species Inventory) in the desk study area. Provisional findings of Highways England field surveys confirmed the following notable species to be present in the Field Survey Area: divided sedge (Carex divisia); Marsh-mallow (*Althaea officinalis*); Water-soldier (*Stratiotes aloides*) (although likely an introduction in Sussex); opposite-leaved pondweed (*Groenlandia densa*); and tubular water-dropwort (*Oenanthe fistulosa*). Numerous Ancient Woodland Indicator species in Binsted Wood Complex LWS.
Reptiles	Four common native reptiles, grass snake (*Natrix natrix*), common lizard (*Zootoca vivipara*), slow worm (*Anguis fragilis*), and adder (*Vipera berus*), are all confirmed in the Field Survey Area by 2017 survey work. The highest suitability habitats for these species are grassland, woodland ride/woodland edge and wetland habitats.
Water vole	Watercourses throughout the Field Survey Area have potential to support water vole (*Arvicola amphibius*) which is protected under the Wildlife and Countryside Act 1981 and is listed as a SPI and a Sussex Biodiversity Action Plan Priority Species. This species has been confirmed as present by 2017 survey work.

SPECIES	HABITAT
White-clawed crayfish	Ditches and ponds that contain water all year round across the Field Survey Area may provide suitable foraging and breeding habitats for white clawed crayfish. Preliminary survey findings from 2017 suggest that the River Arun is not a suitable white clawed crayfish habitat, being highly tidal and partly saline. In addition, some of the drainage ditches on the Arun floodplain area are slow flowing, silted and poorly oxygenated, and hence are also likely to be unsuitable for white clawed crayfish.
Other notable species	Hedgehog (*Erinaceus europaeus*), brown hare (*Lepus europaeus*), harvest mouse (*Micromys minutus*) are all SPIs and are conservation priorities in England. Brown hare is a Sussex Biodiversity Action Plan Priority Species. All species may occur in the Field Survey Area.

2.13 GEOLOGY AND SOILS

2.13.1 This section has been extracted and summarised from Chapter 9 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR and describes a combined study area for Options 1, 3 and 5A.The study area is the maximum physical extent of the potential development footprint plus a buffer zone of 250 metres.

GEOLOGY AND HYDROGEOLOGY

2.13.2 It is assumed that shallow deposits of Made Ground are present associated with current and historical development, including all residential and commercial developments and the existing A27.

2.13.3 Superficial deposits, which underlie the majority of the study area, include Raised Marine Deposits (associated with the River Arun) and other Quaternary age deposits. Bedrock comprises the London Clay Formation (clay, silt, and sand), the Lambeth Group (clay, silt, and sand), and a series of undifferentiated chalk formations which comprise the White Chalk Group (Lewes Nodular Chalk, Seaford Chalk, Newhaven Chalk, and Culver Chalk).

2.13.4 The superficial deposits are Secondary A aquifers. The London Clay Formation is an aquiclude. The Lambeth Group is a Secondary A aquifer. The chalk formations are Principal aquifers. There are no groundwater Source Protection Zones within the study area. There is one groundwater abstraction licence within the study area associated with Havenwood Park, this borehole is founded in the Chalk aquifer[19].

SURFACE WATER

2.13.5 The major surface water feature within the study area is the River Arun. Two tributaries of the River Arun flow southwards through Binsted. These are 'main rivers' defined by the Environment Agency. The land surrounding the River Arun is a flood Zone 3 (≥ 1% annual probability of river flooding). Flood defences are present to mitigate the risk of flooding of the River Arun. There are three surface water abstraction licences (irrigation of agricultural land) and there is one potable water abstraction license at Tortington Park.

[19] The London Gazette (1990). Public Notices. [online] Available at: https://www.thegazette.co.uk/London/issue/52360/page/19069/data.pdf [accessed 17/04/2018F]

ENVIRONMENTAL DESIGNATIONS

2.13.6 There are no geological Sites of Special Scientific Interest and there are no known Regionally Important Geological Sites within the study area. The study area contains soils associated with Ancient Woodland and is likely to contain a proportion of best and most versatile agricultural land.

CONTAMINATED LAND CONCEPTUAL SITE MODEL

2.13.7 Following a review the potential sources of contamination within the study area, the following preliminary conceptual site model has been produced. Risks are qualitatively assessed in accordance with CIRIA C552: Contaminated Land Risk Assessment – A Guide to Good Practice (2001).

SOURCES	PATHWAYS	RECEPTORS	RISK
Made Ground; Arun Valley railway and Arundel railway station; Highways network; Historical gasworks, ironworks, and sewage treatment works, on Ford Road; Historical brick yard on Chichester Road; Arundel Cemetery; Arundel and District Community Hospital; Any other industrial land uses.	Ingestion, inhalation and dermal contact with contaminated soil; inhalation of windblown dust.	Human Health	Low
	Lateral migration of aqueous and dissolved contaminants via groundwater flow or preferential pathways.	Surface water	Moderate /Low
	Vertical migration of aqueous and dissolved contaminants through made ground strata or via preferential pathways.	Groundwater	Moderate /Low
Made Ground	Chemical attack and degradation.	Built Environment	Very Low

2.14 MATERIALS AND WASTE

2.14.1 This section describes the existing conditions associated with material and waste. This information has been extracted from Chapter 10 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR.

MATERIALS

2.14.2 A summary of material availability in the South East of England and the UK is provided in Table 2.9.

Table 2-9 Material Availability in South East of England and the UK

Material Type	Availability (2015 Unless Otherwise Stated)	
	South East	UK
Sand and gravel +	18.8Mt	52.5Mt
Permitted crushed rock *	1.0Mt	99.3Mt
Concrete blocks #	541,000m^3 (2014)	5.4Mm^3 (2014)
Primary aggregate *	13.3Mt	183Mt
Recycled and secondary aggregate *	3.7Mt (2013, consumption)	63Mt
Ready-mix concrete +	0.6Mm^3	25.2Mm^3
Steel +	(no data)	7.6Mt
Asphalt *	3.6Mt	26.3Mt
Key: # stocks Mt : Million tonnes + production Mm^3 : Million cubic metres * sales *Source information* [20] [21] [22] [23] [24] [25]		

WASTE GENERATION AND DISPOSAL

2.14.3 The operation and maintenance of the current A27 Arundel asset is likely to generate small volumes of waste from littering, light replacement, signage replacement, replacement of reflective road studs (cats' eyes) and minor barrier refurbishments, among others. The current generation of waste within the land boundary of the A27 is, therefore, assessed to be negligible.

2.14.4 At the end of 2015, 91 landfill sites in the South East were recorded as having a total of 75.2 million cubic metres of remaining capacity (see EAR, Table 10.3).[28]

2.15 NOISE AND VIBRATION

2.15.1 The following section provides a summary of the baseline conditions for noise and vibration. This information has been extracted from Chapter 11 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR.

2.15.2 The combined study area for Options 1, 3 and 5A has a number of Noise Important Areas (NIAs) and noise sensitive receptors based on baseline conditions, desk based reviews, an initial noise survey and noise modelling which established high levels of road traffic noise. Table 2.10, shows the NIAs within each study area for each option, along with the relevant asset owner, location and coordinates.

[20] Department for Business Innovation & Skills, Monthly Bulletin of Building Materials and Components - January 2016. [link]
[21] South East Aggregates Working Party Annual Aggregates Monitoring Report 2013 [link]
[22] Department for Business Innovation & Skills, Monthly Bulletin of Building Materials and Components - January 2016. [link]
[23] British Geological Society, Minerals produced in the UK, 2014 [link]
[24] Mineral Products Association, The Mineral Products Industry at a Glance (2016) [link]
[25] World Steel Association, Crude Steel Production Statistics [link]
[28] Environment Agency, 2015 Remaining Landfill Capacity – Operator Site Submissions [link]

Table 2-10 Noise Important Area Identification Number and associated option

IMPORTANT AREA ID	OPTION	ASSET OWNER	LOCATION	COORDINATES
12486	1, 3, 5A	West Sussex	Located on A284, Lyminster Road (Calceto Cottage)	502529, 104755 to 502576, 104757
12487	1, 3, 5A	West Sussex	Located on A284, Lyminster Road	502861, 105296 to 502868, 105249
12488	1, 3, 5A	Highways England	Located on Jarvis Road where it joins A27 Chichester Road	500592, 107074 to 500646, 107074
12489	3, 5A	Highways England	Located on A27 Arundel Road	498814, 107371 to 498871, 107375
12490	5A	West Sussex	Located on A29 road, near Slindon	496669, 107636 to 496984, 107993
5484	1, 3, 5A	Highways England	Located adjacent south of A27, The Causeway road	502277, 106573 to 502331, 106528
5485	1	Highways England	Located adjacent to A27 Chichester Road	501090, 106988 to 501119, 106976
5486	1	Highways England	Located on Ford Roundabout	501274, 106940 to 501436, 106835
5487	1, 3, 5A	Highways England	Located on A27 Chichester Road	499743, 107359 to 499781, 107356
5488	1, 3, 5A	Highways England	Located on Binsted Lane where it joins A27 Chichester Road	500169, 107216 to 500196, 107196
5490	3, 5A	Highways England	Located on Arundel Road (slip road)	496538, 106864 to 496592, 106844
6157	1, 3, 5A	Highways England	Located on the A27, The Causeway road	502462, 106404 to 502492, 106376

2.15.3 In addition to the NIAs, residential areas are identified within close proximity to all options. The main concentration of residential properties are along the existing A27 and surrounding the Ford Road Roundabout.

2.15.4 Ecological receptors have also been identified as described per option below:

- Where Option 3 passes through Tortington Common, Barn's Copse and other Ancient Woodland;
- Where Option 3 and Option 5A pass through Coastal and Floodplain Grazing Marsh HPI on the River Arun floodplain;
- Where Option 5A crosses ditches draining into Tortington Rife and through Binsted Park; and
- Where Option 1 crosses the River Arun floodplain, south of the existing A27 Road.

2.15.5 The approach to determining the baseline conditions for sensitive receptors has been predictive with the use of noise modelling software. This model has been validated with data from a noise survey completed in January 2016 as a part of the environmental study for PCF Stage 1.

2.15.6 The survey employed a number of CRTN 3-hour measurements (the shortened measurement procedure). More detailed information regarding the methodology, locations and equipment is provided in the PCF Stage 1 Environmental Study Report[29].

[29] WSP | Parsons Brinckerhoff on behalf of Highways England, (2017), A27 Arundel Bypass PCF Stage 1 Environmental Study Report (HE551523_WSP-PB_A27A_P126_ESR_V1.2.0)

2.15.7 The noise survey results have been reproduced in Table 2-11. The survey results and observations on site demonstrate that the survey locations are currently subject to elevated road traffic noise.

Table 2-11 Summary of attended 3 hour CRTN measurements

Measurement Location	Date and Start Time	LA10, 3h dB	LA10, 18h dB	LAeq, 3h dB	LA90, 3h dB
ML1	19/01/2016 10:05	74	73	70	43
ML2	19/01/2016 13:55	75	74	73	43
ML3	19/01/2016 11:22	67	66	65	59
ML4	19/01/2016 14:30	73	72	68	48

2.16 PEOPLE AND COMMUNITIES

2.16.1 The following sections outline the baseline condition for people and communities. This information has been extracted from Chapter 12 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR. The study area used is shown in Figure 12.1, (see Volume 2, Appendix A, A-5).

MOTORISED TRAVELLERS: VIEWS FROM THE ROAD

2.16.2 Travelling from west to east on the existing A27, the current views from the road are as follows:

- On entering Arundel from the west, on Chichester Road, the road is level with the surrounding land. There are intermittent views on both sides of agricultural land, screened in part by roadside vegetation;
- On the approach to Arundel, vegetation becomes denser, providing no view beyond the immediate border, until passing the cricket ground, where intermittent views of fields are visible on the north side of the road;
- Vegetation again closes in, bordering the road on the approach to Chichester Road roundabout to provide no view beyond;
- Views along the Arundel Bypass are again intermittent, of the surrounding agricultural land; and
- Following the Crossbush roundabout, the Causeway is largely surrounded by flat topography with views of agricultural land with some screening provided by vegetation and existing buildings.

2.16.3 In general, the views from the road for Motorised Travellers on the surrounding road network provide a positive experience.

MOTORISED TRAVELLERS: DRIVER STRESS

2.16.4 The West Sussex Transport Plan 2011 - 2026 describes the A27 at Arundel as a bottleneck, where there are high accident rates and diversions onto unsuitable routes are required at times of delay. This increases the levels of driver frustration.

2.16.5 Due to the presence of connecting footpaths and pavements on stretches of the A27 through Arundel, and the proximity of houses and community facilities, there are likely to be pedestrians crossing or walking alongside the road. This increases the level of fear felt by Motorised Travellers.

2.16.6 It is not possible to assess route uncertainty, however due to the level of driver frustration due to delays experienced by Motorised Travellers; the level of Driver Stress experienced is high. Quantification of Driver Stress, in line with DMRB Vol 11 Section 3 Part 09 will be conducted at PCF Stage 3.

2.16.7 A COBALT assessment was completed to determine the likely number of accidents on the existing A27 between Mill Road/Tye Land and Crossbush Junction between 2023 and 2082 and it was estimated that there would be 346 accidents for the do-minimum scenario.

PEDESTRIANS, CYCLISTS AND EQUESTRIANS: AMENITY AND JOURNEY LENGTH AND COMMUNITY SEVERANCE

2.16.8 A number of PRoWs are located within the study area. The majority of PRoW are outside of the built up areas of Arundel and are located within agricultural land. These are likely to be used primarily for recreational purposes. Total numbers of PROWs relative to each option are summarised below:

- Five footpaths are considered during the assessment of Option 1;
- Six footpaths and one bridleway are considered during the assessment of Option 3; and
- Six footpaths and two bridleways are considered during the assessment of Option 5A.

2.16.9 There are no National Cycle Routes within close proximity to the proposed schemes.

TOURISM AND RECREATION

2.16.10 Within the study area a number of tourism and recreational facilities have been identified. However, these are primarily of local and regional importance and are considered low and medium sensitivity receptors. Some private landowners also operate tourism facilities which are discussed below. The Arundel Castle, Arundel Cathedral, Arundel Wetland Centre, Avisford Park Golf Club and Hilton Hotel are considered of regional importance and have been assessed as medium sensitivity receptors.

2.16.11 The alignments of Options 3 and 5A pass through Billycan Camping, a seasonal high-end campsite. The implementation of Option 1 is also likely to require direct land take from Arundel Cricket Club and the White Swan public house.

HOUSING

2.16.12 The following areas have been identified as strategic locations for growth in the district of Arun under the Local Plan.

- The coastal towns of Littlehampton and Bognor Regis;
- The villages of Barnham, Eastergate and Westergate; and
- Areas in and around Angmering.

2.16.13 The Local Plan does not list any allocated housing sites for development within the footprint of the Scheme.

COMMUNITY LAND

2.16.14 There is a narrow strip of land north of Tortington, known as Broad Green Waste, which is registered as Common Land under the Countryside and Rights of Way Act 2000. Option 5A crosses this parcel of land.

2.16.15 Option 5A crosses land (Binsted Park) that has been identified by local groups in the Binsted Area during consultation as being used recreationally for walking.

DEVELOPMENT LAND

2.16.16 Within the emerging Arun Local Plan, the Policy Maps show that the Arundel Bypass corridor has been safeguarded. The land south of Arundel through which the routes traverse is allocated as a 'Gap between Settlements'. The only other land development allocation under the Plan within the Study Area is an aspiration to develop a cycle path which follows the River Arun on its western bank from Arundel to Littlehampton. The proposed cycle path route will be crossed by all Scheme Options.

AGRICULTURAL LAND

2.16.17 Agricultural land has been classified by the Ministry for Agriculture, Fisheries and Food, now Defra, by grade land according to the extent to which chemical and physical characteristics impose long term limitations on agricultural use for food production.

2.16.18 The ALC map indicates that the land to be considered for the Scheme Options is a mixture of Grade 3 (moderate) and Grade 4 (poor). Without further investigation it is not possible to identify what quantities of each are present.

2.17 ROAD DRAINAGE AND THE WATER ENVIRONMENT

2.17.1 The following outlines the baseline conditions for the water environment. This information has been extracted from Chapter 13 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR.

SURFACE WATER

2.17.2 The River Arun flows through the centre of Arundel, flowing in a southerly direction to discharge to the sea approximately 6.5 kilometres downstream of Arundel at Littlehampton. The River Arun is designated as a Main River and is therefore under the jurisdiction of the Environment Agency. The River Arun and all watercourses in the study area are within the South East River Basin Management Plan. The water quality of the River Arun in the area of the proposed Scheme Options has been assessed against objectives of the Water Framework Directive and the results show that it is a heavily modified waterbody and its current ecological quality is assessed to be moderate, with a chemical status of good.

2.17.3 The River Arun forms an important focal point for the town. The river also has high recreational value for boating and walks along the riverbank within the vicinity of the Scheme Options.

2.17.4 Option 1 crosses the River Arun along the existing alignment of the A27. Options 3 and 5A would require a new crossing over the River Arun to be constructed south east of Tortington Priory.

2.17.5 There are a large number of ordinary watercourses (including Spring Ditch) and land drains that are located to the south of the existing A27 that flow south through Fowler's Copse, Binsted Wood and Tortington Common before confluencing and outfalling to the River Arun south of Ford Station. The majority of these watercourses are designated as ordinary watercourses and are therefore under the jurisdiction of West Sussex County Council as Lead Local Flood Authority. However, the key carrier drains that convey flow from the west and south of Binsted Wood to the River Arun are designated as Main Rivers and are therefore under the jurisdiction of the Environment Agency.

2.17.6 A large number of field drains are located between Ford Road and the Arun Valley Railway (on either side of the River Arun) providing a land drainage function to the low lying agricultural lands within this area and conveying water to the River Arun. All of these watercourses (including Station Ditch, Tortington Upper Ditch and Brookfield Stream) are designated as ordinary watercourses and are therefore under the jurisdiction of West Sussex County Council as Lead Local Flood Authority.

2.17.7 An existing system of ponds is located in the Avisford Park Golf Club to the east and west of Yapton Lane. It is considered likely that the purpose of these ponds is for aesthetical value but little is currently known regarding their ecological value or sensitivity.

2.17.8 Water quality within these surface water features is not monitored against the objectives of the Water Framework Directive and there are no known ecological designations.

GROUNDWATER

2.17.9 British Geological Survey data indicates that bedrock geology within the majority of the study area and to the west of Arundel (therefore partially beneath Options 3 and 5A) comprises Lambeth Group (clay, silt and sand) and London Clay Formation. The Lambeth Group is classified by the Environment Agency as a Secondary A Aquifer, described as permeable layers capable of supporting water supplies at a local rather than a strategic scale, and in some cases forming an important source of base flow to rivers. The London Clay Formation is considered to consist largely of unproductive strata.

2.17.10 British Geological Survey data indicates that the bedrock geology immediately to the north of the A27 (and therefore immediately north of Option 1) and to the east of Arundel (and therefore partially beneath Options 1, 3 and 5A) comprises the Spetisbury Chalk Member. This geology is classified by the Environment Agency as a Principal Aquifer, described as layers of rock or drift deposits that have high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage and may support water supply and/or river base flow on a strategic scale. The Chalk at this location is overlain by approximately 10 metres-30 metres of alluvium (clay).

2.17.11 Superficial deposits of clay, silt, sand and gravel are located throughout the study area and are classified predominantly as Secondary A Aquifers by the Environment Agency.

2.17.12 The Environment Agency's Water Abstraction Licences map and Groundsure report (2015) identify several licensed groundwater abstractions within one kilometre of the Scheme options. Water abstracted from these abstraction points are reported to be used for potable use and also for agricultural, aquaculture and irrigation uses. The abstraction licence borehole construction details are unknown; however, these are likely to be founded in the Chalk Group.

2.17.13 The Groundsure report (2015) identifies six active sewage discharge points to groundwater within one kilometre of the proposed Scheme options. These effluent discharge locations are likely to influence their underlying geologies through infiltration.

2.17.14 Groundwater quality is monitored against the objectives of the Water Framework Directive within the four aquifers under the Scheme options. The water quality of the Chalk aquifer to the north of Arundel (therefore partially beneath Options 1 and 3) has been assessed against objectives of the Water Framework Directive and the results show that its current quantitative status is assessed to be poor, with a chemical status of 'poor' with no change expected by 2021 and improvement to 'good' chemical status by 2027. The water quality of the Lambeth Group aquifer to the south and west of Arundel (partially beneath Options 1, 3 and 5A) has been assessed against objectives of the Water Framework Directive and is assessed to be 'poor', The assessment results show that its current quantitative status is poor, with a chemical quality of 'good' with the objective to achieve 'good' quantitative status by 2021 and 2027.

FLOOD RISK

2.17.15 Review of the Arun District Strategic Flood Risk Assessments 2008 and 2016 indicates records of localised flooding in the areas crossed by all three Scheme Options, namely to the south of Arundel and in the vicinity of Ford Road Roundabout in the centre of Arundel. The source of flooding in the centre of Arundel is identified as fluvial and from sewers. The source of flooding in the area crossed by Options 3 and 5A is not identified but due to its location it is likely to be fluvial or tidal.

2.17.16 The most significant flood risk within the study area is associated with fluvial and/or tidal flooding from the River Arun. Within the vicinity of the Scheme options, this predominantly affects land between Ford Road in the west and the Arun Valley Railway in the east, which is indicated to be located within the high risk Flood Zone 3. All Scheme options are identified to be at risk from this source of flooding, as illustrated on the Flood Zones map provided in Volume 2, Appendix A, A-5 Figure 13.1, flood Zone 3 is described as land having a 1 in 100 or greater annual probability of river flooding or a 1 in 200 or greater annual probability of tidal flooding. Consultation with the Environment Agency confirmed that whilst there is some fluvial interaction the predominant source of flooding is tidal.

WATER RESOURCES

2.17.17 A summary of the water environment resources that are considered most likely to be affected by the Scheme Options is presented in Table 2-12.

Table 2-12 Local Water Resources, Description and Importance

RESOURCE	DESCRIPTION AND IMPORTANCE
The River Arun	A main river under the jurisdiction of the Environment Agency. Current Water Framework Directive classification is moderate. The river flows through a popular urban area and is used for boating and riverside walks. Importance of this resource is considered to be High at this stage of the assessment.
Other Surface Water features	No known designations, although the location of surface water features within the Binsted wood most likely provides local importance to the overall value of these areas. They may support local abstractions for non-potable uses. Importance of these resources is considered to be Medium at this stage of the assessment.
Ponds locations in Avisford Park Golf Club	No known designations and ecological value not known at this stage, although likely to be for aesthetical purposes. Importance of these resources is assumed to be Low at this stage of the assessment.
Groundwater – Secondary A Aquifer	Majority of the Scheme Options underlain by Secondary A Aquifer of the Sussex Lambeth Group, with current Water Framework Directive classification of poor. Supports local abstractions for non-potable uses. Importance of this resource is considered to be Medium.
Groundwater – Principal Aquifer	Chichester Chalk aquifer to the north of A27 has current Water Framework Directive classification of poor, although supports a designated Source Protection Zone. Importance of this resource is considered to be Very High.
Groundwater - Users	The importance of groundwater users is considered to be High.
Flood Plain – River Arun	The identified flood defences and associated fluvial and/or tidal floodplain provide protection to the town of Arundel. Importance of this resource is considered to be Very High.
Flood Plain – other surface waters features	Flood risk predominantly within rural areas with few properties identified to be located in close proximity to mapped extents. Importance of this resource is considered to be Low.

2.17.18 Local groundwater users will likely source their water from the underling Chalk bedrock aquifer. At present, it is believed that the clay units within the Alluvium, London Clay Formation and the Lambeth Group will prevent vertical groundwater flow between the scheme dewatering activities and the deep seated Chalk aquifer.

2.18 CLIMATE

2.18.1 The following outlines the baseline climate conditions in the project area with respect to the assessment of effects on climate (greenhouse gas emissions) and the effect of climate on the proposed scheme (climate resilience). This information has been extracted from Chapter 14 of the PCF Stage 2 A27 Arundel Bypass Scheme EAR.

2.18.2 The greenhouse gas assessment is not restricted by geographical area but instead includes any increase or decrease in emissions as a result of the proposed Scheme. This includes:

- Construction and decommissioning emissions in the area of the Scheme footprint but also related to the transport of materials to and from the site, their manufacturing and disposal; and
- Operational emissions resulting from the new Scheme infrastructure but also emissions (or reduction in emissions) which result from the end-use of the Scheme and any shifts in transport modes or patterns which may occur.

2.18.3 Table 2-13 lists the historic meteorological conditions in the project area, forming the basis of consideration of climate resilience effects.

Table 2-13 Historic Regional Temperature and Precipitation Data for 1961 - 1990

Period	Summer - Mean Daily Temp. (°C)	Winter - Mean Daily Temp. (°C)	Summer -Mean Daily Max. Temp. (°C)	Winter -Mean Daily Min. Temp. (°C)	Summer - Average Precipitation (mm/day)	Winter - Average Precipitation (mm/day)
Historical baseline	15.9 °C	4.6 °C	20.3 °C	1.8 °C	1.4 mm/day	2.6 mm/day

2.18.4 The UK Climate Programme (UKCP09) has been used to identify climate projections using the high emissions scenario and the central estimate (50% probability). The absolute temperature for UKCP09 Area 1743 (Arundel-West Sussex) shows that over the schemes design life (120 yrs), temperatures during both winter and summer are expected to increase. In addition, within this area, summer precipitation is projected to decrease by up to 10% towards 2039 and 32% towards the end of the century.

3 SUMMARY OF PLANNING POLICY

3.1 INTRODUCTION

3.1.1 This section summarises relevant planning policy context and the strategic case for the scheme, considering national, regional and local planning policy.

3.2 KEY LEGAL TESTS OF RELEVANCE

3.2.1 There are a number of principal legal and policy tests that need to be taken into account in the selection of the preferred option. The scheme is likely to be a highway related Nationally Significant Infrastructure Project (NSIP) on the basis that the options currently under consideration will be of a scale large enough to exceed the qualifying area of development thresholds stipulated in the Planning Act 2008.

3.2.2 At this stage in the scheme development process, the focus has been to identify those tests that could potentially preclude the Secretary of State from being able to grant development consent, if a particular scheme option could result in a breach of the UK's international obligations or any duty imposed under UK legislation. The tests of most relevance to the consideration of the preferred option are as follows:

- The European Directive 2008/50/EC, Ambient Air Quality and Cleaner Air for Europe, transposed in to UK legislation by the Air Quality Standards Regulations 2010, which would prevent consent from being granted for any scheme that would result in non-compliance with legally binding limit values for prescribed pollutants, including nitrogen dioxide (NO_2) and particulates of less than 10 microns (PM_{10}). The annual limit values for both are 40 ug m^3.
- The European Directive 2000/60/EC, Establishing a Framework for the Community Action in the Field of Water Policy, transposed in to UK legislation by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 and the Water Industry Act 1991 (Amendment) (England) Regulations 2009. This legislation would prevent consent being granted for any scheme likely to cause deterioration in water quality status; or prevent a waterbody from achieving good ecological status; or compromise the achievement of water framework directive objectives in other classified water bodies within the same catchment.
- The European Directives 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna and 2009/147/EC on the Conservation of Wild Birds, which are transposed in to UK legislation by the Conservation of Habitats and Species Regulations 2010 (as amended by the Conservation of Habitats and Species (Amendment) Regulations 2012). These directives would prevent development consent from being granted for any scheme that would give rise to an adverse effect on the integrity of a European site (a Special Protection Area or a Special Area of Conservation), either individually or cumulatively, unless there was no less damaging, feasible alternative; that there were Imperative Reasons of Overriding Public Interest and that suitable compensation could be secured. The bar for proving an Imperative Reasons of Overriding Public Interest for European Sites is very high, and few schemes meet this test.
- The European Habitats Directive 92/43/EEC and Habitats Regulations 2010 would also prevent consent and/or a mitigation licence from being granted for any scheme that would harm or disturb a European Protected Species, unless there were no satisfactory alternatives; that the favourable conservation status of the species would be maintained and that the development would be in the public interest.
- The Wildlife and Countryside Act 1981, as amended by the Countryside and Rights of Way Act 2000, which would prevent development consent from being granted for any scheme that would disturb or harm nationally protected species, unless there were no satisfactory alternative solution.

3.2.3 In addition, under Section 104 (7) of the Planning Act 2008, development consent cannot be granted for any scheme if the benefits of that scheme do not outweigh its adverse impacts overall.

3.3 NATIONAL POLICY

NATIONAL POLICY STATEMENT FOR NATIONAL NETWORKS

3.3.1 In 2014, the Government adopted the National Policy Statement for National Networks (NNNPS), which sets out the need for and the Government's policies to deliver the development of Nationally Significant Infrastructure Projects (NSIP) on the national road and rail networks in England, as defined by the Planning Act 2008 as amended by the Highways and Railway (Significant Infrastructure Projects) Order 2013. The Planning Act 2008 requires the Secretary of State to use the NNNPS as the primary basis for making decisions on development consent applications for national networks NSIPs in England. The NNNPS sets out the government's position with respect to improvements on the highways network, and indicates that improvements are vital to alleviate congestion, particularly in the south east of England. The NNNPS is consistent with the overall strategic aims of the National Planning Policy Framework (NPPF) and seeks to achieve sustainable development.

NATIONAL PLANNING POLICY FRAMEWORK

3.3.2 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these are expected to be applied. The NPPF is a consideration in decisions on NSIPs, but only to the extent relevant to the scheme where the NNNPS is silent. If the scheme does not qualify as an NSIP and requires planning permission, the NPPF is a material consideration in decision making.

3.3.3 The NPPF adopted in 2012 forms a key part of the reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. There is an overarching presumption in favour of sustainable development that should be the basis of every plan and every decision.

3.4 OTHER RELEVANT DOCUMENTS – NATIONAL LEVEL

ROAD INVESTMENT STRATEGY (2015- 2020)

3.4.1 The Road Investment Strategy (RIS) is a suite of documents prepared by the Department of Transport and Highways England which outlines a long-term programme to improve England's strategic road network. It outlines how opportunities to improve and transform the road network can be met, alongside addressing strategic imperatives such as economic growth and climate change. Fundamentally, the documents outline the vision for smooth, safe and reliable monitoring, sustainable roads and methods for fostering cutting edge technologies.

HIGHWAYS ENGLAND PLANS AND POLICIES

3.4.2 The following Highways England plans and policies are of relevance to the scheme and have been key considerations in its development to date:

- Highways England Licence, which sets out the Secretary of State's statutory directions and guidance to Highways England;
- The Highways England Strategic Business Plan 2015-2020 which sets out how Highways England will achieve its commitments as set out in the RIS over the five-year period from 2015-2020; and
- The Highways England Delivery Plan 2015-2020, which sets out what Highways England will do over the period between 2015 and 2020 to deliver against the commitments set out in the

Strategic Business Plan and RIS. The Delivery Plan outlines how Highways England will deliver the five key strategic outcomes outlined within the Strategic Business Plan (supporting economic growth, creating a safe and serviceable network, create a freer flowing network, improve the environment and create a more accessible and integrated network).

3.5 REGIONAL PLANNING AND TRANSPORT POLICY

SOUTH EAST PLAN 2009

3.5.1 The South East Plan (2009) is the Regional Spatial Strategy for the South East of England and remains a statutory planning document. The South East Plan identified highways capacity issues on the A27/A259 at Arundel and Worthing.

WEST SUSSEX LOCAL TRANSPORT PLAN 2011- 2026

3.5.2 The Local Transport Plan adopted February 2011 sets out the County Council's plan to improve the transport network and deliver sustainable economic growth. The Plan describes the A27 at Arundel as a bottleneck, where there are high accident rates and diversions onto unsuitable routes are required at times of delay. This increases the levels of driver frustration.

3.5.3 The plan outlines key priorities for West Sussex. One of the highest priorities within the plan is: "Improvements to the A27 trunk road and complementary public transport improvements to the current bottlenecks at Chichester, Arundel and Worthing (not currently programmed) to increase capacity, improve reliability and safety and increase the competitiveness of local businesses and attract investment."

3.5.4 It also notes that, because of the presence of connecting footpaths and pavements on stretches of the A27 through Arundel, and proximity of houses and community facilities, there are likely to be pedestrians crossing or walking alongside the road. This increases the level of fear felt by all road users.

3.6 LOCAL PLANNING POLICY

ARUN DISTRICT LOCAL PLAN 2003

3.6.1 The Arun District Local Plan 2003 adopted in April 2003 and covered a period up to 2011. The Planning and Compulsory Purchase Act 2004 contained a provision for the saving of policies in adopted or approved local and structure plans for a period of three years from the commencement of the Act in September 2004. Policies in this plan expired on 27 September 2007 and the Secretary of State agreed to extend these beyond this date until the adoption of the Arun Local Plan 2011 – 2031.

ARUN DISTRICT LOCAL PLAN 2011- 2031

The Arun District Local Plan 2011 – 2031 is currently being prepared, the Council produced a series of modifications to the Arun Local Plan 2011 – 2031 which underwent public consultation concluding on 23rd February 2018. The plan sets out the strategic vision, objectives, policies and proposals for development in the local planning authority to 2031 and beyond. The area includes all of Arun district apart from those parts within the South Downs National Park (SDNP).

One of the aims for Arun's road network include major improvements of the A27 at Arundel which could bring significant improvements to the economy and the environment by reducing the length of traffic delays and reducing congestion. The draft Local Plan explains that improving transport links within Arun District can help to attract businesses to the district which in turn can help achieve sustainable development through increasing job density. The Council's key strategic priority regarding transport infrastructure is to work with partners to facilitate the delivery of the A27 Arundel Bypass.

SOUTH DOWNS LOCAL PLAN

3.6.2 The South Downs National Park Authority is the statutory planning authority for the National Park area and is currently preparing their Local Plan. The Authority concluded consultation on the Pre-submission South Downs Local Plan document in November 2017. On adoption in 2018, the Local Plan will become the statutory development plan for the whole National Park and replace existing local plan policies operating across the National Park.

3.7 OTHER RELEVANT DOCUMENTS

AN ECONOMIC STRATEGY FOR WEST SUSSEX, 2012-2020 (WEST SUSSEX COUNTY COUNCIL)

3.7.1 The strategy sets out a high level approach to supporting sustainable economic growth in West Sussex. The Arundel Bypass would support three of the seven strategic priorities in the strategy:

- Adapt an respond to new funding conditions to ensure that West Sussex secures investment to support its economic development priorities;
- Deliver transport communications infrastructure that businesses and residents need; and
- Support the creation of a range of jobs that enable people to participate in the labour market in a way that best reflects their needs at different life stages.

ARUN ECONOMIC STRATEGY (ARUN DISTRICT COUNCIL)

3.7.2 In 2009, Arun District Council published ‘Open for Business: an Economic Strategy for Arun (2009 - 2026) which provided a thorough analysis of the economic conditions in the district. It set out a vision for the growth of the district’s economy: ‘’to create a vibrant, competitive and sustainable place to live, work and do business’’. The Arundel Bypass would support four of the six objectives of the strategy:

- Increase business competitiveness and growth - with a focus on Arun’s existing businesses;
- Encourage the level and rate of new investment, particularly in high growth sectors;
- Maintain and improve the area’s infrastructure, facilities and physical environment; and
- Maintain and improve transport networks across the district and wider area.

4 SUMMARY OF DO NOTHING SCENARIO

4.1 INTRODUCTION

4.1.1 This chapter summarises the methodology for developing forecasts of traffic conditions including volume and journey time. This chapter also describes future conditions for Walking, Cycling and Horse Riding users and the wider economy. These forecast scenarios have been used as a basis on which to compare the effects of the A27 Arundel Bypass scheme options. For the purposes of this report these scenarios are described as 'do nothing'.

4.1.2 For the purposes of this project, a 2023 opening year and 2041 horizon year have been taken forward to describe do nothing conditions, and to assess the scheme. Scenarios for the average AM, Inter-peak and PM peak periods have been developed. This chapter describes the 2041 conditions.

LAND USE DEVELOPMENT

4.1.3 To develop the forecast scenarios, the committed and proposed land use and infrastructure development within the study area and in the broad vicinity of the A27 has been established. A 'core' forecast scenario has been created based on:

- planned development outside the modelled area
- committed dwellings within the modelled area
- committed jobs within the modelled area

4.1.4 Data was provided by Local Authorities based on current Local Plans to determine the anticipated level of development and this was recorded in an Uncertainty Log[32]. Sites considered to be 'near certain' or 'more than likely' were included explicitly within the forecasts.

4.1.5 The total land use development assumed for the forecast scenarios is consistent with the levels described in the National Trip End Model (NTEM) V7.2 datasets (March 2017). These are summarised below in Table 4-1

Table 4-1 TEMPRO Planning Projections

LOCALITY	HOUSEHOLDS		JOBS	
Year	2015	2041	2015	2041
Arun	70,051	87,587	57,622	63,275
Adur	27,962	32,249	25,913	28,344
Worthing	48,757	55,684	57,782	63,366

INFRASTRUCTURE SCHEMES

4.1.6 The schemes that are included in the forecasts are listed below. Other RIS schemes along the A27 are excluded from the forecasts.

- Bognor Regis relief road – connecting the A29 at Shripney to the A259 at Felpham.
- A284 Lyminster Bypass/ Fitzalan link road – two sections, one to the south of the A27 at Crossbush to East Street in Littlehampton town centre, with a new roundabout on the A259 Worthing Road. The other section between Toddington Nurseries and the A259.

[32] HE551523-WSP-GEN-A27A-PCF2-RP-TR-ComMA_P03.03_ISSUE.pdf

- Ikea signalised access junction – located on the A27 at Lancing.
- A259 corridor improvements – between the new A259/A284 roundabout in the west and the A259/A280 roundabout in the east.

4.2 TRAFFIC GROWTH

4.2.1 The level of traffic growth within the A27 Strategic Model forecast is based on data from a number of sources. Forecasts of the overall growth in car trips was obtained from TEMPRO version 7.2, a software tool that provides projections of growth over time for use in transport models based on outputs from NTEM. Growth for Light Goods Vehicles (LGV) and Heavy Goods Vehicles (HGV) was obtained from the National Transport Model (NTM using National Road Traffic Forecasts (NRTF) 2015 (version 1.0, March 2015).

4.2.2 The combination of NTEM growth, RTF growth and development-specific traffic combined to make up the forecast year matrices for each peak period. The total traffic movements and percentage growth by journey purpose between 2015 and 2041 is set out in Table 4-2. The level of traffic growth in the A27 Strategic Model has increased relative to the level of growth that was set during PCF Stage 1 (described further in Chapter 6).

Table 4-2 Traffic Growth to 2041

PURPOSE	PEAK	2015	2041	%DIFFERENCE (2015 TO 2041)
Car Business	AM	3280	3883	18.4%
	PM	3005	3523	17.2%
Car Commute	AM	12237	14086	15.1%
	PM	13453	15310	13.8%
Car Other	AM	17088	22293	30.5%
	PM	23441	29146	24.3%
LGV	AM	5863	9792	67.0%
	PM	5476	9145	67.0%
HGV	AM	3961	5136	29.7%
	PM	2893	3767	30.2%
Total	AM	42429	55190	30.1%
	PM	48268	60891	26.2%

4.3 TRAFFIC FLOWS

4.3.1 Table 4-2 shows the 2041 AADT volumes in the do nothing scenario, together with the percentage change from the 2015 base year and the HGV percentage.

4.3.2 There is an increase in AADT in 2041 for all routes, with the exception of the A27 between Causeway and Ford Road roundabout where a small decrease is indicated. On the A27, the highest percentage growth is between the Crossbush junction and the Causeway roundabout. However, the increases on the A27 are modest relative to the increase on local roads and are constrained relative to the overall growth percentages shown in Table 4-3.

4.3.3 It is considered that the existing capacity constraints along the single carriageway sections of the A27, in particular past Arundel Railway Station, are constraining traffic volumes. This results in the diversion of traffic onto lower order roads. However, the forecast increase in traffic on particular sections of the A27, without the implementation of a scheme, will exacerbate the current congestion issues.

4.3.4 Figure 4-2 and Figure 4-3 present the year 2041 percentage change on base year peak period traffic flows, capacity and V/C for the same locations presented in Chapter 2. Max RFC or DoS at Ford Road roundabout and Crossbush Junction are also indicated.

Figure 4-1 2041 do nothing AADT forecast

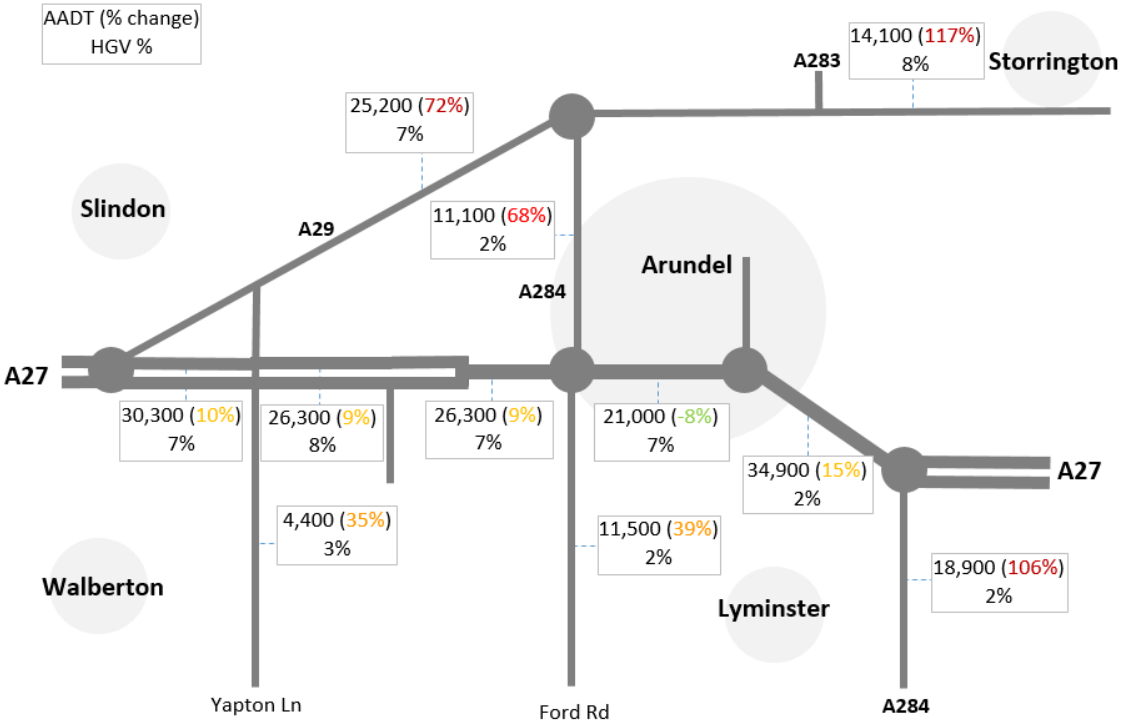


Figure 4-2 2041 do nothing peak period forecast (AM)

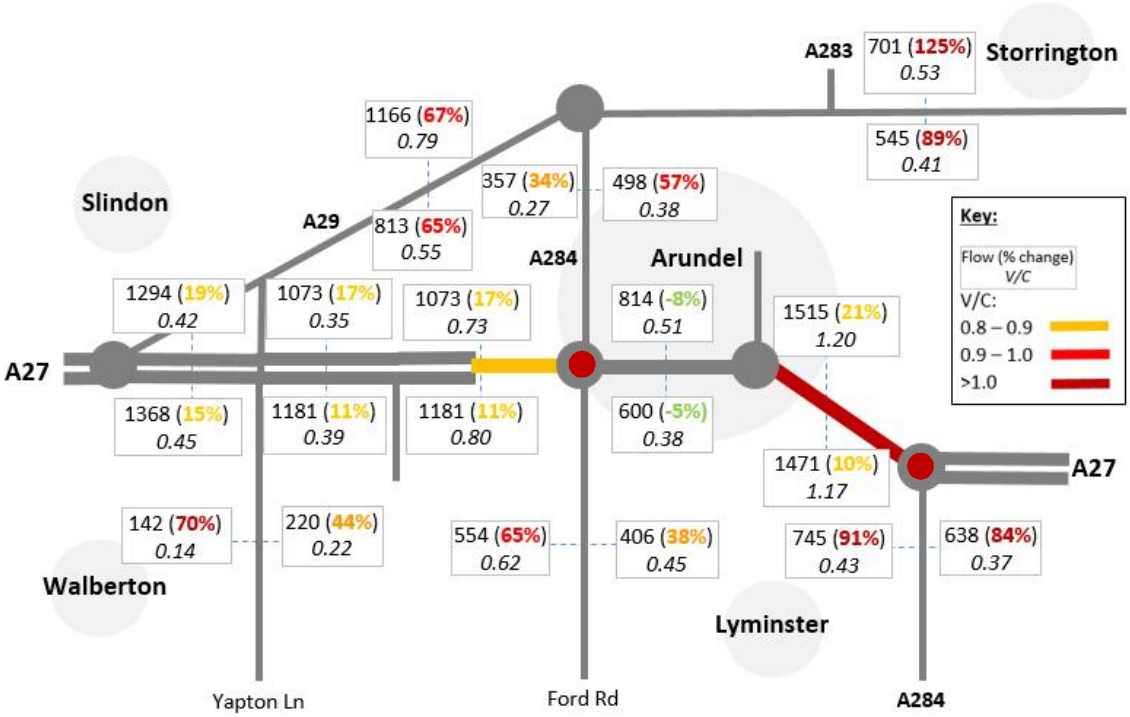
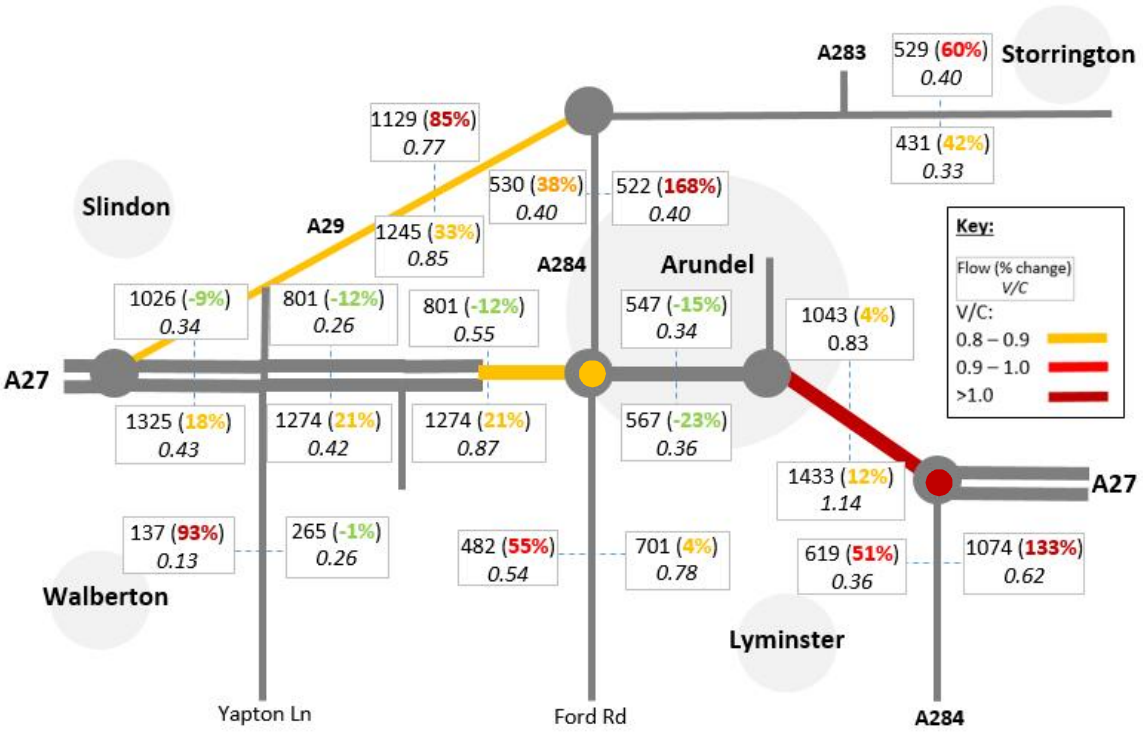


Figure 4-3 2041 do nothing peak period forecast (PM)



4.3.5 On the A27 traffic volumes increase by up to 21%. The sections that experience the highest of these increases are eastbound in the AM between the railway station and Crossbush junction, and westbound in the PM between Ford Road roundabout and Yapton Lane.

4.3.6 There are some sections of the A27 that see reduced flows in comparison to the base year. These include eastbound and westbound directions in the AM and PM peak between Causeway and Ford Road roundabout and generally eastbound during the PM peak. The decreases in flows in the PM reflect the significant link and junction capacity constraints near to Arundel station and at Crossbush junction. This section of the existing A27 is shown to exceed capacity as highlighted with the high V/C's.

4.3.7 The effect of the capacity constraints is for some traffic to re-route to less suitable roads. The traffic flows on other local roads generally see higher increases than on the A27. In addition, the highest increase in flow is shown on the southern section of the A284 travelling southbound in the PM which is associated with the capacity improvements provided by the Lyminster bypass. Although there are significant increases in flow on these local roads, the volume of traffic does not exceed the capacity of each link.

4.3.8 Table 4-3 and Table 4-4 summarise the modelling results of Ford Road roundabout and Crossbush junction in 2041 for both time periods. Both junctions are forecast to operate significantly in excess of capacity by 2041.

Table 4-3 Ford Road Do Nothing Model ARCADY Results (2041 AM and PM Peak)

JUNCTION ARM		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
		RFC	Queue (Veh)	Delay (s/Veh)	RFC	Queue (Veh)	Delay (s/Veh)
A	A284	0.43	0.75	7.55	0.47	0.89	6.84
B	Maltravers Street	0.94	10.31	53.04	0.87	5.95	35.27
C	A27 East (Arundel Bypass)	0.65	1.84	10.23	0.66	1.91	11.26
D	Ford Road	0.99	15.43	92.5	0.80	3.79	27
E	A27 West (Chichester Road)	1.11	65.88	182.48	0.70	2.26	9.38

Table 4-4 Crossbush Junction Do Nothing Results (2041 AM and PM Peak)

JUNCTION ARM / LANE(S)		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
Arm / Movement	Lane(s)	DoS (%)	MMQ (PCUs)	Delay (s/PCU)	DoS (%)	MMQ (PCUs)	Delay (s/PCU)
A27 Westbound Left Turn	1/1	27	4	13	79	22	22
A27 Westbound Ahead	1/2	124	175	421	110	101	215
A27 WB Circulatory	2/1	72	13	50	50	7	46
A284 Northbound	3/1+3/2	126	110	472	111	53	268
A284 N/B Circulatory Right Turn	4/1	78	2	7	79	2	7
N/B Circulatory Give-way Right	5/1	122	66	431	69	11	42
Total Delay (PCUhr)			**296.07**			**131.02**	
Practical Reserve Capacity (%)			**-39.6**			**-23.0**	

4.4 JOURNEY TIMES

4.4.1 Table 4-5 shows the year 2041 forecast journey times along the A27 for the same locations presented in Chapter 2. Free flow conditions are represented by the eastbound direction in the base year IP period (9 minutes 1 second).

Table 4-5 2041 journey times (mm:ss)

ROUTE		AM	IP	PM
A27 EB	Journey time	11:01	10:03	17:07
	Increase relative to base year	+ 2:15	+ 1:02	+ 1:21
	Increase relative to free flow	+ 2:00	+1:02	+ 8:06
A27 WB	Journey time	12:40	10:54	12:46
	Increase relative to base year	+ 2:33	+ 1:04	+ 3:45
	Increase relative to free flow	+ 3:39	+ 1:53	+ 3:45

4.4.2 Without the implementation of a scheme along the A27, journey times deteriorate further and would become more unreliable. The eastbound direction in the PM peak continues to experience the longest journey times which increases by a further 1 minute 21 seconds compared with the base year. For the same direction in the AM and IP, the journey time increases by over 1 minute per vehicle. For the westbound movement, the PM peak sees the highest of all increases in journey times, taking an extra 3 minutes 45 seconds in comparison to the base year journey times.

4.5 WALKING CYCLING AND HORSE RIDING (WCHR)

4.5.1 Without the implementation of a scheme along the A27 at Arundel, travel conditions for WCHRs is expected to deteriorate.

4.5.2 The increase in vehicle numbers along the A27 and the limited crossing facilities will increase the severance between the north and south of Arundel. As a result of this, people may be further discouraged to travel on foot or by cycle, and opt to travel by vehicle. This may further contribute to the increased flows both on local roads and on the A27.

4.5.3 Those that continue to walk and cycle will continue to rely upon the signalised crossing for access to the Arundel railway station and this is a factor in the constrained link capacity which limits vehicle throughput along this section of the A27.

4.5.4 The significant increases in traffic along some of the local roads will change the nature of these routes, many of which are rural country lanes and not intended for use as strategic through-routes. The conditions for pedestrians and cyclists along these routes are expected to deteriorate without intervention, with journey quality and health and safety impacts.

4.6 WIDER ECONOMY

A27 CORRIDOR IMPACTS

4.6.1 An increase in the level of delay and congestion along the A27 at Arundel will impact upon the performance of the route, resulting in a further constraint on the strategic function of the corridor for longer distance traffic movements. The route has an important role in providing accessibility across a wider area and supporting economic activity and growth within the region.

4.6.2 West Sussex currently falls behind other parts of the South East in terms of Gross Value Added (GVA) per head generated and travel conditions and accessibility can be seen as a constraint for the local population in terms of access to employment.

HOUSING AND POPULATION GROWTH

4.6.3 Population estimates from the Office for National Statistics (ONS) show that the Arun District has the highest proportion of the county's population at almost 19%. It is projected that there will be an additional 37,000 residents within the district by 2039.

4.6.4 Population growth brings a growth in housing provision. Arun has one of the highest new housing targets in West Sussex, with the target of an additional 15,158 new residential dwellings by 2031[33]. Commuting data from West Sussex and Arun District indicates that a high proportion of working age residents moving into these new dwellings will commute to their place of work by car, adding to the pressure on the road network.

[33] Based on final (February 2017) trajectory data for use by West Sussex County Council.

PRODUCTIVITY

4.6.5 GVA per head in the Arun and Adur districts has been lower than the UK average, and the 'productivity gap' between the two districts and UK has been increasing over time. The gap for Arun District Council for example was just under £3,900 per head in 1997 whereas by 2015 this had more than doubled to £9,600. Without improved transport provision, the productivity gap is likely to increase.

TOURISM SECTOR

4.6.6 The visitor economy in West Sussex is another key driver of economic activity and is subject to the adverse impacts of constrained highway capacity, especially during busy holiday periods.

4.6.7 The key issues identified in the Sussex by the Sea Visitor Strategy 2006-2011[34] include a lack of investment in the districts' infrastructure. This has a direct reference to the problems associated with the lack of road capacity.

4.6.8 With the area being situated on a strategic corridor for visitors making journeys to and from attractions further afield, the high levels of congestion and unreliable journey times will continue to hold back the potential of the sector.

FUTURE ECONOMIC DEVELOPMENT

4.6.9 Current forecasts suggest that nearly half the new jobs created in the sub-region by 2031 will be in Chichester and Brighton and Hove. This will re-inforce the need for young, qualified people to migrate out of the area to secure employment opportunities. This in turn will further exacerbate sub-regional economic imbalances and add pressure on transport infrastructure, employment land supply and housing provision.

4.6.10 To support local economic development, The Arun Place Plan[35] sets out the emerging priorities for the District which could deliver over 5,000 jobs. These include investment in:

- Littlehampton – A284, A259, town centre and seafront, and public estate optimisation
- Bognor Regis – Enterprise Bognor Regis, town centre and seafront, University of Chichester, and 'Better Bognor' concept
- skills development in emerging growth locations through the Local Plan process
- support for tourism and healthcare sectors to take advantage of future opportunities and to meet demographic challenges in the District

4.6.11 These priorities are consistent with and will contribute to the Coast to Capital Local Enterprise Partnership (LEP) targets to develop 970,000 square metres of employment floor space by 2021.

4.6.12 The accessibility of the local area will be an important factor in the potential to deliver growth and inward investment. Transport infrastructure deficits may constrain the potential of some of the proposed development, with the benefits of investment in Arun not being fully realised.

[34] http://tourisminsights.info/ONLINEPUB/STRATEGY/STRATEGY%20PDFS/Arun%20District%20Council%20(2006),%20Sussex%20by%20the%20Sea%20-%20Visitor%20Strategy%202006-2011,%20ADC,%20Littlehampton.pdf

[35] The Arun Place Plan, Arun District Council and WSCC (January 2016)

4.6.13 The ability of an area to secure higher value employment, develop the skills of the labour force and deliver improved levels of GVA depends upon supporting transport infrastructure. Where accessibility constrains labour market catchments, opportunities to resolve skill gaps and realise business growth opportunities will be missed.

4.6.14 For example, the potential for a comprehensive investment package to support existing and new development in Littlehampton town centre and seafront may be limited by accessibility issues which would present a missed opportunity to support and develop the tourism economy and realise GVA growth in this sector.

4.6.15 Without the Arundel Bypass scheme, development may not be delivered as investors invest in other areas that have higher quality transport links. If these sites still continue to proceed, they may not reach their full potential without improved transport infrastructure.

5 SUMMARY OF ALTERNATIVE SCHEMES

5.1 INTRODUCTION

5.1.1 This section of the report contains a brief description of the development of the options in PCF Stage 1 and describes the three route options, Options 1, 3 and 5A that were taken forward for further assessment in Stage 2. The designs described will be subject to change as the chosen preferred route is developed further. This is in order to optimise its design and to develop measures to mitigate its impacts.

5.2 OPTION IDENTIFICATION

5.2.1 This section contains a brief description of the development of the options in PCF Stage 1. For more details see Chapter 12 of the A27 Arundel Bypass Technical Appraisal Report (TAR).

5.2.2 During this stage a total of 10 alternative options were identified from earlier studies and a series of stakeholder consultation events. These covered a range of solutions including:

- full offline bypasses;
- partial on-line widening; and
- modest packages of junction improvements.

5.2.3 Seven of the options where taken forward from Stage 0 and developed from the A27 Feasibility Study. A further three options where developed during Stage 1. A summary of the options is provided in Table 5-1 and Table 5-2. The best performing options were identified for full WebTAG appraisal. This process informed the decision made about which options would be progressed into Stage 2 and considered for inclusion in the public consultation.

Table 5-1 Options Taken Forward from PCF Stage 0 to PCF Stage 1

OPTION	SUMMARY DESCRIPTION
Option 0A	Junction improvements at Crossbush Junction, Causeway roundabout and Ford Road roundabout. The existing single carriageway section of the A27 would be retained.
Option 0B	Widening the existing single carriageway section of the A27 to provide a narrowed dual carriageway with two lanes in each direction with improvements at Crossbush Junction, Causeway roundabout and Ford Road roundabout.
Option 1	D2UAP widening on existing A27 alignment, then offline D2AP to tie into Crossbush Junction to incorporate an online then offline improvement, running west to east.
Option 2	D2AP offline bypass with the route situated lower in the valley. This alignment is approximately 4.4km in length. It commences from a proposed new interchange adjacent to The White Horse Public House, to the west of Arundel, on the existing A27 Chichester Road. The alignment then turns toward the south to run adjacent to Tortington Lane and then south eastward. The alignment continues in a south east direction to cross the River Arun, before turning northwards to run adjacent to the existing A27. This alignment then continues on to cross over the Arun Valley Railway and ties into the existing A27 to form a new grade separated interchange at Crossbush Junction. Option 2 would incorporate a standard D2AP corridor along its entire length.
Option 3	An offline D2AP route bypassing the existing A27 alignment. This alignment continues in a south east direction through Ancient Woodland at Tortington Common to create four new under bridges at Old Scotland Lane, Binsted Lane, Tortington Lane and Ford Road. The alignment then turns eastwards to create two new over bridges at the River Arun and Arun Valley Railway. The alignment then ties into the existing A27 to form a new grade separated interchange at Crossbush Junction.
Option 4	An offline D2AP route. This option commences further west than Options 2 and 3. The alignment continues in a south east direction adjacent to the border of the South Downs National Park (SDNP) with four new under-bridges at Binsted Lane (north),

Option	Summary Description
	Old Scotland Lane, Binsted Lane (south) and Ford Road. The alignment then continues east, similar to Option 3, and would include two new over-bridges at the River Arun and Arun Valley Railway. The alignment then ties into the existing A27 to form a new grade separated interchange at Crossbush Junction.
Option 5 –	An off line D2AP route. Option 5 runs north of Tortington Priory, thereby allowing for the shortest distance possible over the floodplain, then intersects the Ancient Woodland and SDNP. The alignment then continues east, similar to Option 3 above, and will create two new over-bridges at the River Arun and Arun Valley Railway. The proposed alignment then ties into the existing A27 to form a new grade separated interchange at Crossbush Junction.

Table 5-2 Further Options Developed in PCF Stage 1

Option	Description
Option 0AB	A narrowed dual carriageway corridor with two lanes in each direction along the existing A27 alignment. This is in addition to the improvements at Crossbush Junction, Causeway roundabout and Ford Road roundabout and supplemented by a short offline section past Arundel Railway Station. The current road section past the railway station would become a local off-slip/ on slip from the short new offline dual carriageway section
Option 5A	An offline dual carriageway corridor with two lanes in each direction to the south of Arundel. A hybrid of Option 3 and Option 5 alignments, avoiding passing south of the Guest Houses on Priory Lane along Ford Road. This option joins with the existing A27 dual carriageway at Crossbush, with a new grade separated junction near Yapton Lane.
Option 5B	An offline dual carriageway corridor with two lanes in each direction to the south of Arundel. Starting at Crossbush Junction to form a new grade separated interchange with the existing A27 dual carriageway and running west. It passes south of Arundel town, and across the Arun floodplain between Tortington Priory and Tortington village. It bypasses the Ancient Woodland and South Downs National Park completely running between Binsted and Walberton, to join the existing A27 dual carriageway north of the Hilton Hotel and Avisford Park Golf Course, west of the existing junction with Mill Road/Tye Lane.

5.2.4 In Stage 1 an environmental assessment of all ten options was carried out together with an assessment of each options 'advantages and disadvantages. At a series of stakeholder events the findings of these assessments where discussed. This resulted in five options identified as the best performing and recommended to be taken forward for further development and webtag appraisal. Table 5-3 presents a summary of the high level assessment carried out during Stage 1. For more details, see Chapter 12 of the TAR. The five options taken forward for detailed appraisal in Stage 1 are illustrated in Figure 5-1, while Figure 5-2 illustrates the rejected options.

Table 5-3 Summary of High Level Assessment of route Options in PCF Stage 1

Scheme Options		Key Benefits and Issues		Taken Forward for Detailed Appraisal in Stage 1	
Ref	Description	Benefits	Issues		
OA	Improvements to Crossbush, Causeway, and Ford Road junctions	No impact on SDNP and Ancient Woodland. Strong value for money case	Poor strategic case. Limited support to economic growth Residual traffic performance issues	Y	Low cost option retained for consideration
OB	Online dualling with junction improvements	Minimal impact on SDNP and Ancient Woodland. Strong value for money case	Impact on properties adjacent to A27 and on heritage sites. Impact on bridge over railway	N	Engineering and property issues. Discarded in favour of other part-online options
OBA	Online dualling as option OB with	Route avoids weak bridge over	Deliverability issues for new	N	Engineering and property issues.

Scheme Options		Key Benefits and Issues		Taken Forward for Detailed	
	new bridge across the railway	railway Minimal impact on SDNP and Ancient Woodland. Strong value for money case	railway bridge associated with a veteran tree		Discarded in favour of other part-online options
1	Online dualling with offline section from east of River Arun to Crossbush roundabout	Strong value for money case. Link east of Arundel avoids property impacts	Involves substantial earth-works (cutting) Floodplain issues	Y	Optimal part-online scheme which would deliver RIS objectives. Retained for consideration.
2	Offline link aligned to the north of Tortington Priory	Makes use of the existing A27 dual carriageway	Close to existing urban area resulting in noise and vibration issues. Landscape and visual impact Sub-standard alignment due to sharp bends	N	Engineering issues in relation to alignment. Does not mitigate landscape impacts. Discarded in favour of other offline options
3	Offline link to the south of Tortington Priory. Similar to 'Pink Blue' route.	Makes full use of existing dual carriageway. Strong value for money case	Floodplain issues Landscape and visual impact. Impacts on SDNP and Ancient Woodland	Y	Selected as the Preferred Route previously, this route is supported by many key stakeholders
4	Offline link to the south of Tortington Priory, a variation of Option 3	It reduces impact on Ancient Woodland in comparison to other offline options. Strong value for money case	Bypasses existing dual carriageway section west of Arundel. Floodplain issues. Route passes close to Binsted. The section outside the National Park is still within the area of influence of SDNP. Impacts on Ancient Woodland at western end	N	Does not provide further scope for mitigation of SDNP and Ancient Woodland impacts and is discarded in favour of other offline options as it provides no additional benefit
5	Offline route to the north of Tortington Priory	Minimises impact on Ancient Woodland and SDNP in comparison to other offline options. Limits floodplain issues. Strong value for money case	Close to existing urban area. Bypasses existing dual carriageway sections. Engineering issues associated with topography and a requirement for a higher crossing of River Arun	N	Inferior to other offline options due to engineering Issues and greater visual and heritage impacts
5A	Offline route to the south of	Reduced negative visual	Bypasses existing dual	Y	Reduced visual and heritage

Scheme Options		Key Benefits and Issues		Taken Forward for Detailed	
	Tortington Priory. Hybrid of other options. Similar to 'Orange' Route	impact on Tortington Priory. Minimises impact on Ancient Woodland and SDNP in comparison to other offline options. Strong value for money case	carriageway section west of Arundel		impacts and limited Ancient Woodland impact compared with other offline options.
5B	Offline route to the south of Tortington Priory connecting with the existing A27 west of Yapton Lane	No impact on Ancient Woodland Limited impact on SDNP. Reduced negative visual impact on Tortington Priory	Higher cost option Modest value for money case. Runs close to Binsted	Y	No impact on Ancient Woodland and limited impact on SDNP. Reduced visual impacts in comparison to other offline options

Figure 5-1 Route Options Subjected to Detailed Webtag Appraisal in PCF Stage 1

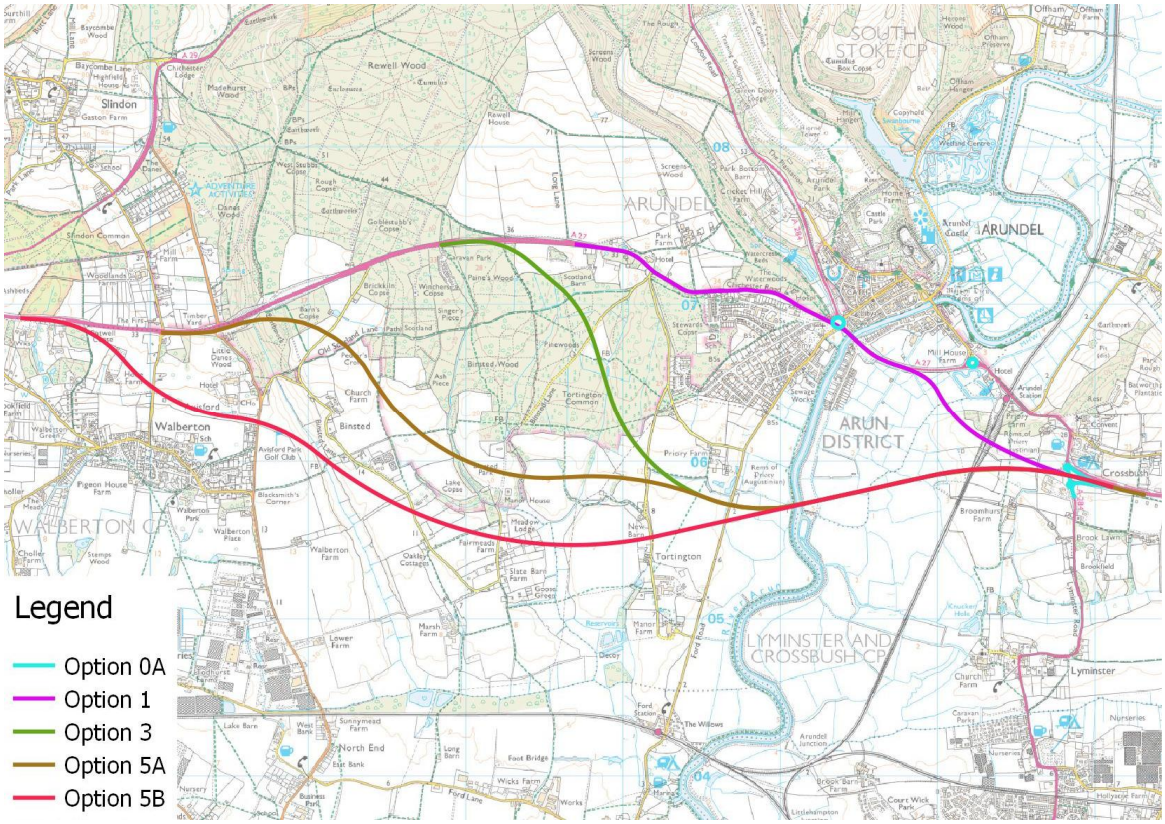
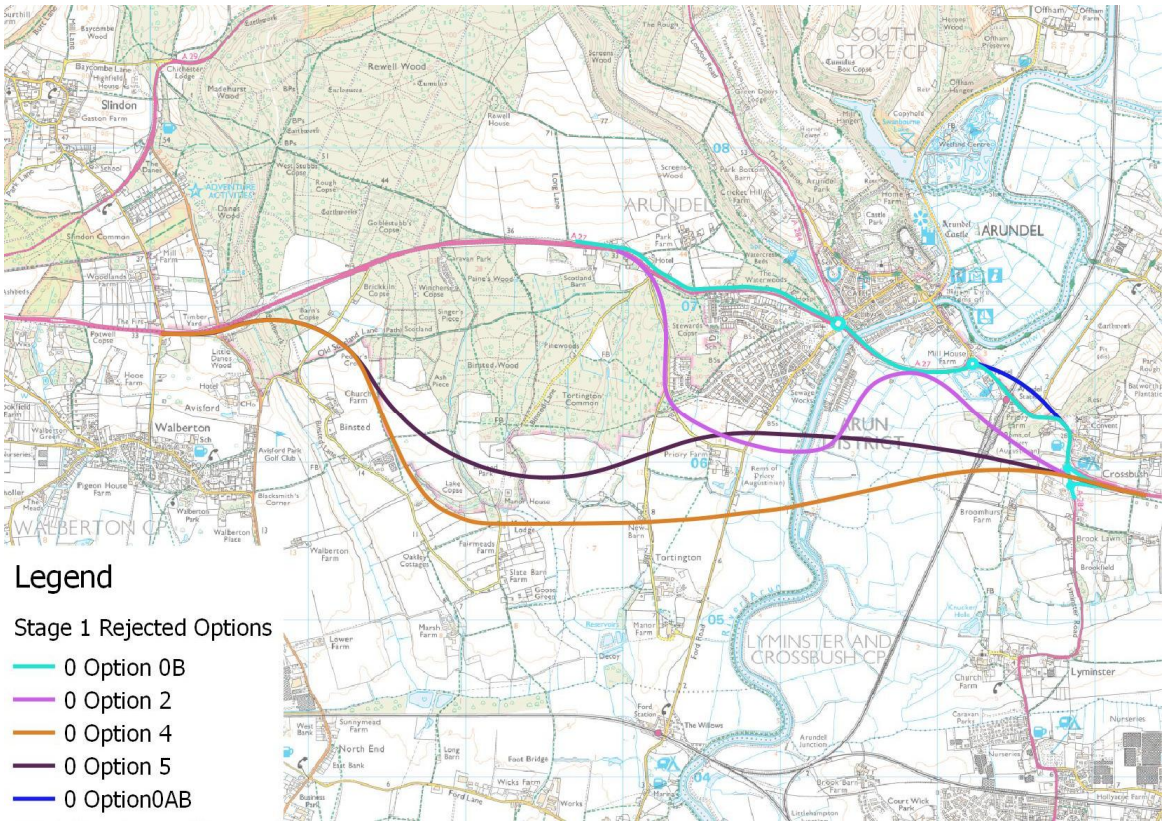


Figure 5-2 Route Options Rejected in PCF Stage 1



5.3 STAGE 1 OPTION APPRAISAL

5.3.1 The best performing route options, Options 0A, 1, 3, 5A and 5B, were then subjected to a further full WebTAG appraisal. This was in order to inform the decision on which options would be taken forward to public consultation and further design development in Stage 2. Details of the results of the appraisal can be found in Chapter 12 of the TAR.

5.3.2 Appraisal Summary Tables (ASTs) were produced for each route option to collate all the assessments against the criteria of Economy, Environmental, Social and Distributional impacts and Public Accounts, as presented in Chapter 20 of the A27 Arundel Bypass TAR 2017.

SELECTION OF OPTIONS FOR PUBLIC CONSULTATION

5.3.3 The performance of the five options were assessed by the Project Board in April 2017 with the aim of recommending options to be taken forward to public consultation in PCF Stage 2.

5.3.4 The differences between the options were highlighted and discussed in order to present justifications for shortlisting options for further consideration in PCF Stage 2. This was achieved via the following considerations:

- How well does each option fit with the Road Investment Strategy (RIS) requirements?
- How well does each option fit with the project objectives (as set out in the Client Scheme Requirements)? In particular, how do the options help achieve the objectives on environment and journey times?
- How well does each option fit with the NNNPS?
- How affordable is each option?

- How well do the options perform in terms of providing value for money?

5.3.5 At the Board meeting a series of recommendations were made based on the overall performance of each option:

- Though Option 0A performs well in terms of value for money, it does not meet the RIS requirements and does not adequately meet project objectives. It was therefore not recommended that Option 0A be taken forward to public consultation.
- Options 3, 5A and 5B meet the RIS requirements. Option 5B performs marginally better in terms of environmental impacts and significantly better on compliance with two of the four key NNNPS clauses. However, it performs least well in terms of value for money, possessing the highest cost to deliver the scheme. This cost was assessed as above the scheme affordability range. Option 5B was therefore not recommend to be taken forward to public consultation, while both Options 3 and 5A were.
- Option 1 out-performs Options 3 and 5A in overall value for money, compliance with two of the four key NNNPS clauses and has a lower overall environmental impact. Though it does not meet the stated RIS policy of providing a bypass it was assessed as performing well against some of the project objectives. Option 1 was therefore recommended to be taken forward to public consultation.

5.3.6 In summary, it was recommended that Options 1, 3 and 5A were taken forward to public consultation and Option 0A and 5B were not.

5.3.7 The recommendations were made based on the evidence available at PCF Stage 1. Further assessments have been made in Stage 2 for the three public consultation options as summarised in Chapters 6 to 8.

5.4 ROUTE DESCRIPTIONS

OPTION 1

5.4.1 Option 1 would take an offline course to the south of the existing A27 between Crossbush and the River Arun. It would then largely follow the existing A27 alignment.

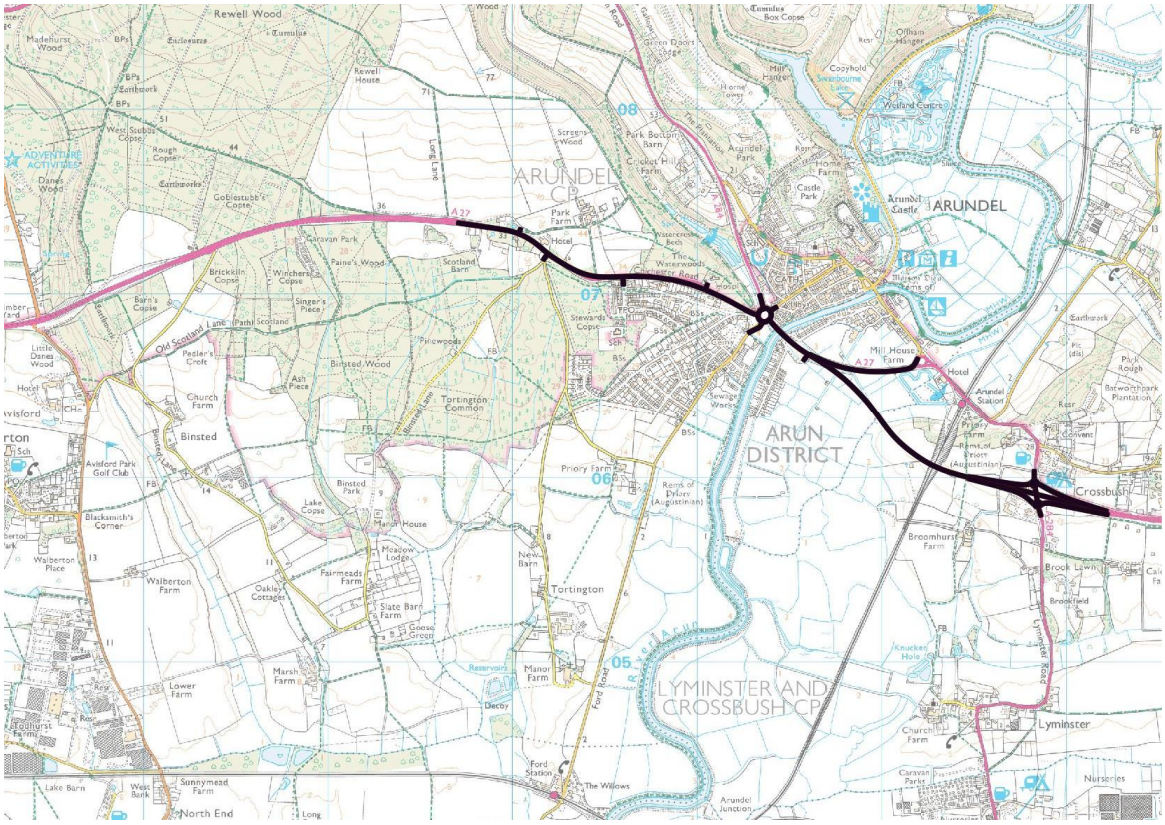
5.4.2 The centre line of the option is illustrated in Figure 5-3. General layout drawings for Option 1 are given in Appendix B

5.4.3 Starting in the east all the options commence at the end of the dual carriageway section of the existing A27 at the Crossbush junction. The Crossbush junction was originally designed to cater for continuation of the dual carriageway past Arundel from this point. The route would travel westward and bear north west passing first over the Arun Valley Railway line before then descending down the eastern valley side of the River Arun. The route would then cross the River Arun floodplain on a low embankment located to the south of Arundel Station to re-join the existing A27 near the existing junction with Fitzalan Road. It would then cross the River Arun alongside the existing bridge carrying the A27 over the river, which would be retained for eastbound traffic.

5.4.4 From the Ford Road Roundabout the route would rise up Chichester Road largely following the existing alignment of the A27 past the Arundel & District Community Hospital. The route is aligned to minimise impact on Ancient Woodland whilst avoiding demolition of adjacent properties and businesses. There would be some direct impact on Arundel Cricket Ground and White Swan Hotel. The route would end were the existing single carriageway section transitions to dual carriageway near Long Lane.

5.4.5 The route would be dual carriageway with two lanes in each direction. East of the river Arun the route would comprise high standard dual carriageway. West of the Arun the route would be lower category dual carriageway with a reduced standard cross section to reduce impact on Ancient Woodland at grade junctions and a number of local accesses with direct access to residential properties.

Figure 5-3 Option 1 Centre Line



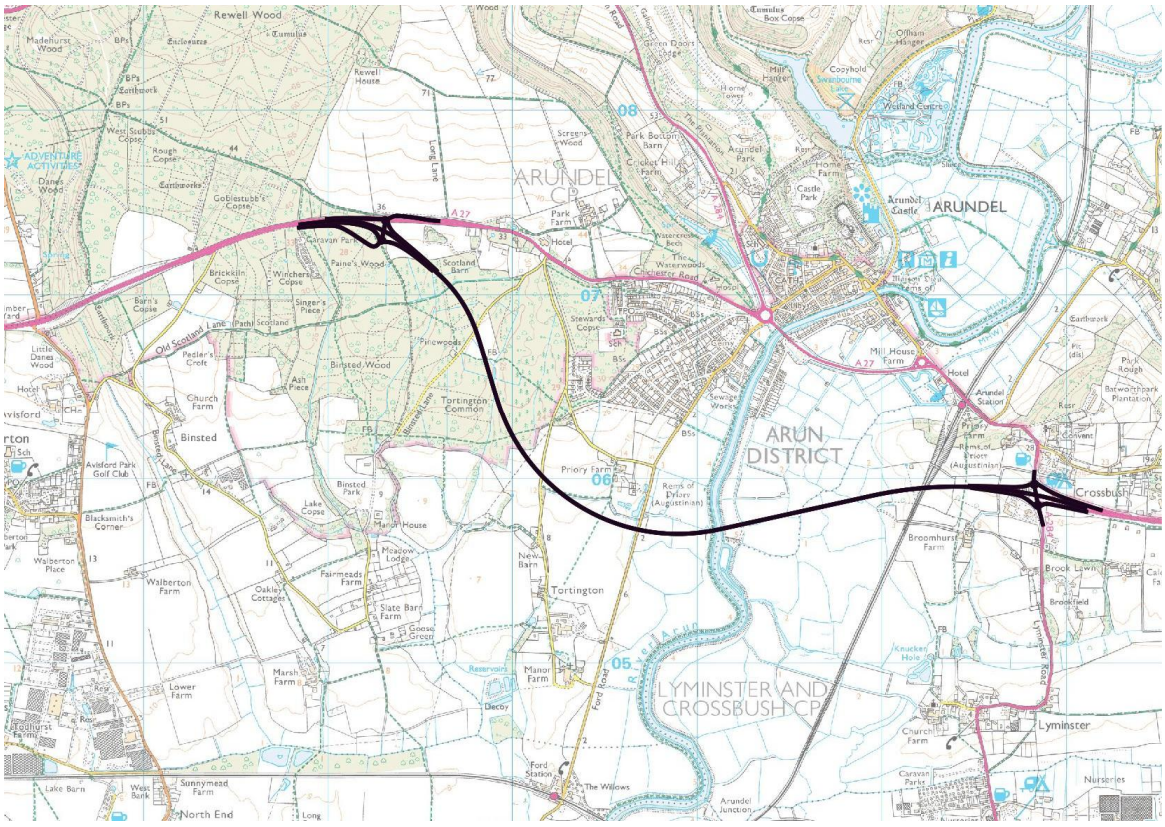
OPTION 3

5.4.6 Option 3 would take an offline course to the south of the existing A27.The centre line of the option is illustrated in Figure 5-4. General layout drawings for Option 3 are given in Appendix B

5.4.7 Similar to Option 1 the alignment starts at the end of the existing section of dual carriageway at the Crossbush junction. Upon passing below Lyminster Road the route would bear south west passing over the Arun Valley Railway line and then descending the eastern valley side of the River Arun to cross the Arun floodplain either on a low embankment or on a viaduct. Here, the route would be prominent in the landscape with extensive views across the floodplain and of the town of Arundel. The route would then cross the River Arun near the site of Billycan Camping and then crosses Ford Road immediately to the south of the Scheduled monument of Tortington Priory. It would then bear North West away from New Barn Farm, crossing Tortington Lane before entering the South Downs National Park and passing through the Ancient Woodland at Tortington Common. The route would then cross Binsted Lane to the north east of Pinewoods cottage before bearing west to leave Tortington Common to re-join the existing A27 west of the Havenwood Park.

5.4.8 The route would be dual carriageway with two lanes in each direction with national speed limits. There would be a grade separated junction at Crossbush with the A284 and a new grade separated junction at the western tie in with the existing A27. A new access road would link Havenwood Park to the new junction. Local roads would be diverted to pass either under or over the new dual carriageway.

Figure 5-4 Option 3 Centre Line



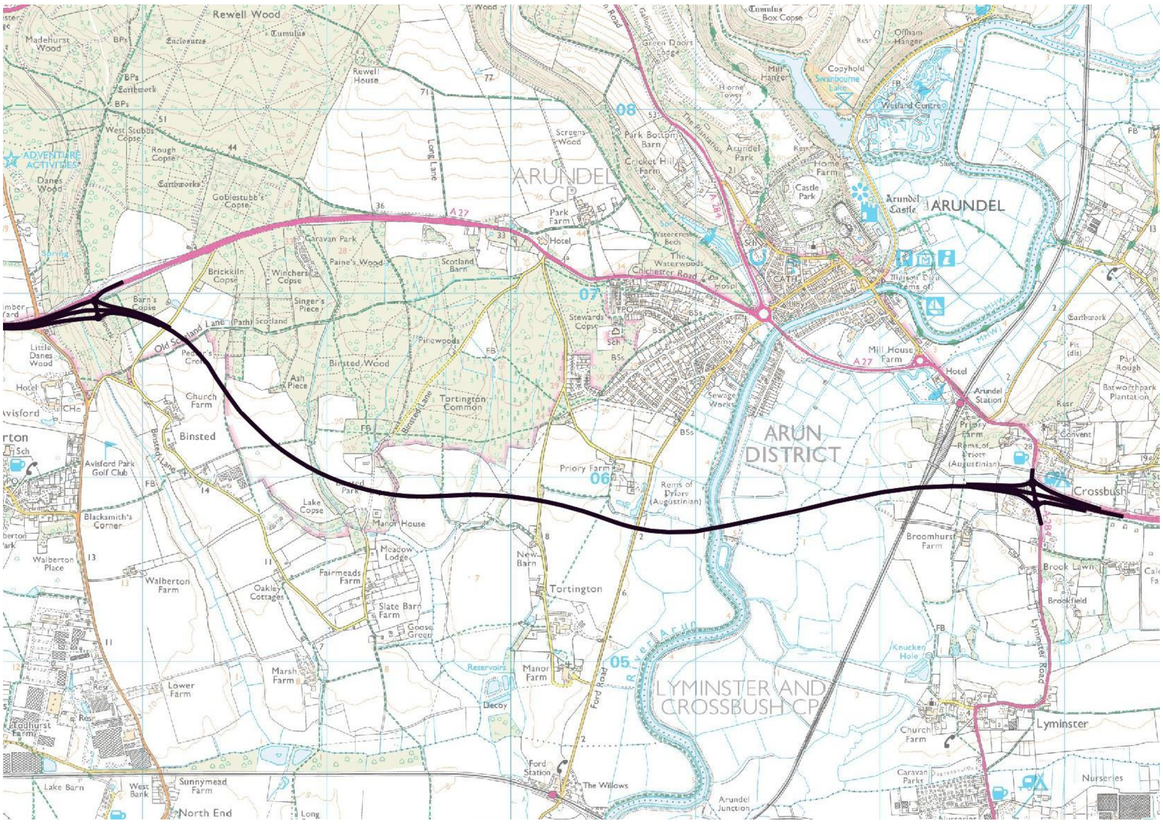
OPTION 5A

5.4.9 Option 5A would take an offline course to the south of the existing A27. The centre line of the route is illustrated in Figure 5-5. General layout drawings for Option 5A are given in Appendix B

5.4.10 The route follows the same alignment as Option 3 across the River Arun floodplain and past the scheduled monument at Tortington Priory. It would then bear west to pass to the south of Tortington Common passing through farm land in the low lying south facing upper coastal plain/footslopes of the South Downs. It would cross Tortington Rife and pass through woodland and historic park land at Binsted Park located within the South Downs National Park. Here the route would cross Binsted Lane close to residential properties within Binsted village. The route then bears north west crossing farm land located between the Binsted village and the Ancient Woodland of Binsted Woods. The route would cross Old Scotland Lane and Binsted Lane before bearing west, re-entering the South Downs National Park and passing through the Ancient Woodland and local nature reserve at Barns Copse and Hundredhouse Copse. The route would cross Binsted Rife and then tie into the existing A27 close to the existing junction with B2132 Yapton Lane and Shellbridge Road,

5.4.11 The route would be dual carriageway with two lanes in each direction with national speed limits. There would be a grade separated junction at Crossbush with the A284 and a new grade separated junction at the western tie in connected to Yapton Lane and Shellbridge Lane. Local roads would be diverted to pass either under or over the new dual carriageway.

Figure 5-5 Option 5A Centre Line



5.5 JUNCTION STRATEGY

5.5.1 Different junction strategies have been proposed for the different route options. Option 1 would have a mixture of full movement grade separated and at-grade junctions. Full movement grade separated junctions are proposed for Options 3 and 5A.

5.5.2 For all options, a new all-movements junction is proposed to replace the existing Crossbush junction at the eastern end of the scheme. This would provide connections to Arundel and Littlehampton via the existing A27 and A284 Lyminster Road. The specific junction proposals with each option are as follows:

OPTION 1

- Grade separated junction with A284 at Crossbush as described above.
- At-grade signalised roundabout at the existing Ford Road roundabout with the A284, Ford Road and Maltravers Street

OPTION 3

- Grade separated junction with A284 at Crossbush as described above.
- No junction with Ford Road
- Full movement grade separated junction at the western end of the scheme with the existing A27 providing access to Arundel from the west via the existing A27.

OPTION 5A

- Grade separated junction with A284 at Crossbush as described above.
- No junction with Ford Road

- Full movement grade separated junction at the western end of the scheme with the existing A27
- Existing Yapton Lane and Shellbridge Road closed and diverted to the new junction at the western end of the scheme.

5.5.3 Descriptions of the proposed junctions are given in section 5.7. The junction strategy for the scheme would be developed further in Stage 3.

5.6 TREATMENT OF SIDE ROADS AND ACCESSES

5.6.1 Option 1 has the potential to be most disruptive to local journeys as it would directly impact a greater number of side roads than the other options. In addition to the Ford Road junction with the A284, Ford Road and Maltravers Street, other existing local roads along the proposed route would be connected by priority junctions with restricted movements. They are as follows:

- Fitzalan Road (westbound only and left in left out only)
- Existing A27 (eastbound off slip to Causeway roundabout)
- Jarvis Road (left in – left out only)
- Binsted Lane / Tortington Lane (gap in central reserve with restricted right turn from side road)

5.6.2 The following accesses would be retained as priority junction onto the A27 with restricted turning movements:

- The Water Woods (Fishery) - (left in – left out at signalised junction)
- Arundel and District Community Hospital (gap in central reserve with restricted right turn from access)
- Park Farm Access - (left in – left out)
- Arundel Cricket Ground Access - (left in – left out)
- The White Swan - (gap in central reserve with restricted right turn from access)
- Arboretum - (left in – left out)
- Other Properties - (left in – left out)
- Long Lane (Park Farm) - (gap in central reserve with restricted right turn from access)

5.6.3 Provision of at these junctions and accesses, in particular with gaps provided in the central reserve, at locations where significant departures in geometric standard are proposed lead to safety concerns requiring specific mitigation measures as outlined in section 5.8.

5.6.4 No changes are proposed to the existing accesses to Havenwood Park, Binsted Lane junction or the Yapton Lane / Shellbridge Road Junction.

5.6.5 For Options 3 and 5A, the existing A27 would be retained to provide local access to Arundel and surrounding villages and bridge crossings would be provided where the route for both options cross the existing local road network including at Ford Road, Tortington Lane and Binsted Lane. This retention of the existing A27 means that construction works would have a lower impact on the public than Option 1, as their current journeys would have minimal disruption.

5.6.6 For Option 3, the existing access to Havenwood Park would need to be closed due to its proximity to the proposed junction at the western end of the route. A new two way access road would be provided from the proposed junction to the Park to provide safe access.

5.7 HIGHWAY ALIGNMENT AND COMPLIANCE WITH STANDARDS

STANDARDS USED

5.7.1 The geometric design of the proposed A27 main carriageway and associated junction connector roads for both route options has been developed in accordance with the Design Manual for Roads and Bridges (DMRB) Volume 6. In particular, the following Design Standards have been used:

- TD9/93 Highway Link Design (DMRB 6.1.1)
- TD27/05 Cross Sections and Headroom (DMRB 6.1.2)
- TD22/06 Layout of Grade Separated Junctions (DMRB 6.2.1)
- TD 16/07 Geometric Design of Roundabouts
- TD 50/04 The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts
- TD 42/95 Geometric Design of Major/Minor Priority Junctions

5.7.2 Principles of DMRB Volume 6 will also be applied to the design of local roads although this approach is subject to agreement with the local highway authority, West Sussex County Council. Relaxations from the requirements of the DMRB may be necessary along local roads to ensure these works are appropriate to the standard and character of adjacent existing roads.

DESIGN SPEED

5.7.3 Option 1 has been designed with different design speeds along its length. From Crossbush to Ford Road roundabout the mainline A27 is proposed to be a dual carriageway, subject to the National Speed Limit, with a Design Speed of 120kph in accordance with Figure 1 of TD 9/93. From Ford Road roundabout to transition back to the existing A27 a design speed of 70 kph and 85kph is proposed corresponding to enforced speed limits (see section 5.8) of 40 and 50mph.

5.7.4 For both Options 3 and 5A the proposed A27 mainline would be a dual carriageway, subject to the National Speed Limit, with a Design Speed of 120kph in accordance with Figure 1 of TD 9/93.

5.7.5 Slip roads and other junction link roads will have a Design Speed of 70kph as per Table 4/1 of TD22/06.

5.7.6 Design speeds for local roads will be subject to agreement with the local highway authority.

CROSS SECTION

5.7.7 Two different cross section standards have been applied for Option 1. From Crossbush to Ford Road roundabout the dual carriageway section have been designed as Dual 2 lane All-Purpose (D2AP) carriageways as detailed in Figure 4-3a of TD27/05. From Ford Road the cross section has been designed as Dual 2 lane Urban All-Purpose Road as detailed in Figure 4-4a in TD 27/05. This narrower cross section has been selected to reduce the impact on adjacent Ancient Woodland.

5.7.8 For Options 3 and 5A the standard Dual 2 lane All-Purpose (D2AP) has been applied across the full length of the dual carriageway, as detailed in Figure 4-3a in TD27/05.

5.7.9 It is possible that a rigid (concrete) vehicle restraint system may be selected for the central reserve as an alternative to a flexible (steel) system that is conventionally used on D2AP carriageways. This option provides a number of benefits, including reduced maintenance costs and improved road worker safety.

5.7.10 Single carriageway sections will generally be as per single carriageway (S2) standard as detailed in Figure 4-3a of TD27/05. However, in some cases these cross-sectional standards may be relaxed by agreement with West Sussex County Council to ensure works to local roads are appropriate to the standard and character of adjacent existing roads.

JUNCTION DESIGN

5.7.11 The proposed junction at Crossbush for all options has been designed as fully grade separated junctions in accordance with TD22/06. The junction would comprise of a standard dumbbell arrangement with east and west facing slip roads connected to two roundabouts linked by the existing Crossbush overbridge. Access to the service area would be retained as existing.

5.7.12 For Option 1 the proposed Ford Road Junction has been design as a signal controlled roundabout to TD 50/04.

5.7.13 For Option 3 the proposed junction at the western tie has also been designed as a fully grade separated junction in accordance with TD22/06. The junction is proposed as a standard dumbbell arrangement with a single bridge across the mainline route. At either end of the bridge two roundabouts would provide access to the slip roads for all traffic. Access to Havenwood Park would be provided off the junction.

5.7.14 For Option 5A a non-standard dumbbell arrangement has been proposed at the western tie-in to accommodate the existing Yapton Lane / Shellbridge Road junction. Two-way connector roads are proposed linking Yapton Lane and Shellbridge Lane to the junction. Priority junctions would be located at the end of the connector roads, including merges and diverges with the A27. A departure from standard would be required for an element not covered by standard. A further departure from standard would be required due to the proximity of the existing Mill Lane junction.

5.7.15 The traffic forecasts suggest that merging and diverging traffic at all junctions on the scheme will be sufficiently low to justify single lane slip roads and simple tapered merges and diverges.

5.8 DEPARTURES FROM STANDARD

5.8.1 The three options have been assessed for departures from standard that would be required to be implemented. Table 5-4 identifies the number of departures for each option.

Table 5-4 Departures from Standard for the Route Options

OPTION	TD 9/93	TD 22/06	TD 27/05	TD 42/95
1	8	1	1	0
3	2	1	1	0
5A	2	3	1	3

5.8.2 Option 1 would require a significantly greater number of departures from standard to be implemented. This is due to the fact that it is constrained by the existing A27 corridor west of the Ford Road roundabout and by the alignment at the existing bridge crossing of the River Arun. Departures include for a vertical crest curve with a K value of 10 at the crossing of the River Arun which is 5 steps below the desirable minimum for a 120kph design speed and would still be 2 steps below with a design speed based on an enforced speed limit of 40mph. The horizontal alignment includes an s-curve comprising 350m and 510m radii which are respectively three and two steps below desirable minimum radius with super-elevation of 7% for a 120kph design speed but for the 350m curve would be 1 step below with a design speed based on an enforced speed limit of 50 mph. There are a number of instances where the gradient used is above the desirable maximum gradient for an all-purpose trunk road of 4% including a maximum gradient of 8% over a length of 30m immediately west of the Ford Road Junction. A departure from standard would be required for the approach to selecting the design speeds adopted.

5.8.3 The combination of departures from standard for Option 1 result in safety concerns which would require specific safety mitigation measures to be implemented. These measures would need to include enforced speed limits of 40mph and 50mph. Even with design speeds adopted to reflect these speed limits departures from standard would still be required as indicated by Table 5-4.

5.8.4 Option 3 and 5A both would require departures from standard for combinations of curves below desirable minimum at the vicinity to the western tie in junctions.

5.9 WCHR FACILITIES

5.9.1 Proposals for new WCHR facilities along the detrunked section of the A27 would be developed in the next stage of the scheme in consultation with West Sussex County Council and local groups.

5.9.2 For all options, provision of a link between WCHR facilities proposed on the West Sussex County Council Lyminster Bypass and facilities provided as part of the A27 Arundel Bypass scheme will be explored further in consultation with West Sussex County Council as both schemes develop.

5.9.3 The specific WCHR proposals for each option are as follows.

OPTION 1

5.9.4 Footpath 2207, which runs between Lyminster and Arundel would be locally diverted to cross the proposed route under the proposed railway bridge overbridge.

5.9.5 It is proposed to provide new shared use facility alongside the detruncked section of the A27 between the Ford Road roundabout and the Causeway roundabout. This includes a new bridge across the River Arun adjacent to the existing road bridge. This would connect with the existing cycle and pedestrian route that runs from Arundel Station to Queen Street. A footbridge and dedicated pedestrian and cycle crossing facilities would be incorporated at the new signal controlled Ford Road roundabout. This would improve pedestrian access between the residential area to the south of Arundel and the town centre. Further facilities are proposed from the Ford Road Roundabout to the Arundel District and Community Hospital.

OPTION 3

5.9.6 As with Option 1, Footpath 2207 would be locally diverted to cross the proposed route under the proposed railway bridge crossing.

5.9.7 Four existing footpaths (3403, 3404, 342, 347) between Ford Road and Old Scotland Lane would be directly affected by the proposed route. These would be locally diverted to cross the proposed route at the same locations as the local road network or on separate footbridges. Where the route crosses the bridleway - Old Scotland Lane - the proposal is for a wide bridge to give pedestrians, cyclists and equestrians safe access over the proposed Bypass at this point.

OPTION 5A

5.9.8 As with Option 1 and 3, Footpath 2207would be locally diverted to cross the proposed route under the proposed railway bridge crossing.

5.9.9 Footpaths 3403 and 3401 which would be directly affected by the route and would be locally diverted under the new route via Tortington Lane underbridge and Binsted Lane underbridges respectively.

5.9.10 To the south of Tortington Common/Binsted Woods, footpaths 341 and 342 would be directly affected by the new bypass. The proposal is to locally divert one or both of them in the vicinity of the new A27 so they can share a footbridge over the new Bypass. This will be established in more detail if Option 5A is taken forward to Stage 3.

5.9.11 It is proposed that the Old Scotland Lane bridleway would be locally diverted to cross the proposed route via the proposed Binsted Lane overbridge. Segregated pedestrian, cyclist and equestrian facilities would be proposed on the bridge.

5.9.12 Bridleway 336, which would be directly affected by the route at the western end of the scheme, would be diverted to cross the proposed route at the proposed new junction. This would provide a link to the section of the Bridleway 336 to the north of the existing A27.

5.9.13 Opportunities for the provision of additional WCHR facilities on the detruncked section of the existing A27 would be developed in consultation with West Sussex County Council and local stakeholder groups.

5.10 STRUCTURES

EXISTING STRUCTURES

5.10.1 The following structures are located on the existing A27:

Table 5-5 Existing Structures

STRUCTURE NAME	STRUCTURE TYPE	STRUCTURE KEY	STRUCTURE NO.	COMMENT
Crossbush	Underbridge	19729	/A27//68.30//	No structural work required
Arundel Rly R/W South East	Retaining wall	1240	/A27//68.9/R/2	
Arundel Station	Underbridge	9398	/A27//68.90//	Structure in poor condition
Arundel Rly R/W South West	Retaining wall	1239	/A27//68.9/R/1	
Fitzalan Arundel	Underbridge	9399	/A27//71.00//	Structure in good condition
Spring Ditch Culvert	Culvert	9946	/A27//71.20/Q/	

5.10.2 Arundel Station Bridge is a three span structure which carries the A27 trunk road over the Arun Valley Railway line. It comprises a filler-beam slab made up of precast units with a brickwork sub-structure consists of two piers with half height arches along their base, and two full height abutments. The bridge would be included in the de-trunked section of the existing A27 for all three route options. The structure is known to be in poor condition. Prior to transfer to WSCC the structure would need to be replaced.

5.10.3 Fitzalan Arundel is a three span structure with a superstructure comprising a combination of box beams with cantilever wings and beam and slab. It also includes a sub structure comprising of insitu reinforced concrete bank and cantilever abutments and piers. The structure carries the A27 trunk road over a public footpath under the North span, River Arun under the central span and Fitzalan Road under the South span. The headroom for Fitzalan Road is 3.02m with advanced warning signs advising low headroom of 2.80m. No changes to this structure are proposed for Options 3 and 5A. For Option 1 it is proposed to modify the structure to accommodate a dedicated pedestrian / cycle facility.

5.10.4 Crossbush is a single span reinforced concrete bean and slab deck with full height reinforced concrete abutments. The structure was intended to carry the A284 Lyminster Road over the A27 trunk road. The cancellation of the Arundel Bypass resulted in the structure now carrying the West bound A27 over landscaped ground. For all options the existing bridge would be retained and would span the proposed route. No works are proposed to the bridge although improvement to pedestrian facilities may be made and the existing parapet reviewed.

5.10.5 Spring Ditch Culvert is a 1.8m diameter corrugated steel pipe buried under the A27 and Ford Road roundabout to the West of Arundel. The culvert flows from North to South and discharges into the River Arun. For Option 3 and 5A no works to the structure are proposed and it would be transferred to WSCC as part of the de trunking of the existing A27. For Option 1 it would be necessary to extend the culvert to accommodate the enlarged signal controlled roundabout at the Ford Road Junction.

NEW STRUCTURES

5.10.6 Three new structures are proposed for Option 1 in addition to the modifications outlined above. These are listed in table 5-6 below:

Table 5-6 Option 1 New Structures

REFERENCE	TYPE	CROSSING
01/A	Three span variable depth bridge	Railway
02/B	Existing Bridge Widening and Improvement for Pedestrian & Cyclist	River Arun
03/C	Footbridge	Ford Road Roundabout

5.10.7 Severn new structures are proposed for Option 3 in addition to the modifications to the existing Crossbush Bridge. These are listed in table 5-7 below.

Table 5-7 Option 3 New Structures

REFERENCE	TYPE	CROSSING
05/A	Three span variable depth bridge	Railway
06/A	Three span variable depth bridge	River Arun
07/A	Three span variable depth bridge	Ford Road
08/E	Rigid frame overbridge	Tortington Lane
09/E	Rigid frame overbridge	Binsted Lane
11/E	Rigid frame overbridge	New route of A27 at proposed junction

5.10.8 Seven new structures are proposed for Option 5A in addition to the modifications to the existing Crossbush Bridge. These are listed in table 5-8 below.

Table 5-8 Option 5A New Structures

REFERENCE	TYPE	CROSSING
05/A	Three span variable depth bridge	Railway
06/A	Three span variable depth bridge	River Arun
07/A	Three span variable depth bridge	Ford Road
12/E	Three span Rigid frame overbridge	Tortington Lane
13/G	Rigid frame overbridge	Binsted Lane
15/E	Rigid frame overbridge	New route of A27 at proposed western junction

5.10.9 For each option additional accommodation structures may be required depending upon further consultation with land-owners and businesses who may be affected as a result of land being severed by the proposed road.

ALTERNATIVE VIADUCT CROSSING OF RIVER ARUN FLOODPLAIN

5.10.10 For Options 3 and 5A the current proposal is for the route to be constructed on embankment across the River Arun floodplain. To mitigate flooding impacts and visual intrusion an alternative viaduct solution has been considered. This would be approximately 1,650km long with an average height of 5m across the flood plain. The viaduct would be a composite built, with a slender deck supported by single monolithic piers. The viaduct would replace new structures 05/A, 06/A and 07/A.

5.10.11 Further work would be undertaken in Stage 3 on a viaduct solution if either route options are taken forward as the preferred route.

5.11 EARTHWORKS

5.11.1 The bulk excavation and deposition quantities for each of the route options have been calculated using 3D modelling software. Modelling has assumed scheme-wide slopes of 1:3. This approach would be refined during the development of the preliminary design following ground investigations.

5.11.2 Anticipated quantities of material for each option are shown in Table 5-9. These exclude allowance for topsoil, structural fills and for drainage, removal of unsuitable material and any earthworks for flood plain compensation and assume an embankment across the River Arun floodplain. These outstanding quantities will be produced in later design stages.

Table 5-9 Estimated bulk earthworks quantities

OPTION	CUT	FILL	BALANCE
1	43,842	106,073	-62,232
3	510,381	398,789	111,593
5A	459,627	851,410	-391,784

5.11.3 The balance of earthwork material would be significantly affected by the choice of construction across the River Arun floodplain for Options 3 and 5A.

5.12 GEOTECHNICS

5.12.1 A Preliminary Sources Study Report (PSSR) has been produced for this scheme. This report documents geotechnical (below ground) risks, implications and feasibility of scheme options. A geotechnical site investigation (GI) is planned for later in 2018. In the interim, knowledge of the properties and risks associated with in situ material on the site is limited to the content of the PSSR.

5.12.2 For all the options the construction of embankments over the soft ground of the River Arun Flood Plain is likely to cause engineering challenges. Depending on the requirements of the Environment Agency, it is possible that sections of embankment could perform dual roles of not only carrying the new A27 carriageway over the flood plain but also providing flood protection.

5.12.3 The key issues associated with each option are summarised below.

OPTION 1

5.12.4 The new bridge crossing at the River Arun would require deep piled foundations through up to 20m of soft alluvial Tidal River Deposits. The bridge is likely to be founded in the Spetisbury Chalk.

5.12.5 The route would cross the river Arun floodplain on an embankment of varying height between 1.50 and 4.20m above surrounding ground level. The embankment would be an estimated 800m in length. Due to the depth of soft Tidal River Deposits (anticipated to be up to 23.50m) the embankment would likely be constructed on either a Load Transfer Platform or a Light Weight Fill.

5.12.6 The new bridge crossing of the Arun Valley railway would require deep piled foundations. The Tidal River Deposits are thought to be significantly thinner at this location than at the new River Arun Overbridge. The bridge is likely to be founded within the Lambeth Group.

5.12.7 To reduce the possibility of differential settlement and subject to the results of the GI, the embankment over the River Arun flood plain is likely to require a load transfer platform with deep depth piled foundation and/or the use of light weight fill.

OPTIONS 3 AND 5A

5.12.8 The routes for Options 3 and 5A are geotechnically more complex comprising sections of both deep cutting and high embankments with significantly more structures. Both of these options would require the construction of a significantly longer section of either piled embankments with load transfer platforms or a viaduct over the River Arun Flood Plain. Both of these options follow a similar corridor across the River Arun Flood Plain where the respective embankments range in height between approximately 1.70m and 8.00m. The two sections of embankment, Ford Road to the River Arun and the River Arun to the Arun Valley Rail Crossing, would be an estimated 400m and 1000m in length respectively. Due to the depth of soft Tidal River Deposits (anticipated to be up to 30m) the embankment is likely to be constructed on either a Load Transfer Platform or of Light Weight Fill.

5.13 LIGHTING

5.13.1 An assessment will be made in the next stage of the scheme development to confirm lighting requirements for the scheme in accordance with TA49/07 Appraisal of New and Replacement Lighting on the Strategic Motorway and All-Purpose Trunk Road Network (DMRB 8.3). It is not expected that the main carriageway will require lighting for any of the three options.

5.13.2 An assessment would also be made of all junctions. It is anticipated that for Option 1 Ford Road junction would be lit (as it currently is), along with the roundabout junctions at the proposed Crossbush junction. For Option 3 it is anticipated that the roundabout junctions at the proposed western tie in junction would be lit. For Option 5A it is anticipated that the roundabout junctions and Yapton Lane / Shellbridge Road connector roads would also be lit.

5.14 TECHNOLOGY

5.14.1 There are currently no commitments for the scheme to become an expressway. As a result it is not intended to provide the technology that would be associated with an Expressway. Therefore, the technology provision would be probably limited to the provision of the minimum/standard technology required for a dual two-lane all-purpose carriageway. This is likely to involve the provision of:

- National Traffic Information Service (NTIS) vehicle counting sites;
- Emergency Roadside Telephones at any proposed layby; and
- Associated ducting and cabling routes within the proposed verge to accommodate these installations.

5.14.2 For Option 1 additional technology requirements are likely to include:

- Average speed cameras;
- Possible provision of pan-tilt-zoom CCTV mast mounted cameras at Ford Road Junction; and
- Traffic signal controllers using either MOVA or a SCOOT type system for Ford Road Junction

5.15 BUILDABILITY

5.15.1 The services of a Delivery Partner were commissioned during the option selection stage to provide advice regarding the buildability of all the three options under consideration. Aspects considered included construction phasing, temporary works considerations, programme constraints, traffic management, potential environmental impacts and constraints, and risks and opportunities.

5.15.2 Principal findings from this work are summarised in the following sections.

- Option 1 will require complex traffic management layouts and phase switching to allow for sufficient working space while maintaining current capacity during the busy daytime periods. The majority of the works on Ford Road roundabout would need to be done at night under additional lane closures to allow for sufficient working space and adequate safety zones to protect the workforce and travelling public.
- For Option 1 where works are to be carried out along the existing A27 alignment there would need to be speed limits of 40mph in the 60mph zone and 30mph in the 40mph zone respectively.
- With much of the work able to be built off-line, traffic management phasing for the proposed Crossbush Junction for all options would be relatively simple, as there is minimal impact on the existing road layout.
- For Options 3 and 5A much of the scheme would be built off-line. The traffic management for these options would be achieved using standard solutions, as there is minimal impact on the existing road layout.
- For Options 3 and 5A single alternate line traffic (SALT) would be required on the side roads for the construction of the bridge structures at Ford Road, Tortington Lane, Binsted Lane (East) and Binsted Lane (West). Overnight closures will also be required for beam installation. These side roads have very low traffic flow, and traffic management arrangements would have little impact on existing flows.
- For all Options, in order to build the new A27 over the floodplain area between the river Arun and the Arun Valley Railway Line, a haul road would need to be constructed from the existing A27. The proposed 1.6km route would go via the current farm access from Fitzalan Road, at the Junction with the A27.
- Should the section of the A27 between the Western Tie-in and the Ford Road Roundabout require closure on a short term basis, a relatively short diversion route of around 10km to the north of the A27 can be set up via the A29 and A284. This would apply to all options though is most likely to be required for Option 1.
- For closing the section from the River Arun Crossing to Crossbush Junction, including works at Crossbush Junction (if necessary), a significantly longer diversion route of around 26km will need to be made via the south of the A27, along the A259. This would apply equally to all Options.
- For all options, environmental mitigation (including translocation) and earthworks are the key drivers to the construction duration for the scheme. The duration could be significantly reduced if a suitable large volume of local material supply is obtained.
- For all options the top risks to construction are:

- Ecological mitigation, including Ancient Woodland translocation. The impact would be greatest for Option 3.
- Limited imported material supply dictating rate to fill new embankments. This would particularly be the case for Option 5A with an embankment constructed across the Arun floodplain.
- Building across the River Arun floodplain with poor ground conditions during construction resulting in limited progress.

→ Overall, from a buildability perspective Option 1 offers a shorter programme duration than Options 3 and 5A, with less demand on imported materials and reduced land take.

→ It would however require complex and detailed planning of traffic management layouts to the west end of the scheme to ensure the works can be built safely, with minimal disruption to the public and neighbouring residencies along the route.

→ Option 3 and 5A would result in minimal impact to existing traffic flows as they are both largely off line. Option 5A would have significantly less need for translocation of Ancient Woodland compared to Option 3 and its construction duration could be significantly reduced with a viaduct across the Arun floodplain.

→ Estimated construction duration:

- Option 1 – 2 years and 2 months;
- Option 3 – 3 years and 4 months; and
- Option 5A – between 4 year and 7 months and 2 years and 5 months depending on the form of construction across the floodplain and rate of material import.

5.16 COSTS

5.16.1 The current scheme estimates for the three options are:

→ Option 1 - £134.47m

→ Option 3 - £260.00m

→ Option 5A - £249.34m

6 SUMMARY OF TRAFFIC AND ECONOMIC APPRAISAL

6.1 INTRODUCTION

6.1.1 This chapter describes the impacts of the A27 Arundel Bypass scheme options in comparison to the do nothing scenario described earlier in this report. The forecast traffic flows, link capacities and journey times are described for each option. The impact of the options on economic and social conditions is also described.

6.1.2 As context for the appraisal, a description of how the A27 Strategic Traffic Model has been developed between PCF Stages 1 and 2 is set out below.

6.1.3 The PCF Stage 1 model was developed through refinement of the existing West Sussex County Transport Model owned by WSCC. For PCF Stage 2, further development of the model was considered necessary in order to refine the models representation of observed transport conditions. To inform this, Highways England's South East Regional Transport Model (SERTM, Version DF3) was made available. A cordon of the SERTM network and matrix was extracted to produce the PCF Stage 2 A27 Strategic Traffic Model. For PCF Stage 2, the refinements to the model comprise:

- the inclusion of a richer set of observed 2015 origin – destination data sourced from the anonymised mobile phone data which informed the demand matrices within SERTM
- extension of the transport model network to reflect a broader geography of routes that may influence or be affected by the scheme
- introduction of further traffic and journey route data for the calibration or validation of a wider set of locations within the study area
- updated generalised cost parameters using the latest Highway England Transport Planning Group (TPG) VoT/VoC spreadsheet (*VoT_and_VOC_from_webTAG_Databook_(July 2017) - release040817v2*).
- improved model performance in terms of the fit between observed and modelled traffic and journey time data for the base year 2015
- updated housing development and employment Uncertainty Log using information from West Sussex County Council, Arun District Council and Adur and Worthing Council
- updated car forecast growth factors using NTEM version 7.2 datasets accessed via the TEMPRO version 7.2 program
- updated LGV and HGV growth forecasts taken from NRTF 2015 published by DfT

6.1.4 A comparison of the base year model performance between PCF Stages 1 and 2 is summarised below.

6.1.5 The PCF Stage 1 model forecasts were produced on the basis of a fixed level of forecast demand, consistent with NTEM forecasts. Commensurate with the stage of analysis, for PCF Stage 2 a variable demand component to the model has been included using the DfT's DIADEM (Dynamic Integrated Assignment and Demand Modelling) software (version 6.3.3). Variable demand forecasts the travel demand response to changes in the transport system, including the introduction of new highway infrastructure. This typically has the effect of inducing more traffic demand in a scenario with a new scheme, relative to a scenario without the scheme in place. This has the effect of increasing the level of delay within a transport network, and reducing the economic benefits of a transport scheme. Table **6-1** outlines the performance of the Stage 1 and 2 models. The results presented in this section reflect the effect of variable demand.

Table 6-1 Performance of PCF Stage 1 and 2 base year models

MODEL / PEAK	FLOW CALIBRATION			FLOW VALIDATION			JOURNEY TIME	
	No. of Links	% Flow Criteria	% GEH	No. of Links	% Flow Criteria	% GEH	No. of routes	Pass
PCF Stage 1								
AM	18	83%	83%	13	92%	85%	4	100%
PM		89%	89%		92%	85%		100%
PCF Stage 2								
AM	41	93%	93%	46	97%	96%	16	100%
PM		95%	95%		91%	93%		100%

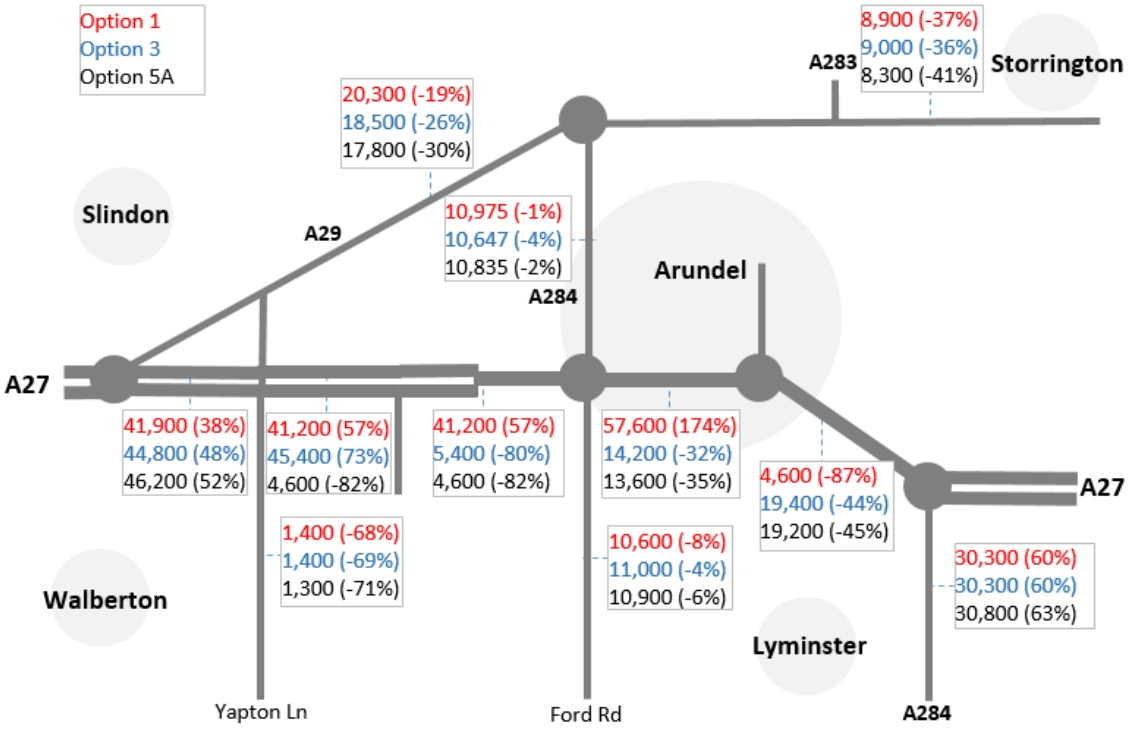
6.2 TRAFFIC APPRAISAL

6.2.1 As discussed in section 6.6 of this report the results for A27 Arundel Bypass (Option 1) are presented for completeness. It should be borne in mind that the SATURN model currently underrepresents the delays which may potentially remain on the scheme section of the A27 – specifically at Ford Road Roundabout - for the current A27 Arundel Bypass (Option 1) scheme design. In effect, this means it is likely that fewer vehicles would be able to pass through this section of the scheme than indicated below.

6.2.2 Figure 6-1 presents the 2041 AADT values and percentage differences in comparison to do nothing with the implementation of each of the options. The forecast traffic volumes on the bypass sections of the A27 Arundel Bypass options are listed below. The flows on the Option 1 Bypass are higher as they capture the north-south movement between the A284 (N) and A284 (S), whereas Options 3 and 5A do not.

- Option 1 – 57,300
- Option 3 – 40,400
- Option 5A – 43,900

Figure 6-1 2041 AADT figures and percentage change



IMPACTS OF OPTION 1

6.2.3 Option 1 results in an increase in traffic volume along the existing A27 as illustrated by the increase in flow to the west of the new offline section of road, between Ford Rd roundabout and Causeway roundabout. The volume of traffic reaches 57,600 which is an increase of 174% on do nothing conditions, resulting from the increased capacity provided by the route. The new offline section of road accommodates 57,300 vehicles. As a result, the traffic volumes on the existing A27 past Arundel Station reduce markedly, from 34,900 in the do nothing scenario down to 4,600, a reduction of 87%.

6.2.4 The proposed new offline section accommodates the east – west strategic movement along the A27 and also a north – south movement, along the A284 between locations to the north and Littlehampton, via Crossbush junction and the Lyminster bypass. As a result of the introduction of Option 1, the existing A27 route between Causeway roundabout and Crossbush junction is used by local traffic, with origins or destinations within the Arundel and surrounding area.

6.2.5 Local roads generally see a decrease in traffic volumes in comparison to do nothing, with the exception of the A284 to the south of Crossbush. This road would see a high increase in flows of 60% which is due to the combined effect of the capacity improvements provided by Option 1 and the Lyminster Bypass. Yapton Lane would see the biggest reduction in flows by almost 70% as a result of reduced rat running.

6.2.6 The A259 which runs on an east – west alignment to the south of the A27 is forecast to experience a modest reduction in traffic volume. From 26,700 in a Do Nothing scenario to 24,900 with Option 1, a reduction of approximately 7%.

IMPACTS OF OPTION 3

6.2.7 Traffic flows on the existing A27 increase to the west of the bypass tie-in; traffic flows exceed 45,000 vehicles, a 73% increase on do nothing, and are over 4000 vehicles higher than Option 1. To the east of the tie in, traffic flows reduce significantly, reaching a low of 5,400 vehicles, an 80% reduction in comparison to do nothing and nearly 36,000 less than Option 1. The traffic flows on the section of road near Arundel Station are higher than with Option 1 as the existing route retains the movement between the A284 and Littlehampton. The new offline bypass in Option 3 is forecast to accommodate 40,400 vehicles per day.

6.2.8 Traffic volumes on local roads see a similar pattern of change to Option 1, with decreases on all roads except the A284 to the south of Crossbush, which would again see an increase in flows of 60%. Traffic volumes on Yapton Lane, the A284 (north of Arundel), and the A29 all see larger decreases in flows compared to Option 1. Ford Road and B2139 by Storrington would see smaller decreases than with Option 1.

6.2.9 The A259 to the south experiences a greater reduction in traffic volume in comparison to Option 1, with flows reducing by 2,300 to 24,300, a reduction of almost 10%.

IMPACTS OF OPTION 5A

6.2.10 The impacts of Option 5A are similar to Option 3. As with all options, traffic volumes generally increase on the A27 as a result of the provision of additional capacity along the route. To the west of Arundel, traffic flows are forecast to reach 46,200, an increase of 52% and higher than both Option 1 and 3.

6.2.11 The proposed offline bypass would accommodate traffic volumes of 43,900 per day, a higher volume than Option 3. This results in a significant decrease in traffic flow on the existing A27 to the east of Yapton Lane, reducing from 26,300 to 4,200, a decrease of 84%. On local roads, again the A284 to the south of Crossbush experiences the only increase in flows of 63%, a level that is higher than both Option 1 and Option 3. All other local roads see a reduction in flows and the flows through Storrington in the SDNP decrease most significantly with Option 5A.

6.2.12 The A259 is forecast to experience the greatest reduction in traffic volume with Option 5A relative to the other options, with flows reducing by 3,000 to 23,700, a reduction in excess of 10%.

TRAFFIC FLOWS AND CAPACITIES

6.2.13 The following figures illustrate the 2041 AM and PM peak flow changes compared with do nothing, the percentage change and the V/C for selected sections of road. Maximum junction RFC or DoS is also indicated. Figure 6-2 and Figure 6-3 present the results for Option 1.

Figure 6-2 Flows and capacities with Option 1 (AM)

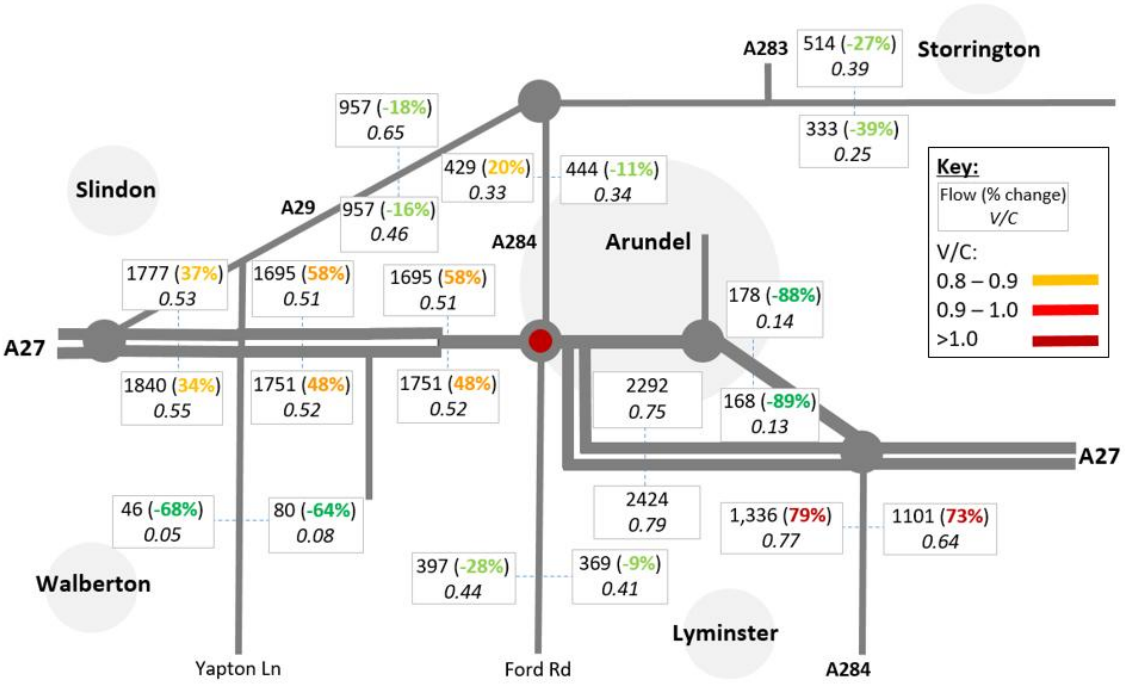
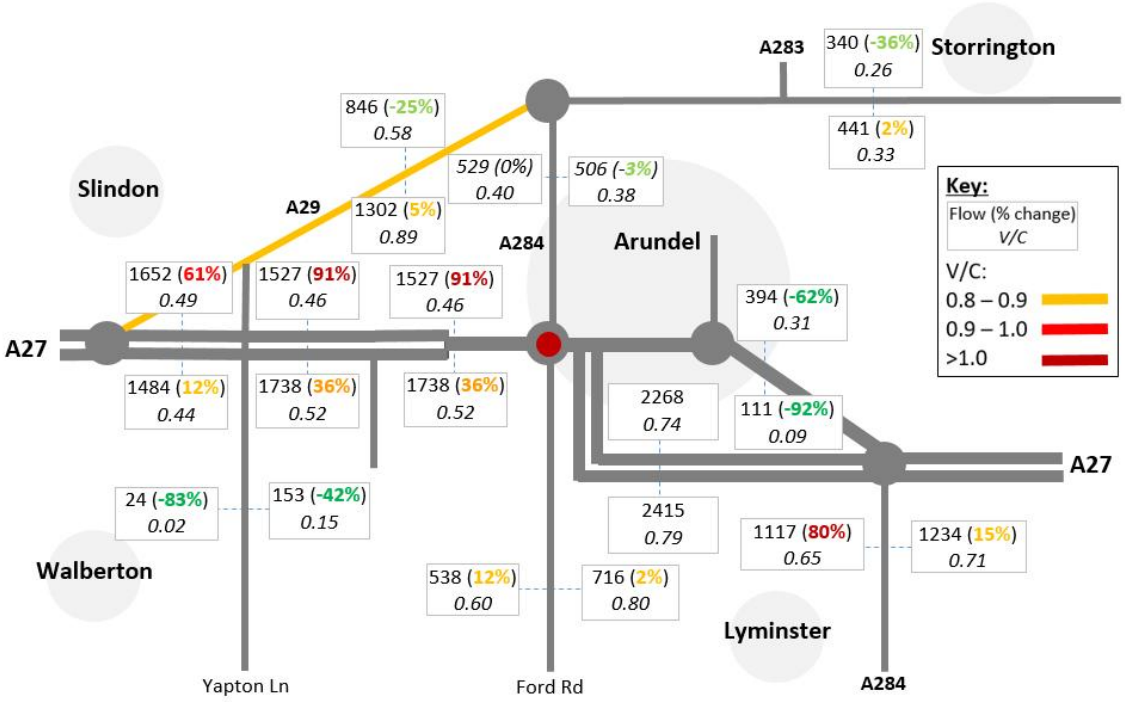


Figure 6-3 Flows and capacities with Option 1 (PM)



6.2.14 During peak hours, traffic flow changes follow a similar pattern to daily flows, and includes a significant reduction in traffic between the Crossbush junction and Causeway roundabout, the largest of which is westbound in the PM peak scenario. The V/C data shows that the proposed new offline section would operate well within capacity, and the changes in traffic flows on the existing single carriageway of the A27 would result in those sections of road operating with maximum V/C's of around 0.30.

6.2.15 Where the offline bypass ties in to the existing A27, V/C increases to a maximum of 0.72 in the westbound direction. West of Ford Road roundabout, V/C decreases again to around 0.50.

6.2.16 Along local roads, the highest V/C is found on the A284 south of Crossbush, where the level of traffic flow is approaching the capacity of the link. The A29 southbound in the PM is also close to capacity. All other local roads sit within the 0.85 threshold and operate within capacity.

6.2.17 Figure 6-4 and Figure 6-5 present the flow changes and V/C information for Option 3 in the AM and PM peaks respectively.

6.2.18 With the implementation of Option 3, peak hour flows will reduce markedly in both the AM and PM peaks through Arundel, as the longer distance strategic traffic movements transfer to the bypass. Along the existing A27 therefore, the road will operate within capacity, with a V/C high of 0.73 and a low of 0.12. Once the new bypass ties in to the existing A27 to the west of Arundel, V/C increases, however the road still operates within capacity with V/C's less than 0.70.

6.2.19 The surrounding local roads operate within capacity including Yapton Lane, A284 to the north of Arundel, Ford Road and the B2139 near Storrington and these routes generally experience a reduction in traffic flow. The A29 is approaching capacity in the PM peak with V/C exceeding 0.85.

6.2.20 Figure 6-6 and Figure 6-7 shows the 2041 AM and PM peak flow changes in comparison to do nothing and the V/C for Option 5A

Figure 6-4 Flows and capacities with Option 3 (AM)

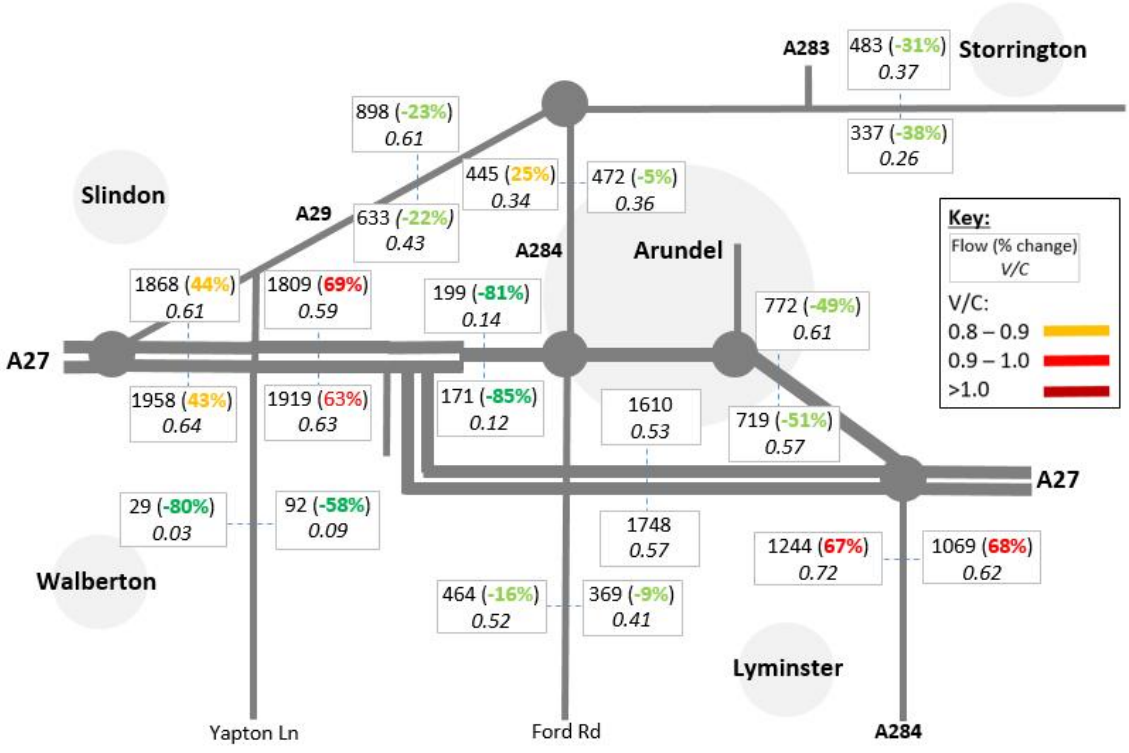


Figure 6-5 Flows and capacities with Option 3 (PM)

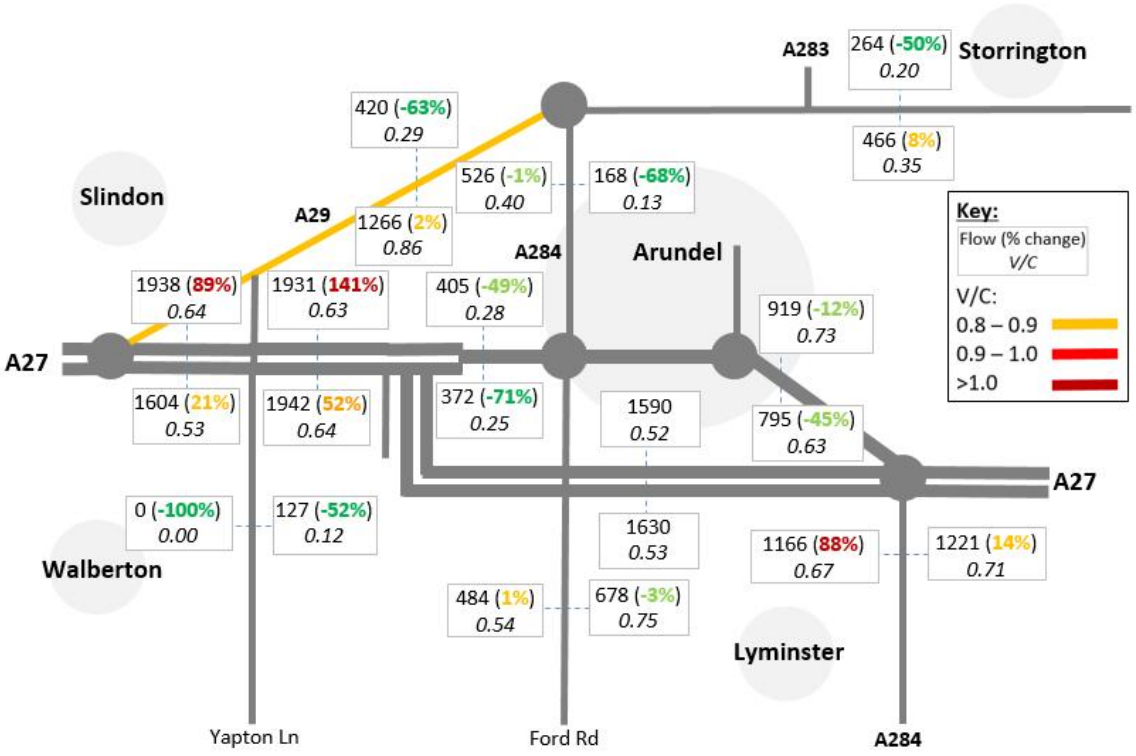


Figure 6-6 Flows and capacities for Option 5A (AM)

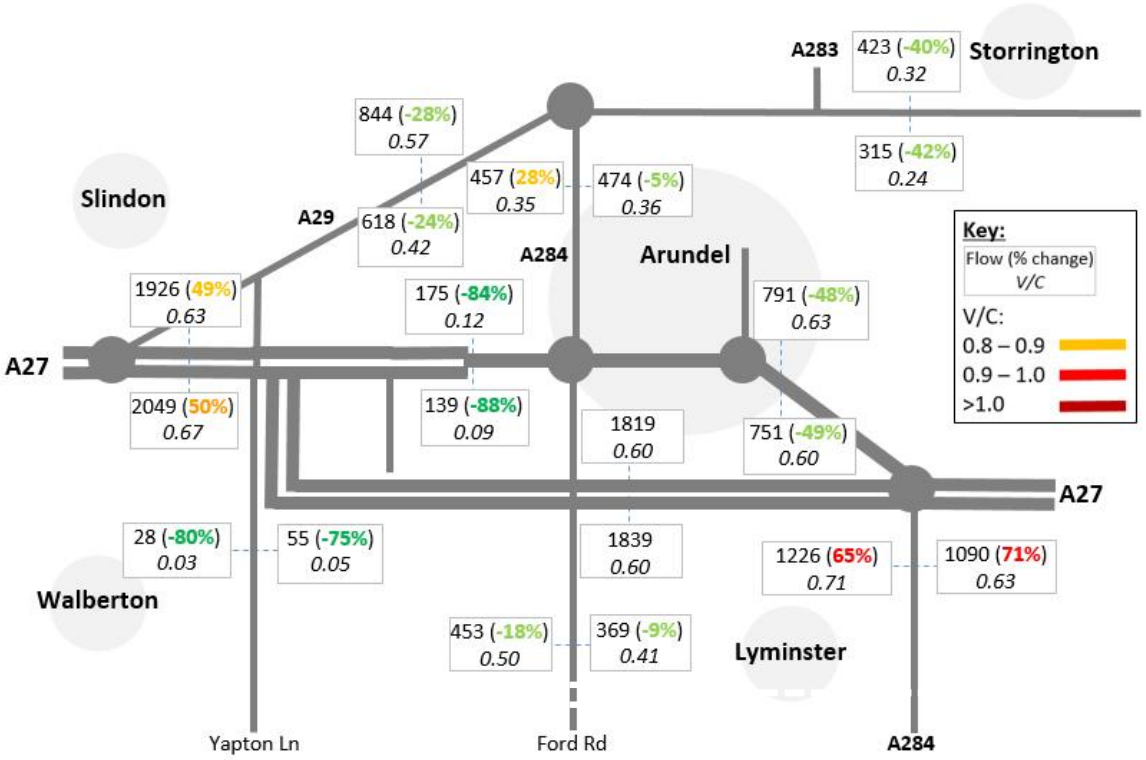
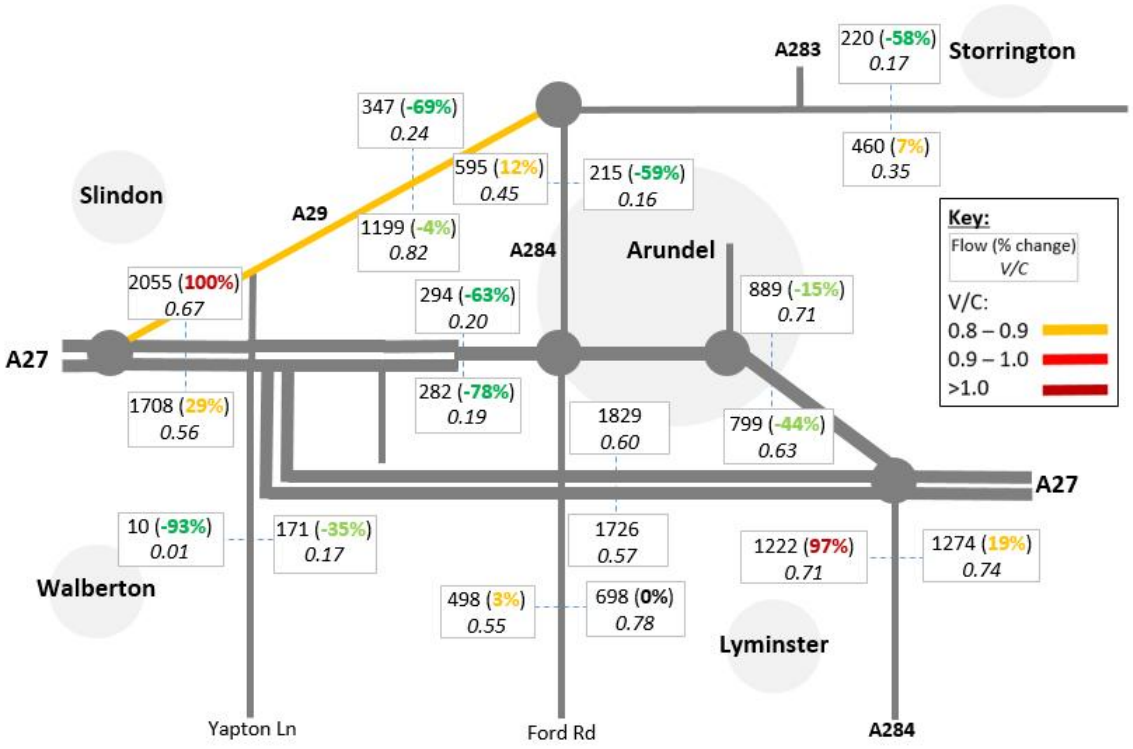


Figure 6-7 Flows and capacities for Option 5A (PM)



6.2.21 The effects of Option 5A are similar to that of Option 3. In general, a slightly greater volume of traffic transfers away from the existing A27 on to the new route, resulting in lower V/C's on the existing route in relation to Option 3. A greater volume of traffic is transferred onto the bypass and onto some other local routes including the southern section of the A284 where the V/Cs indicate the link approaching or above capacity.

OPERATIONAL ASSESSMENT

6.2.22 This section includes an assessment of the performance of the junctions that were also considered in sections 2 and 4. The assessment shows the extent to which the operational issues described earlier in this report are resolved by each option. A description of the operational modelling and how this differs from strategic modelling is included in section 6.6.

6.2.23 Table 6-2 and Table 6-3 summarise the modelling results of Ford Road roundabout and Crossbush junction with the implementation of Option 1 for the year 2041. The tables show that the concept layout for Option 1 does not operate within capacity.

6.2.24 On investigation it has been found that delays at Ford Road roundabout, as predicted by the LINSIG operational junction model, are not accurately represented in the strategic SATURN model. The consequence of this is that the consulted on A27 Arundel Bypass (Option 1) scheme, as currently designed, is not likely to accrue the benefits currently suggested by the strategic SATURN modelling and the subsequent economic assessment of that scheme.

6.2.25 It should be noted that this has implications not only for journey time and vehicle operating cost impacts, but also for other impacts which take the SATURN modelling results as their input. These include air quality, noise and greenhouse gas impacts as well as accidents and wider economic impacts which would be all affected.

6.2.26 This junction is now exceeding capacity as a result of a marked increase in forecast traffic volume at the junction in PCF Stage 2 when compared with the forecast at PCF Stage 1 when the Option 1 concept was developed. Two key factors have contributed to the increase in traffic forecast at this junction and these are:

- → the development of a new version of the A27 Arundel Bypass traffic model which provides an improved representation of traffic flows and journey times locally, and across the wider area covered by the model
- → the introduction of variable demand as part of the traffic forecasting process has resulted in a higher level of traffic movements within the vicinity of the scheme

Table 6-2 Partially Signalled Ford Road Roundabout (Option 1) LinSig Results (2041 AM and PM Peak)

		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
Junction Arm	**Lane(s)**	**DoS (%)**	**MMQ[36] (PCUs)**	**Delay (s/PCU)**	**DoS (%)**	**MMQ (PCUs)**	**Delay (s/PCU)**
A284 Entry	1/1 & 1/2	99	20	81	112	69	233
A284 Circulatory	2/1	61	3	8	70	4	12
A284 Circulatory	2/2	65	3	8	68	3	11
A284 Circulatory	2/3	67	3	8	74	4	13
Maltravers Street Entry Give-way	3/1	34	1	16	42	1	18
A27 WB Entry	4/1 & 4/2	94	16	20	109	97	177
A27 WB Entry	4/3	62	8	8	76	12	17
A27 WB Circulatory	5/1	38	2	32	40	2	18
A27 WB Circulatory	5/2	62	3	45	56	4	24
Ford Road Entry	6/1 & 6/2	71	5	32	87	8	42
Ford Road Circulatory	7/1	52	2	5	40	1	3
Ford Road Circulatory	7/2	68	3	7	62	1	4
Ford Road Circulatory	7/3	68	3	7	67	2	5
A27 EB Entry	8/1 & 8/2	104	54	117	112	78	232
A27 EB Entry	8/3	64	8	15	72	9	25
A27 EB Circulatory	9/1	55	4	19	41	4	11
A27 EB Circulatory	9/2	60	5	20	43	4	10
A27 EB Circulatory	9/3	32	3	16	30	4	9
Total Delay (PCU hours)			**88.91**			**236.70**	
Practical Reserve Capacity (%)			**-16.0**			**-24.4**	

[36] Mean Maximum Queues

Table 6-3 Crossbush Junction (Option 1) ARCADY Results (2041 AM and PM Peak)

		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
Node	**Arm**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**
North Rbt	The Causeway	0.25	0.33	6.08	0.29	0.41	3.47
	Over-bridge Northbound	0.36	0.58	2.57	0.28	0.4	2.26
	A27 Eastbound Off-slip	0.71	2.49	11.51	0.37	0.62	4.42
South Rbt	Over-bridge Southbound	0.42	0.77	2.98	0.37	0.61	2.69
	A27 Westbound Off-slip	0.24	0.32	3.03	0.41	0.7	3.54
	A284 Lyminster Road	0.65	1.89	4.65	0.57	1.33	3.92

6.2.27 Table 6-4 and Table 6-5 summarise the modelling results of Ford Road roundabout and Crossbush junction with the implementation of Option 3 for the year 2041. The results show these junctions operate well within capacity.

Table 6-4 Ford Road Roundabout (Option 3) ARCADY Results (2041 AM and PM Peak)

JUNCTION ARM		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
		RFC	**Queue (Veh)**	**Delay (s/Veh)**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**
A	A284	0.55	1.23	6.37	0.36	0.56	4.79
B	Maltravers Street	0.09	0.1	4.54	0.14	0.17	4.47
C	A27 East (Arundel Bypass)	0.4	0.67	4.01	0.56	1.27	6.15
D	Ford Road	0.54	1.18	8.45	0.6	1.51	10.32
E	A27 West (Chichester Road)	0.25	0.33	5.39	0.42	0.72	5.88

Table 6-5 Crossbush Junction (Option 3) ARCADY Results (2041 AM and PM Peak)

		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
Node	**Arm**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**
North Rbt	The Causeway	0.5	1.01	4.31	0.52	1.08	3.85
	Over-bridge Northbound	0.63	1.75	4.43	0.61	1.6	4.19
	A27 Eastbound Off-slip	0.69	2.25	32.92	0.53	1.15	18.49
South Rbt	Over-bridge Southbound	0.38	0.64	2.77	0.31	0.46	2.44
	A27 Westbound Off-slip	0.39	0.63	3.43	0.52	1.11	3.89
	A284 Lyminster Road	0.69	2.24	5.94	0.67	2.01	5.69

6.2.28 Table 6-6 and Table 6-7 summarise the modelling results of Ford Road roundabout and Crossbush junction with the implementation of Option 5A for the year 2041. The results show these junctions operate well within capacity.

Table 6-6 Ford Road Roundabout (Option 5A) Results (2041 AM and PM Peak)

JUNCTION ARM		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
		RFC	**Queue (Veh)**	**Delay (s/Veh)**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**
A	A284	0.54	1.15	6.11	0.37	0.59	4.63
B	Maltravers Street	0.11	0.12	4.45	0.14	0.17	4.35
C	A27 East (Arundel Bypass)	0.39	0.64	3.93	0.54	1.17	5.79

JUNCTION ARM		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
D	Ford Road	0.53	1.1	8.02	0.6	1.5	9.95
E	A27 West (Chichester Road)	0.22	0.28	5.21	0.32	0.46	5.14

Table 6-7 Crossbush Junction (Option 5A) ARCADY Results (2041 AM and PM Peak)

		2041 AM PEAK PERIOD			2041 PM PEAK PERIOD		
Node	**Arm**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**	**RFC**	**Queue (Veh)**	**Delay (s/Veh)**
North Rbt	The Causeway	0.5	1.0	4.16	0.53	1.14	4.21
	Over-bridge Northbound	0.6	1.52	4.06	0.6	1.52	4.06
	A27 Eastbound Off-slip	0.71	2.58	29.2	0.71	2.46	27.81
South Rbt	Over-bridge Southbound	0.42	0.75	2.95	0.34	0.53	2.55
	A27 Westbound Off-slip	0.39	0.63	3.73	0.55	1.23	4.31
	A284 Lyminster Road	0.68	2.18	5.89	0.68	2.16	5.84

6.2.29 Table 6-8 shows the 2041 journey times for each of the options and compares to the do nothing scenario.

Table 6-8 2041 journey times (mm:ss)

ROUTE	AVERAGE PEAK HOUR PERIOD	OPTION 1	DIFFERENCE ON DO NOTHING	OPTION 3	DIFFERENCE ON DO NOTHING	OPTION 5A	DIFFERENCE ON DO NOTHING
A27 EB	AM	7:24	- 3:37	4:51	- 6:10	4:29	- 6:32
	IP	6:19	- 3:44	4:50	- 5:13	4:29	- 5:34
	PM	9:13	- 7:54	4:51	-12:16	4:30	- 12:37
A27 WB	AM	6:22	- 6:18	4:51	- 7:49	4:30	- 8:10
	IP	6:19	- 4:35	4:51	- 6:03	4:29	- 6:25
	PM	6:07	-6:39	4:53	- 7:53	4:30	- 8:16

6.2.30 Option 1 would see reductions in journey times across all time periods and in both directions compared to do nothing. The largest improvement is the PM peak journey in an eastbound direction, where journeys are almost 8 minutes less. However, there are still differences in journey time when the different directions and peak periods are compared, particularly in the eastbound direction, and this reflects the capacity constraints at the Ford Rd roundabout junction.

6.2.31 Implementing the offline bypass Options 3 or 5A would result in free flowing journey times, with consistent journey times across directions and the different time periods. Option 5A would see slightly improved journey times relative to Option 3, with a further saving of approximately 20 seconds due to the more direct route alignment. Option 5A presents a journey time saving of up to 12 minutes 37 seconds compared to do nothing.

6.3 ECONOMIC APPRAISAL

6.3.1 As discussed in section 6.6 of this report the results for A27 Arundel Bypass (Option 1) are presented for completeness, but it should be borne in mind that the benefits are likely to be over-estimated. This is because the SATURN model currently underrepresents the delays which may potentially remain on the scheme section of the A27 – specifically at Ford Road Roundabout - for the current A27 Arundel Bypass (Option 1) scheme design.

6.3.2 The economic appraisal was undertaken in accordance with WebTAG Unit A1.1 Cost-Benefit Analysis. The economic appraisal was informed by data taken from the A27 Strategic Model. Further detail in relation to the methodology and the results of the economic appraisal are presented in the ComMA report[37].

6.3.3 The economic appraisal of the options comprises the following:

- Transport user benefits
- Accident benefits
- Impacts during construction
- Environmental impacts (including greenhouse gases, air and noise)

6.3.4 This economic appraisal produces an ‘initial’ benefit-cost ratio (BCR) that is then ‘adjusted’ through the inclusion of Wider Economic Benefits (WEB’s), which are summarised later in this section.

TRANSPORT USER BENEFITS

6.3.5 The appraisal of the transport user benefits incorporates the effects relating to time savings, vehicle operating cost savings and indirect tax revenue. The economic appraisal reflects the benefits over a standard 60-year appraisal period, from 2023 (opening year) to 2082 informed by trip distance and journey time data by vehicle type and journey purpose from the A27 Strategic Model.

6.3.6 Travel time savings are monetised as a perceived benefit, reflecting users’ willingness to pay for a quicker journey and expressed in the market price unit of account. The value of those savings differs depending on the reason for the trip, of which three are defined in TAG; business users, commuters, and non-commuting consumers.

6.3.7 Vehicle operating cost savings accrue in two categories:

[37] A27 Arundel Bypass - Combined Modelling and Appraisal Report (January 2018)

- fuel costs, a function of the speed of the vehicle through the network and fuel efficiency
- non-fuel costs such as oil, tyres, vehicle maintenance depreciation and business vehicle capital costs, largely a function of the distance travelled by the vehicle

6.3.8 WebTAG 1-1[38] describes indirection taxation as similar to VAT, meaning that different users perceive costs differently. For example the price of petrol is different for businesses, which can reclaim VAT, and personal travellers, who can't. Different users are perceiving costs in different units of account. Individual consumers perceive 'market prices', including indirect taxation, while businesses and government perceive costs in the 'factor (or resource) cost' unit of account, net of indirect taxation. They are included in the public accounts table as central government funding: non transport and are not included in the broad transport budget.

6.3.9 **Table 6-9** summarises the transport user benefits relating to economic efficiency (section 6.1 describes the limitations of these results).

Table 6-9 Transport User Benefits (£000)

TYPE	OPTION 1	OPTION 3	OPTION 5A
Economic Efficiency: Consumer Users (Commuting)	£40,177	£50,311	£64,478
Economic Efficiency: Consumer Users (Other)	£63,516	£64,417	£78,333
Economic Efficiency: Business Users and Providers	£55,722	£52,090	£67,242
Economic Efficiency: Total	**£159,415**	**£166,818**	**£210,053**

6.3.10 The table shows that Option 5A has the largest benefit to consumer users and business users and providers.

ACCIDENT BENEFITS

6.3.11 Cost and Benefit to Accidents – Light Touch (COBALT) is a computer program used to undertake the analysis of the impact on accidents as part of economic appraisal for a road scheme. The assessment is based on a comparison of accidents by severity and associated costs across an identified network in the Do Nothing and Do Something forecasts using details of link and junction characteristics, relevant accident rates and cost and forecast traffic volumes by link junction.

6.3.12 The accident analysis, in COBALT, for the A27 Arundel Bypass scheme options is based on traffic flows from strategic SATURN modelling. Due to the issues with the A27 Arundel Bypass (Option 1) scheme as discussed in section 6.6, it follows that the accident analysis for Option 1, and only for Option 1, is likely to be misstated. For example, the fewer vehicles that can get through a junction should mean fewer accidents and vice-versa.

6.3.13 Figure 6-8 to Figure 6-10 show the difference in number of accidents between Do Nothing and each Option (1, 3 and 5A) respectively. A positive number shows that there is a decrease in the number of accidents between the scheme and Do Nothing, whereas a negative number shows an increase in the number of accidents as a result of the scheme. Blue indicates a decrease in accidents as a result of the scheme and amber / red an increase.

.

[38] https://www.gov.uk/government/publications/webtag-tag-unit-a1-1-cost-benefit-analysis-december-2017

Figure 6-8 Option 1 accident difference on Do Nothing

Figure 6-9 Option 3 accident difference on Do Nothing

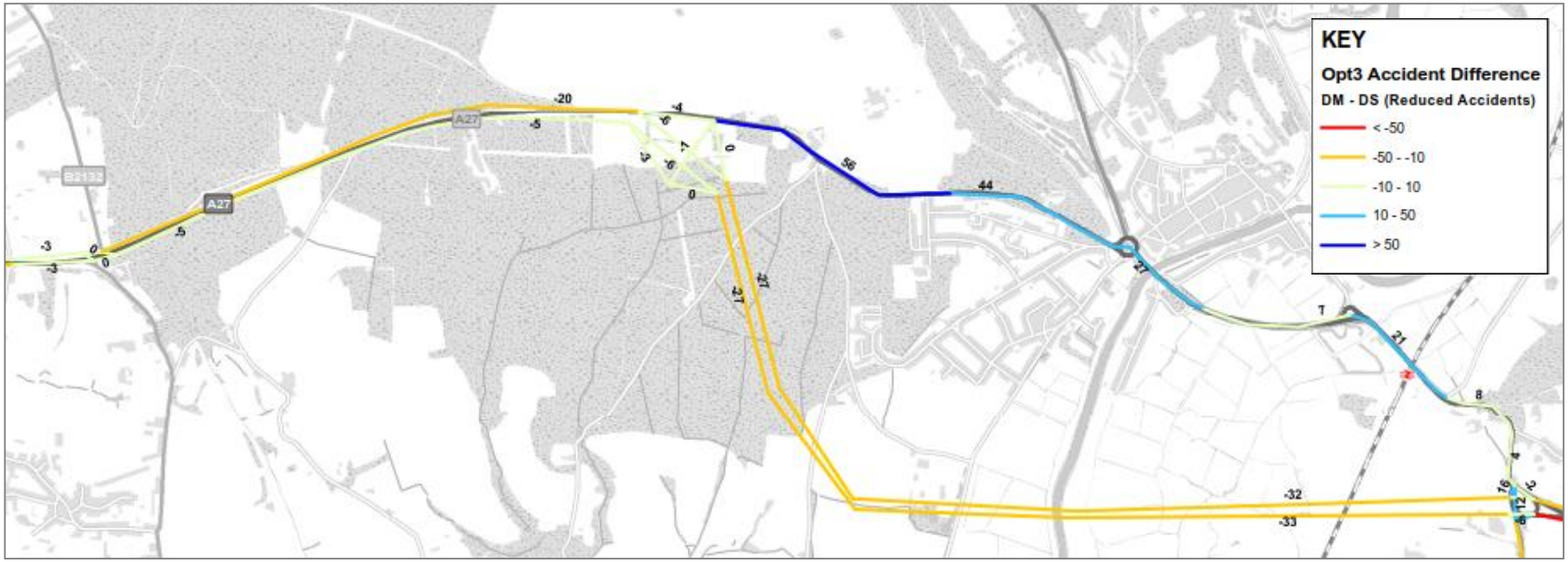
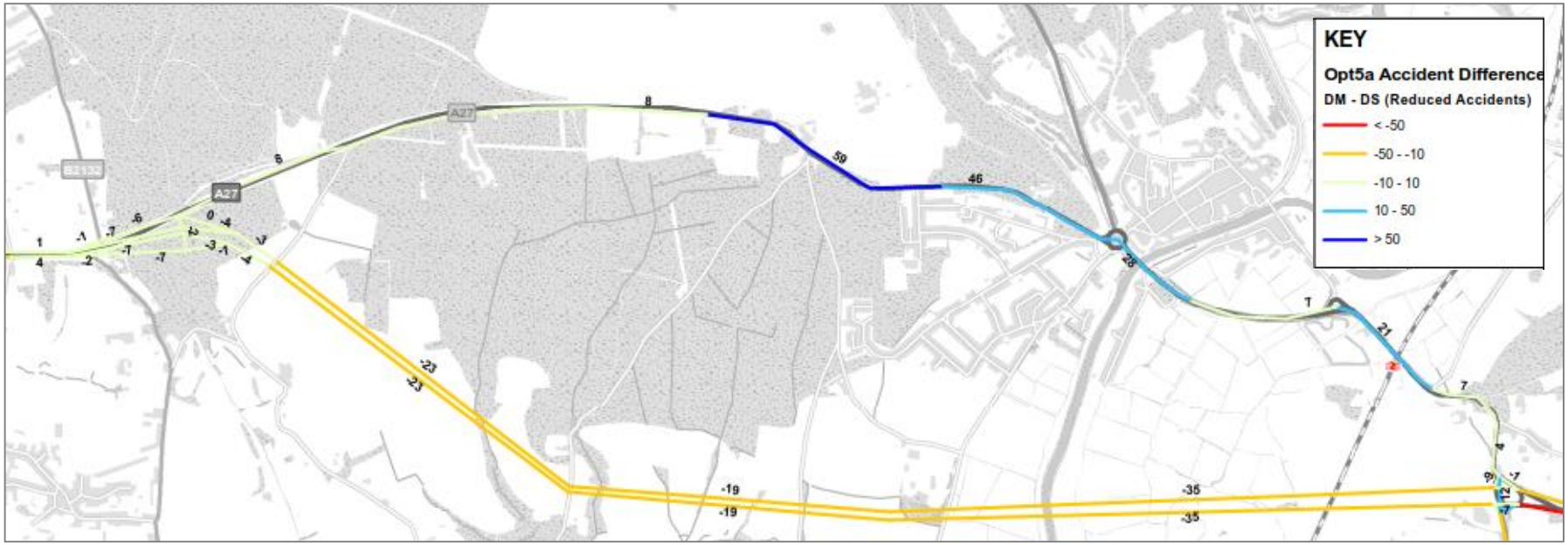


Figure 6-10 Option 5A accident difference on Do Nothing



6.3.14 From the figures above it can be seen that where the options bypass the existing A27, there are reductions in the number of accidents due to reduced flows. The transfer in traffic to the new bypass sections result in some accidents forecast on the new sections of road. Option 1 would result in an increase in accidents of 104 on the A27 just east of Ford Road roundabout.

6.3.15 Table 6-10 shows the total number of accidents on the proposed or existing SRN, as extracted from the COBALT programme. This is then compared to Do Nothing to show how the scheme influences the number of accidents. The information is the predicted number of accidents between Mill Road / Tye Lane and Crossbush on both the existing and proposed A27.

Table 6-10 Number of accidents and accident savings of each option

	DN	Option 1	Option 3	Option 5A
Total number of accidents	346	538	219	191
Difference in accidents to DN	-	192	-127	-155

6.3.16 As can be seen from Table 6-10 the total number of accidents increases with Option 1, but decreases with Option 3 and Option 5A, with Option 5A having the largest decrease of 156 accidents. This is a result of the improved road standard provided by Options 3 and 5A relative to Option 1.

6.3.17 The results of the COBALT analysis for the A27 Arundel Bypass scheme options are presented in Section 10.

6.3.18 The monetised accident benefits of each option which considers the impact of the schemes across the entire road network are presented in Table 6-12. Whilst all options provide an overall benefit related to accident savings, these are significantly lower for Option 1 than the other two options.

Table 6-11 Accident summary

Period	Option 1	Option 3	Option 5A
Total without-scheme accidents	38,431	38,419	38,421
Total with-scheme accidents	38,185	37,776	37,873
Total accidents saved by scheme	245	642	548

Table 6-12 Total accident benefits (£m)

Period	Option 1	Option 3	Option 5A
Total without-scheme accident costs	£1867.756	£1867.252	£1867.321
Total with-scheme accident costs	£1851.748	£1833.474	£1837.279
Total accident benefits saved	£16.008	£34.778	£30.042

6.3.19 The economic benefits associated with the reduction of accidents is a result of the provision of a higher standard of route. Users that transfer from existing lower standard strategic routes or local roads benefit from driving on a new route with a lower accident rate.

IMPACTS DURING CONSTRUCTION

6.3.20 The costs of delays during construction were estimated by coding traffic management measures provided by the Skanska Buildability Report in the do nothing models for 2023 and running TUBA (version 1.9.9) comparing the construction models against the do nothing models.

6.3.21 The economic impacts during construction for each option are presented **Table 6-13**

Table 6-13 Delays during construction (£m)

	OPTION 1	OPTION 3	OPTION 5A
User time (a)	-£52.28	-£1.143	-£1.416
Vehicle Operating Costs Fuel (b)	-£10.68	-£0.250	-£0.280
Vehicle Operating Costs Non Fuel (c)	-£0.898	-£0.209	-£0.234
Indirect Taxation Revenues (d)	£0.672	£0.157	£0.175
Total (a+b+c+d)	**-£6.522**	**-£1.445**	**-£1.755**

6.3.22 The table above shows that the A27 Arundel Bypass scheme options are forecast to result in economic disbenefits to traffic as a result of delays associated with construction of £6.5m for Option 1 , £1.4m for Option 3 and £1.8m for Option 5A. These results illustrate the impacts on vehicle delay during construction are around four times greater with the part-online improvement of Option 1 in comparison to the fully offline Options 3 and 5A.

SCHEME COSTS

6.3.23 The scheme costs for the A27 Arundel Bypass (Option 1, Option 3 and Option 5A) are produced by Benchmark Estimating Ltd in Quarter 1 year 2016 prices. These prices are then inflated to outturn costs using Highways England projected construction related inflation and then rebased to 2010 calendar year prices for economic calculations using the GDP price deflator as published in the TAG Databook (July 2017 – release 040817v2).

SUMMARY OF ECONOMIC IMPACTS

6.3.24 A summary of the economic impacts of each option is presented below in **Table 6-14** (section 6.1 describes the limitations of these results).

Table 6-14 Analysis of Monetised Costs and Benefits, Variable Demand Assignment (£m)

TYPE	OPTION 1	OPTION 3	OPTION 5A
Transport Economic Efficiency	£159.415	£166.818	£210.053
Greenhouse Gases	-£19.145	-£25.181	-£23.899
Wider Public Finances (Indirect Taxation Revenues)	£17.056	£23.821	£21.461

TYPE	OPTION 1	OPTION 3	OPTION 5A
Accident benefits	£16.008	£34.778	£30.042
Construction Delay	-£6.522	-£1.445	-£1.755
Air Quality	9.252	9.016	9.465
Noise	-£9.967	-£1.334	-£1.519
Present Value of Benefits (PVB)	£166.097	£206.473	£243.848
Broad Transport Budget	£87.190	£166,997	£162,005
Present Value of Costs (PVC)	**£87.190**	**£166.997**	**£162.005**
Net Present Value (NPV)	**£78.907**	**£34.476**	**£81.843**
Benefit to Cost Ratio (BCR)	**1.91**	**1.24**	**1.51**

6.3.25 **Table 6-14** shows that Option 1 has the highest forecast BCR of the three options (section 6.1 describes the limitations of these results) with Option 5A the second highest.

6.3.26 As discussed in section 6.6 of this report the results for A27 Arundel Bypass (Option 1) are presented for completeness, but it should be borne in mind that the benefits are likely to be over-estimated.

6.4 SUMMARY OF WIDER IMPACTS

6.4.1 All the results of the Wider Economic Benefits analysis for the A27 Arundel Bypass scheme options are based on information from strategic SATURN modelling however the A27 Arundel Bypass (Option 1) benefits may be over-estimated but the results are reported for completeness.

6.4.2 An adjusted BCR has been calculated by including the Wider Economic Benefits (WEB) that are forecast to occur with the introduction of the A27 Arundel Bypass. These benefits reflect the enhanced connectivity the scheme will provide on the A27 and the accessibility and productivity benefits this generates for those making work-related trips to have much better access to jobs, especially those jobs in higher value sectors. This results in agglomeration and labour market impacts, and these are outlined further below.

6.4.3 The concept of agglomeration reflects that where there is good connectivity, productivity will be higher as workers can access a far greater range of jobs at the same time as businesses and companies have a much broader pool of employees from which to draw their staff from.

6.4.4 Agglomeration can be viewed as the intensity of economic activity in a particular area and is measured by productivity, or GDP per worker in the appraisal guidance. Agglomeration improvements occur under a transport intervention – such as the Arundel Bypass – when the enhanced connectivity translates into productivity improvements.

6.4.5 Labour market impacts may also occur due to the expected increase in jobs from people entering work who would otherwise be inactive due to high commuting costs on the basis that insufficient transport accessibility is a barrier to people entering the labour market and gaining employment.

6.4.6 Agglomeration-based impact only has been quantified and presented in **Table 6-15**. These are covered under DfT's Wider Impacts guidance and have been calculated in a specified way since January 2014. They are calculated over a standard 60 year appraisal period and the total value given below covers the four sectors of the economy within the appraisal guidance (construction, consumer services, manufacturing, and producer services).

6.4.7 **Table 6-15** shows the high level benefits and costs for the bypass options (section 6.1 describes the limitations of these results). The adjusted BCR includes the agglomeration-based impacts highlighted above.

Table 6-15 Summary of benefits and costs (£m)

TYPE	OPTION 1	OPTION 3	OPTION 5A
Present Value of Benefits (initial)	166,097	209.473	243,848
Wider Economic Benefits	47,500	20,800	19,300
Present Value of Benefits (adjusted)	213,597	227,273	263,148
Present Value of Costs	87,190	166,997	162,005
Net Present Value (adjusted)	126,407	60.276	101,143
Adjusted BCR	**2.45**	**1.36**	**1.62**

6.5 SOCIAL APPRAISAL

6.5.1 Social impacts are the intended and unintended consequences of an intervention on the community, which are not considered in the Analysis of Monetised Costs and Benefits, but are reported in the Appraisal Summary Table.

6.5.2 The impacts of a scheme may differ across social groups, hence a transport scheme will also have distributional effects. Some users may experience a benefit whilst others will experience a disbenefit. The distributional impacts assessment considers variations in transport intervention impacts across different social groups.

USER BENEFITS

6.5.3 For Options 1, 3 and 5A, time savings from a decrease in congestion will benefit commuters and other users; a significant proportion of users will also have a reduction in journey time by travelling distances at higher average speeds (using the scheme links). Journey time reductions are greatest during the PM peak period, but there are also significant benefits in the Inter-peak and AM peak periods.

6.5.4 It is also likely that there will be journey time reductions during non-modelled periods, at the weekend and during the off-peak period, and benefits to 'other' users are likely to be significant given the higher proportion of these user related trips during these periods.

PHYSICAL ACTIVITY

6.5.5 The Arundel section of the A27 deters vulnerable road users such as cyclists and pedestrians from using the route, resulting in increased levels of car usage.

6.5.6 The Arundel Bypass scheme is forecast to redistribute traffic towards the upgraded road, reducing traffic volumes on lower order roads. This will improve the safety conditions on these roads and encourage more activity of WCHRs. This will increase physical activity and health benefits. However, Option 1 will have less of an impact on this than the other options with the road and level of traffic flow passing through Arundel continuing to act as a barrier for WCHRs.

6.5.7 Inactivity currently costs the NHS £1.06 billion per annum. The cost of lost productivity due to sickness is also particularly high at £5.5 billion per year, plus £1 billion per year in productivity loss due to premature death[39]. Therefore, increased physical activity brought about by the new bypass will reduce these costs, as well as improving people's health and quality of life.

6.5.8 The increase in cyclists will also help improve road safety as car drivers will become more aware of sharing the road with cyclists and will therefore adjust their driving behaviour accordingly.

SEVERANCE

6.5.9 Each of the options cause varying degrees of severance, the most significant of which is caused by Option 1. Option 1 is online through Arundel and this acts as a physical barrier between the residential areas to the south of Arundel, the town centre, and Arundel railway station. The current severance the A27 causes will remain, and may worsen as the road is upgraded to dual carriageway. Although Option 1 will include provision for WCHRs, those trying to undertake the north-south movement will continue to experience the effects of severance, as large volumes of vehicles travel along the road at high speeds.

6.5.10 Option 3 and Option 5A cause significantly less severance in Arundel as the offline bypass is located further south, allowing for the Arundel urban area to be reconnected again. However, the small villages and settlements to the south of this, including Tortington, Binsted and Ford, could feel additional severance effects from Arundel. This option also cuts through the Ancient Woodland and therefore leisure walkers could be impacted.

ACCIDENTS

6.5.11 COBALT assessment has shown that Option 1, 3 and 5A would bring about significant accident benefits, with the scale of benefits for Options 3 and 5A being twice as much as Option 1 due to the fully grade-separated standard of the route Evidence indicates that people living in more deprived areas are more vulnerable to accidents on the road network. Therefore, a reduction in accidents would have a relatively high impact in Arun, given that several wards in this area are amongst the most deprived in West Sussex.

SECURITY

6.5.12 With regards to security, the benefits from options 1, 3 and 5A are indirect in that the schemes will not generate direct security enhancements but will instead enable drivers to feel more secure on a faster flowing, greatly improved section of the A27. Improved security will include less risk and less perceived risk of in-vehicle thefts and other adverse incidents when traffic is stationary (this is particularly relevant for the large numbers of older drivers in the area).

ACCESS TO SERVICES

6.5.13 Since the scheme does not change public transport services, the change in generalised journey time associated with modelled car trips (from the SATURN traffic model) have been used to assess 'access to services'. The assessment indicates that accessibility increases for all income groups to the destinations, with the highest accessibility benefits for the lowest income group.

[39] Department of Public Health et al, 2011.

6.5.14 Option 1 has the greatest impact on services as a result of dualling, restricting local roads to a left in left out turning. This is a particular problem for Arundel District Hospital access, where right turning vehicles will have to travel longer distances along the A27 before turning back on themselves to get to their destination.

AFFORDABILITY

6.5.15 Since the Arundel improvement scheme primarily entails the provision of new roads, any changes in affordability are more likely to be indirect impacts rather than direct consequences of the scheme. As such, only a qualitative assessment has been undertaken. As the intervention is expected to reduce congestion, and thereby the amount of time spent queuing as well as the additional distance travelled to avoid congestion, this will reduce vehicle operating costs. Examples of these costs include fuel, tyres and the depreciation costs associated with maintenance. These latter costs are dependent on distance travelled and can make travelling more affordable

JOURNEY QUALITY

6.5.16 Journey quality is a measure of the real and perceived environment experienced when travelling, and may affect travel decisions.

6.5.17 Different factors can influence the quality of the journey. They can be grouped into:

- → Traveller Stress – frustration, fear of potential accidents, route uncertainty
- → Traveller Views – views and pleasantness of the surroundings during the journey
- → Traveller Care – general transport environment

6.5.18 The scheme will reduce travellers' stress by improving general road conditions and by enabling road users to make reliable progress on this busy section of the A27. A new roundabout and grade separated interchanges will improve road safety and reduce the perceived likelihood of accidents. These will increase journey quality. However, the at-grade junctions that are part of Option 1 may contribute to frustration and therefore traveller stress associated with road layout and geometry and the ability to make good progress along the route. Travellers may also experience an increased fear of potential accidents with Option 1, relative to Options 3 and 5A.

OPTION AND NON-USE VALUES

6.5.19 Since the scheme will not change the availability of transport services within the study area, option values and non-use values are not applicable for this assessment and have therefore not been assessed.

6.6 FURTHER ASSESSMENT

6.6.1 The traffic forecasting results presented in **Table 6-2** have shown that the Ford Road roundabout would operate in excess of capacity, resulting in long queues. The forecast performance of this junction has deteriorated since the earlier assessments undertaken in PCF Stage 1. This is due to the significant increase in forecast traffic volumes at the junction which is a result of the reasons set out earlier in this chapter. A summary of the forecast traffic volumes at the Ford Road roundabout from PCF Stage 1 and 2 is presented in **Table 6-16**.

Table 6-16 Summary of 2041 total traffic volumes at Ford Rd roundabout

TOTAL TRAFFIC VOLUME	AM PEAK	PM PEAK
PCF Stage 1	4,467	5,085
PCF Stage 2	5,688	5,970
Difference	+1,221	+885
% Difference	+27%	+17%

6.6.2 A transport model is a mathematical representation of all or part of a transport system and is used to evaluate existing conditions and to project future effects and needs.Transport modelling operates at various levels of detail and scale, covering regions all the way down to single junctions. The general hierarchy is:

- Strategic models e.g. SATURN, VISUM, EMME: Typically cover very large areas and model the balance of trips between available modes. Given that strategic models can cover large areas, the road network is modelled at an aggregate level of detail. Traveller demand is usually defined in trips and can be derived from Mobile Network Data (MND), Roadside Interview (RSI) data and Census data. It is designed to predict the impact of area-wide, road-based trip diversion and route choice with junction capacity coded accurately to ensure that journey times between nodes, and delay within the model, are representative of on-street conditions.
- Micro-simulation models e.g. VISSIM, Paramics: Micro-simulation modelling is able to simulate the movement of individual vehicles travelling within a road network through the accurate replication of driver behaviour. In this regard micro-simulation modelling is distinct from strategic, cordon area and local models within which all vehicles exhibit a common, uniform behaviour.
- Junction models e.g. LINSIG, ARCADY, PICADY: Junction models can range in size from an individual junction to multiple junctions. This level of modelling focuses in detail on the capacity of individual links and junctions, and the interaction between them. A high level of accuracy is required relative to a strategic model. Junction models focus predominantly on individual junctions to allow option testing of modifications to geometric layout and signal staging design. These models are sensitive to small changes in junction layout and/or signal control.

6.6.3 Following a review of the PCF Stage 2 model outputs, it was found that both scales of model (strategic and operational) show the Ford Road roundabout junction would operate in excess of capacity by 2041 in Option 1, but within capacity for Option 3 and 5A. However, there is a notable difference in the forecast level of delay when the strategic and operational models are compared for the Option 1 results. The operational model forecasts a greater level of delay than that indicated by the strategic model.

6.6.4 A consequence of the difference in delays between the operational and strategic models is that the A27 Arundel Bypass (Option 1) scheme, as presented at the consultation, is not likely to accrue the benefits currently suggested by the strategic modelling and the subsequent economic assessment of that scheme.

6.6.5 It should be noted that this has implications not only for journey time and vehicle operating cost impacts, but also for other impacts which take the SATURN modelling results as their input. These include air quality, noise and greenhouse gas impacts as well as accidents and wider economic impacts which would be all affected. This may have implications for the value for money assessment and for achieving scheme objectives.

6.6.6 The results for A27 Arundel Bypass (Option 1) are presented for completeness, but it should be borne in mind that the benefits are likely to be over-estimated. The implications of the difference in the forecast level of junction delay have therefore been considered further. A sensitivity assessment has been undertaken whereby the outputs (signal timings/capacities) from the junction operational modelling have been input into the current A27 Arundel Bypass (Option 1) scheme design. The strategic model has been re-run and the travel time and accident benefits have been assessed to provide an indication of the likely changes to economic benefits when the delays predicted by the operational model are reflected within the strategic model.

6.6.7 The results of this assessment are presented in the ComMA Table 15.36 and illustrate a reduction in the level of economic benefits, bringing the BCR for Option 1 to 1.65 which is broadly in line with the BCR's for options 3 and 5A of 1.24 and 1.51 respectively.

6.6.8 As part of the continued development of scheme options during PCF Stage 2, the concept design of the Ford Road junction has been developed further in order to mitigate the capacity issues identified within both the strategic and operational modelling. Assessment of these design variants are presented under section 10.5.

7 SUMMARY OF ENVIRONMENTAL APPRAISAL

7.1 ENVIRONMENT

7.1.1 This section summarises the results of the environmental assessment of the options during operation and construction. The assessments are summarised from the PCF Stage 2 A27 Arundel Bypass EAR. More detail can be found in the PCF Stage 2 EAR which considers Scheme Options 1, 3 and 5A. The summary presented below takes into account the design, mitigation and enhancement measures proposed in the PCF Stage 2 EAR, these are particularly relevant for the assessments of noise, cultural heritage and road drainage and the water environment.

7.2 LOCAL AIR QUALITY

7.2.1 All Scheme Options have the potential to cause air quality effects during the construction and operation phases. The potential impacts for consideration within the assessment of local air quality are listed below:

- Onsite dust emissions arising from construction activities and vehicle movements. Dust has the potential to be mechanically transported (either by wind or re-suspension by vehicles) and may also arise from wind erosion on material stock piles and earth moving activities;
- Impacts of additional traffic emissions on the public highway associated with heavy duty vehicles delivering materials, components and disposing of excess soils and waste during the construction period; and
- Impacts on local air quality due to changes in traffic-related emissions associated with predicted increases or reductions in vehicle flows, speed and any variations in traffic composition on roads within the local road network as a result of the opening of the Proposed Scheme.

7.2.2 Taking into account the background PM_{10} concentrations and the current emissions of NO_2 and PM_{10} from the current A27 corridor, and with the adoption of appropriate dust control measures, emissions from construction vehicles and non-road mobile machinery are expected to be negligible within the context of existing background levels.

7.2.3 In addition to public exposure assessment, an ecological assessment was undertaken with regard to nitrogen oxides (NO_x) concentrations and nitrogen deposition rates for a number of statutory designations that are situated within 200 metres of the Scheme's Affected Road Network. The results from the ecological assessment indicate that the total NO_x concentrations and nitrogen deposition rates would not increase at any of the considered ecological designations as a result of the Scheme.

7.2.4 As a result of the proposals for Options 1,3 and 5A, road traffic is predicted to reduce from 15,287 AADT in the opening year DM scenario to 12,441 AADT (for Option 1), 12,140 AADT (for Option 3), and 12,170 AADT (for Option 5A) in the DS scenario on the A283 High Street, Storrington road link that is situated within the Storrington AQMA. This is a decrease of 2,846 AADT (or 18.6%)(for Option 1), 3,147 AADT (or 20.6%) (for Option 3) and 3,116 AADT (or 20.4%) (for Option 5A).

7.2.5 Although there was no representative receptor modelled within the Storrington AQMA for this option, it may be considered that with the decrease of traffic flow utilising the A283 High Street, Storrington link as a result of the Scheme, that sensitive receptors situated in this area may experience an improvement in local air quality conditions based on the decrease of AADT.

OPTION 1

7.2.6 During operation, with respect to public exposure receptors and ecological receptors, Option 1 was not anticipated to contribute to a worsening of local air quality that already exceeds objectives, at risk of exceeding objectives or creating new exceedances. The assessment has demonstrated that there will be no significant adverse effects on air quality.

7.2.7 It was determined that Option 1 will have 'Low risk' of non-compliance of the Air Quality Directive.

OPTION 3

7.2.8 During operation, with respect to public exposure receptors and ecological receptors, Option 3 was not anticipated to contribute to a worsening of local air quality that already exceeds objectives, at risk of exceeding objectives or creating new exceedances. The assessment has demonstrated that there will be no significant adverse effects on air quality.

7.2.9 It was determined that Option 3 will have 'Low risk' of non-compliance of the Air Quality Directive.

OPTION 5A

7.2.10 During operation, with respect to public exposure receptors and ecological receptors, Option 5A was not anticipated to contribute to a worsening of local air quality that already exceeds objectives, at risk of exceeding objectives or creating new exceedances. The assessment has demonstrated that there will be no significant adverse effects on air quality.

7.2.11 It was determined that Option 5A will have 'Low risk' of non-compliance of the Air Quality Directive.

7.3 CULTURAL HERITAGE

7.3.1 The cultural heritage assessment used the 'simple assessment' methodology set out in the DMRB, which is appropriate to this stage of the project. During the next stage of work, more detailed assessment and further mitigation proposals will be developed in PCF Stage 3 in consultation with WSCC and Historic England.

7.3.2 The following potential impacts have been assessed:

- → Potential impacts on archaeological below ground and earthwork remains;
- → Potential impacts on built heritage (impacts on setting) and historical landscapes; and
- → Potential impacts on social value.

7.3.3 The magnitude of impact on archaeological remains will be largely influenced by the extent and depth of intrusive groundworks during construction. Intrusive works that have the potential to disturb below-ground and historical earthwork remains include, but are not limited to, the excavation for the road options, additional land allocated to ecological and flood compensation, associated services, compound areas, landscaping features, retaining ponds, geotechnical trial pits, temporary access routes and topsoil stripping. These works are likely to completely remove or partially disturb archaeological assets within their footprint. Potential moderate/large adverse permanent effects are anticipated on hitherto unknown below ground archaeological remains.

OPTION 1

7.3.4 Improvements to the Ford Road roundabout have the potential to disturb or damage the structural remains of the WWII loophole wall (MWS7583). Ground disturbance within the Brooks Innings flood plain has the potential to disturb archaeological and earthworks remains associated with the use of this landscape from the Early Medieval period. The impact of Option 1 on local hydrogeology might affect the preservation of geo-archaeology (e.g. peats, pollen samples) as well as preservation of waterlogged artefacts.

7.3.5 Although the existing A27 follows a largely similar route, a total of four heritage assets are expected to be affected adversely as a result of Option 1. These include one Scheduled Monument (Arundel Castle), one Grade II* Listed Building (Priory Farm House), one Conservation Area (Arundel Conservation Area), and one historic landscape (Brooks Innings).

7.3.6 The Arundel Conservation Area (which includes Arundel Castle) will experience a moderate/large adverse permanent effect from the Scheme. Additionally, this option will have a large adverse permanent effect on the Grade II* Listed Building the Priory Farm House. Option 1 will traverse the only surviving part of the asset's original agricultural setting. The property will be completely surrounded by modern infrastructure, which will substantially reduce the understanding and appreciation of the asset.

OPTION 3

7.3.7 Ground disturbance has the potential to disturb archaeological and earthwork remains that are associated with the Arundel to Chichester Romano-British road and the use of Brooks Innings flood plain and Ancient Woodland from the Prehistoric Period onwards. The construction of the Option 3 is very likely to require the complete or partial removal of ancient hedgerows that relate to the cohesive assarts (HWS24819). Disturbance to potential below-ground remains associated with the Romano-British and medieval period settlement is also a risk within the Scheme footprint of Option 3.

7.3.8 A total of 13 heritage assets are expected to be affected adversely as a result of Option 3. These include two Scheduled Monuments (Arundel Castle and Tortington Augustinian Priory), two Grade II* (Tortington Priory Barn and Priory Farm House) and three Grade II Listed Buildings, one Conservation Area (Arundel Conservation Area) and five non-designated heritage assets including three historic landscapes (Brooks Innings, Cohesive Assarts and Assart Woodlands).

7.3.9 This option will have a moderate/large adverse permanent effect on the Arundel Conservation Area and Arundel Castle. Additionally, moderate/large adverse permanent effects are expected for the Tortington Augustinian Priory and the Grade II* Listed Buildings of Tortington Priory Barn and three historical landscapes that include Brooks Innings, Cohesive Assarts and Assart Woodlands. A large adverse effect is anticipated for the Priory Farm House. Option 3 will traverse across agricultural land to the northwest of the Priory House Farm, resulting in a significant loss of its setting.

7.3.10 Option 3 has potential to have a negative adverse effect on the spiritual value of the Binsted area through the introduction of noise, movement, and a large development which is anticipated to be in stark contrast to the surrounding rural environment.

OPTION 5A

7.3.11 It is anticipated that the impacts for Option 5A will be similar to Option 3. Option 5A is likely to necessitate a more extensive removal or partial removal of ancient hedgerows as the Scheme follows a course across a less densely wooded landscape. There will be physical impacts on the historic parkscape associated with the now demolished Binsted House (MWS2354). It is noted that a new property has been built on the site of the former Binsted House.

7.3.12 A total of 23 heritage assets are expected to be affected adversely as a result of Option 5A. These include two Scheduled Monuments (Arundel Castle and Tortington Augustinian Priory), two Grade II* (Tortington Priory Barn and Priory Farm House) and thirteen Grade II Listed Buildings, one Conservation Area (Arundel Conservation Area) and four non-designated heritage assets including two historical landscapes (Brooks Innings and Cohesive Assarts).

7.3.13 Moderate/large adverse permanent effects are expected on Arundel Conservation Area (and Arundel Castle) as well as two historical landscapes that include Brooks Innings and Cohesive Assarts. The alignment of Option 5A follows a course through the key view from Arundel Castle within Arundel Conservation Area and therefore has the same effect as Option 1 and 3 upon the setting of these assets. Moderate/large adverse permanent effects are expected for the Tortington Augustinian Priory and the Grade II* Listed Buildings of Tortington Priory Barn. A large adverse effect is anticipated for the Priory Farm House. Option 5A will traverse agricultural land to the northwest of the Priory House Farm, resulting in a significant disruption to its setting.

7.3.14 Option 5A also has potential to have a negative adverse effect on the spiritual value of the wider Binsted area through the introduction of noise, movement, and a large development which is anticipated to be in stark contrast to the surrounding rural environment.

7.4 LANDSCAPE

7.4.1 The following potential impacts have been assessed:

- → Potential impacts on landscape character; and
- → Potential impacts on visual amenity.

CONSTRUCTION

LANDSCAPE CHARACTER

7.4.2 Potential significant effects would arise as a result of Option 1 on landscape character area 4 – Lower Arun Valley and landscape character area 5 – Arundel, as a result of changes occurring within the character areas that would remain post construction and extend into the Design Year. Effects are anticipated to be of moderate adverse significance.

7.4.3 The potential effects of Options 3 and 5A on landscape character area 2 - Fontwell Upper Coastal Plain landscape character area are expected to be significant, with Option 5A being at the upper end of the scale at large adverse. Both options are expected to have significant adverse effects on landscape character area 4 - Lower Arun Valley, being large adverse, whilst the effects of both options on landscape character area 5 – Arundel are anticipated to be moderate adverse.

VISUAL AMENITY

7.4.4 The potential effects arising during the construction phase as a result of Option 1 are anticipated to be significant where open views, associated with the River Arun floodplain and Arundel are afforded. These comprise six of the 30 viewpoints selected for the visual amenity assessment. These include large adverse effects for Arundel Castle and Priory Farm.

7.4.5 Option 3 is anticipated to give rise to significant effects (moderate and large adverse) on 16 of the 30 viewpoints selected. These include large adverse effects for Arundel Castle and Priory Farm.

7.4.6 Option 5A is anticipated to give rise to significant effects (moderate and large adverse) on 19 of the 30 viewpoints selected. These include large adverse effects for Arundel Castle and Priory Farm.

7.4.7 East of Ford Lane the effects of Options 3 and 5A are anticipated to be comparable as a result of the shared alignments between options, with significant effects occurring in views associated with the open River Arun floodplain during construction.

OPERATION

LANDSCAPE CHARACTER

7.4.8 Potential significant effects would arise as a result of Option 1 on landscape character area 4 – Lower Arun Valley and landscape character area 5 – Arundel, as a result of changes occurring within the character areas that would remain post construction and extend into the Design Year. Effects are anticipated to be of moderate adverse significance.

7.4.9 The potential effects of Options 3 and 5A on landscape character area 2 - Fontwell Upper Coastal Plain are expected to be significant, with Option 5A being at the upper end of the scale at Large adverse. Both options are expected to have significant adverse effects on landscape character area 4 - Lower Arun Valley, being large adverse, whilst the effects of both options will be comparable on landscape character area 5 – Arundel, at moderate adverse.

VISUAL AMENITY

7.4.10 The potential effects arising as a result of Option 1 are anticipated to be no greater than moderate adverse significance in the Design Year and with significant effects at 4 of 30 viewpoints. Significant effects of large adverse are anticipated to arise post construction on two viewpoints (Arundel Castle and Priory Farm) but are anticipated to reduce to moderate adverse in the Design Year as a result of mitigation and integration of the proposals.

7.4.11 Option 3 is anticipated to have significant (moderate and large adverse) effects on 15 of the 30 identified viewpoints.

7.4.12 Option 5A is anticipated to have significant (moderate and large adverse) effects on 18 of the 30 identified viewpoints. These include viewpoints to the west associated with views around Binsted, Binsted Woods and Binsted Park, as well as the setting of the South Downs National Park.

7.4.13 Option 3 will have significant effects (large adverse) on views from footpaths within the woodland associated with Binsted Lane and Tortington Common.

7.4.14 East of Ford Lane, significant effects on viewpoints are anticipated to be comparable for Options 3 and 5A as a result of their shared alignments. Significant effects would occur in views associated with the River Arun floodplain post construction and remaining significant in the Design Year due to the limited capacity to provide extensive mitigation measures.

7.5 BIODIVERSITY

7.5.1 The following potential impacts have been assessed:

- → Potential impacts on designated sites; and,
- → Potential impacts on protected and notable species.

7.5.2 The summary below presents an assessment of ecological effects that are likely to arise during construction and operational phases for the three Scheme Options. The assessment was undertaken following the Ecological Impact Assessment methodology published by the Chartered Institute of Ecology and Environmental Management (CIEEM) and guidance provided by Highways England Interim Advice Note 30/10. Information used in this assessment has been produced at a time approximately mid-way through an ecological field survey programme which is due to be completed in the summer of 2018, therefore some information is based on preliminary survey results and may be conservative.

7.5.3 The assessment identified a range of adverse residual ecological effects which are likely to arise from construction of each of the Scheme Options summarised in Tale 7-1.

Table 7-1 Likely residual significant ecological effects

IMPORTANT ECOLOGICAL FEATURE	OPTION 1	OPTION 3	OPTION 5A
The Arun Valley SAC, SPA and Ramsar site	No residual significant effects are likely.		
Binsted Wood Complex Local Wildlife Site	Ancient Woodland, Ancient/Veteran trees and Wood Pasture and Parkland Habitats of Principal Importance are all irreplaceable. A residual significant ecological effect significant at the national level/of Very Large Magnitude will remain after compensation measures have been applied. The residual effect will be lower in magnitude for Option 1 than for Option 3 or Option 5A.		
Rewell Wood Complex Local Wildlife Site	Ancient woodland is irreplaceable. A residual significant ecological effect at the national level/of Very Large Magnitude will remain after compensation measures have been applied. The residual effect for Option 3 and 5A will be lower in magnitude to than for Option 1 (but note that Option 1 has a lower residual effect on Ancient Woodland overall).		
Ancient Woodland	See Binsted Wood Complex Local Wildlife Site and Rewell Wood Complex Local Wildlife Site.		
Wood pasture and parkland Habitats of Principal Importance including Ancient/Veteran trees (located in Binsted Wood Complex LWS)	No residual effect likely.	Ancient/Veteran trees are irreplaceable a residual effect , significant at the national level/of Very Large Significance, will remain after compensation measures have been applied. Parkland and Wood Pasture Habitats of Principal Importance is unlikely to be affected.	Ancient/Veteran trees are irreplaceable a residual effect, significant at the national level/of Very Large Significance, will remain after compensation measures have been applied.
Hedgerow (thought to comprise the majority of hedges between Ford Road and west branch of Binstead Lane)	No residual effects are likely. Hedgerow compensation measures are likely to be successful in the long-term.	Removal of a small number of species-rich hedges is likely to result in a residual adverse effect which cannot be compensated. However, in general hedgerow compensation measures are likely to be successful in the long-term resulting in a neutral magnitude effect.	
Wetland Habitat (including Coastal and Floodplain Grazing Marsh HPI, River Habitats of Principal Importance, Reedbed Habitats of Principal Importance and Lowland Fen Habitats of Principal Importance)	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	Uncertainty remains over whether impacts on Tortington Rife can be adequately mitigated. A residual adverse effect, significant at the county level/Moderate magnitude, is probable.	Uncertainty remains over whether impacts on Binsted Rife and Tortington Rife can be adequately mitigated. A residual adverse effect, significant at the county level/Moderate magnitude is probable.

The River Arun	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	
Waterbodies (including Pond Habitats of Principal Importance)	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	
Grassland and other habitats	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	
Amphibians	No residual effects are likely. Habitat creation is likely to be successful.	Uncertainty remains over whether habitat severance can be adequately mitigated. A residual adverse effect, significant at the county level/Moderate magnitude, is probable.
Aquatic Features (fish and aquatic invertebrates)	No residual effects are likely. Habitat creation is likely to be successful.	Uncertainty remains over whether habitat severance can be adequately mitigated. A residual adverse effect, significant at the county level/Moderate magnitude, is probable.
Badger	No residual effects are likely. Habitat creation and measures to facilitate badger road crossing are likely to be successful.	
Bat (the woodland bat assemblage)	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	Uncertainty remains over whether habitat severance can be adequately mitigated as mitigation would be partly experimental and untested. Uncertainty remains over whether suitable roost replacement can be achieved given the rare bat species present and their complex tree roosting requirements. A residual adverse effect, significant at between the national or county level/Very Large to Moderate magnitude, is likely in the long-term depending which species are affected.
Birds (woodland)	The woodland bird assemblage requires mature woodland which cannot be recreated in until the long-term. A residual adverse, significant at the county level/Moderate magnitude, effect is likely to remain associated with the loss of woodland habitat.	
Birds (farmland)	No residual effects are likely habitat creation is likely to be successful in the long-term.	
Birds (wetland)	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	
Hazel dormouse	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	Uncertainty remains over whether habitat severance can be adequately mitigated as mitigation would be partly experimental (e.g. wildlife crossing structures). A residual adverse effect, significant at the county level/Moderate magnitude, is likely.
Otter	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	
Plants	No residual effects are likely. Habitat creation is likely to be successful in the long-term.	
Reptiles	No residual effects are likely. Habitat creation and translocation measures are likely to be successful in the long-term.	
Terrestrial invertebrates	The woodland invertebrate assemblage requires mature woodland which cannot be recreated until the long-term. A residual adverse effect, significant at up to the national level/Very Large magnitude, is likely to remain associated with the loss of woodland habitat.	
Water vole	No residual effects are likely. Habitat creation is likely to be successful.	Uncertainty remains over whether habitat severance can be adequately mitigated. A residual adverse effect, significant at up to the county level/Large Magnitude, is probable.
Other Notable Mammal Species	No residual effects are likely. Habitat creation is likely to be successful.	Uncertainty remains over whether habitat severance can be adequately mitigated. A residual adverse effect, significant at up to the county level/Moderate Magnitude, is probable.

7.6 GEOLOGY AND SOILS

7.6.1 The following potential impacts have been assessed, and those with non-negligible significance are discussed in more detail:

- Soil erosion as a result of new road cuttings leading to sediment loading of nearby surface water bodies;
- Soil compaction and devegetation as a result of increased hardstanding cover leading to a reduction in infiltration and an increase in surface water runoff;
- Contamination of controlled waters as a result of contaminated surface water runoff from the proposed development discharging into surface water bodies or groundwater resources;
- Creation of new migratory pathways between potentially contaminated soils and underlying aquifers through ground disturbance;
- Impacts to the health of end users arising from contact with contaminants within made ground or historical landfills and
- The introduction of contaminative materials, for example, due to inappropriate storage and use of fuels, which may impact water resources.

7.6.2 All Scheme Options are expected to result in a neutral or slight adverse effect on the geology and geomorphology within the potential development footprint plus a 250 metres buffer study area.

7.6.3 All Scheme Options are likely to result in the loss of best and most versatile agricultural land, with Option 5A resulting in the greater loss and Option 1 in the least. All options have the potential for disturbance of soils associated with clearing of Ancient Woodland sites, particularly with Options 3 and 5A. Option 1 is expected to have neutral or slight adverse effects on soils within the study area, while Options 3 and 5A are expected to have slight adverse effects.

7.6.4 All options have the potential to impact on groundwater quality through the creation of new migratory pathways for contaminants during the construction process; the risks of which will be assessed following a Ground Investigation to be undertaken in PCF Stage 3. There is a potential for slight adverse effect on groundwater quality as a result of Option 1 or a moderate adverse effect as a result of Options 3 and 5A depending on which option is chosen.

7.6.5 Neutral effects are expected on the built environment assets and on end users for all options.

7.7 MATERIALS AND WASTE

7.7.1 The following potential impacts have been assessed:

- Consumption of natural and non-renewable resources;
- Reduced need to consume primary resources; and
- Generation of and disposal of waste.

CONSTRUCTION

7.7.2 The impacts of the Scheme Options from materials and site arisings, and waste generation and disposal, are likely to occur on-site, off-site within the UK and, potentially, internationally. It is expected that most direct and indirect effects will occur during site construction and the first full year of operation. Effects arising further into the operational lifecycle are expected to be negligible for all options.

OPTION 1

7.7.3 Option 1 is expected to require the consumption of primary and secondary materials for the construction of the offline road section, and the extensive widening of the existing (online) asset. Widening of the existing A27 Arundel is also forecast to produce approximately 73,700 cubic metres of construction arisings (top soil, planings and other earthworks).

7.7.4 As a result, Option 1 is expected to result in a slight adverse effect on regional and national construction materials, a very large beneficial effect resulting from the diversion of site arisings from landfill and a neutral effect on the remaining regional landfill capacity.

OPTION 3

7.7.5 A large volume of primary and secondary materials are expected to be consumed to deliver Option 3, as it requires the construction of a new large section of major highway and supporting infrastructure. The scale of the works would also result in large scale ground works, excavation and site clearance which are likely to produce large amounts of topsoil, spoil and vegetation arisings (approximately 676,400 cubic meters).

7.7.6 The construction of Option 3 is expected to result in a large adverse effect in relation to the consumption of materials, a moderate beneficial effect resulting from the diversion of site arisings from landfill, and a slight adverse effect on the remaining regional landfill capacity.

OPTION 5A

7.7.7 The production of over approximately 459,600 cubic metres of site arisings is expected to occur during the construction of Option 5A (excluding the WCHR lanes), and a proportion may need to be exported off-site and potentially disposed of as waste.

7.7.8 Option 5A is expected to result in a large adverse effect in relation to the consumption of materials, a large beneficial effect resulting from the diversion of site arisings from landfill, and a slight adverse effect on the remaining regional landfill capacity.

OPERATION

7.7.9 The operational consumption of materials, production of site arisings, and generation and disposal of waste for all options is expected to be negligible beyond the first full year of operation.

7.8 NOISE AND VIBRATION

7.8.1 During construction, nearby noise sensitive receptors are likely to be temporarily affected by increased noise levels. During operation, the scheme has the potential to result in permanent changes to existing levels of noise and vibration levels at sensitive receptors within the study area. Potential impacts include the following:

- → Construction
  - Movement of construction plant;
  - Transport of materials and equipment;
  - Use of heavy equipment such as concrete breakers, pile drivers and earth moving equipment;
- → Operation
  - Alignment of existing roads including new slip roads;
  - Junction reconfiguration; and;
  - Changes to traffic flows, speeds, or the proportion of heavy vehicles.

CONSTRUCTION

7.8.2 As a result of the implementation of Option 1, it is likely that noise sensitive receptors in Arundel town that are located in close proximity to the Scheme may experience a significant adverse effect due to construction noise.

7.8.3 Options 3 and 5A follow a route which is primarily rural with a limited number of receptors and the distances to the nearest noise sensitive receptors are greater. Therefore, construction noise is likely to result in an adverse effect on a lower number of receptors and also likely to be of lower magnitude compared to Option 1.

OPERATION

7.8.4 The largest proportion of sensitive receptors within the defined study areas are in Arundel town. Noise from Option 1, which is largely online, is likely to have a higher impact in this area. Offline Options 3 and 5A may shift this impact toward the more rural areas to the south of Arundel. The offline options are likely to affect fewer people and noise mitigation could be incorporated more easily in new segments of the Scheme.

7.8.5 With the implementation of mitigation measures the assessment concludes that the operational impact of Option 1 reduces in the long term, from 522 dwellings in the short term subject to a major impact and therefore large adverse effects to none in the long term. In the long term there would be 709 dwellings subject to a moderate adverse impact and therefore large adverse effects. Noise contours for the long term impact in Option 1 are shown in Figure 11.12, Appendix A, A-4, Volume 2.

7.8.6 With the implementation of mitigation measures the assessment concludes that for Option 3, the major adverse impacts and therefore large adverse effects reduce in the long term from 165 to 6 dwellings. The number of properties subject to a moderate adverse impact and therefore large adverse effects is 188 dwellings in the long term. In this option, beneficial impact is predicted at properties along the existing A27, including NIAs. Noise contours for the long term impact in Option 3 are shown in Figure 11.13, Appendix A, A-4, Volume 2.

7.8.7 With the implementation of mitigation measures the assessment concludes that for Option 5A, the major adverse impacts and therefore large adverse effects reduce in the long term from 156 to 34 dwellings. The number of properties subject to a moderate adverse impact and therefore large adverse effects is 220 dwellings in the long term. Other areas that are likely to be adversely affected by Option 5A include the connection to Reynolds Lane in Slindon and the Lane towards Walberton. In this option, beneficial impact is predicted at properties along the existing A27, including NIAs. Noise contours for the long term impact in Option 5A are shown in Figure 11.14, Appendix A, A-4, Volume 2.

7.9 PEOPLE AND COMMUNITIES

7.9.1 The following potential impacts have been assessed:

- → Potential effects on all travellers; and,
- → Potential effects on communities.

CONSTRUCTION

7.9.2 Option 1 is expected to have effects on motorised travellers through increased driver stress during construction as a result of increased levels of disruptions associated with online improvements. It has not been possible to quantify the driver stress at this stage; however Option 1 would have higher impacts on driver stress than Options 3 and 5A.

OPERATION

EFFECT ON ALL TRAVELLERS

7.9.3 Views from the road are likely to remain largely the same for all Options at the western end, as they will be within cuttings or screened by vegetation. Towards the east, as the route options traverse agricultural land, views from the road are likely to be more open.

7.9.4 All options are expected to result in an overall decrease in accidents over the full road network when compared to the Do Minimum scenario with Options 3 and 5A performing significantly better than Option 1.

7.9.5 Options 3 and 5A are likely to result in the most significant reduction in driver stress (from high to low). Option 1 is not expected to perform as well (from high to low-moderate).

7.9.6 Access between communities by vehicle will not be permanently affected by Option 3 and Option 5A as all local roads would be retained through the provision of under- and over-bridges. For Option 1 some access would be restricted by the provision of a dual carriageway (see paragraph 5.6.1).

7.9.7 A number of PRoW and pedestrian, cyclist and equestrian routes will be affected by the route options. Option 5A will result in the most new severance followed by Option 3, with seven and four PRoWs respectively affected. Although journey lengths will be increased in some instances, these are routes which are largely used for recreational purposes and do not provide essential links to services. Diversion routes have been proposed as part of the Scheme Option designs to ensure journeys are still possible.

7.9.8 Option 1 will affect one PRoW which will require a diversion between Arundel Rail Station and the St Mary Magdalene Church in Lyminster. This may adversely affect users of this route; however, the improvements at Ford Road Junction and the retention of the existing A27 are anticipated to provide overall improvements to pedestrian, cyclist and equestrian facilities, therefore enabling increased community movement.

7.9.9 Pedestrian, cyclist and equestrian amenity is likely to be reduced on all options where there is interaction with PRoW or PRoW located in the vicinity of any new section of road.

EFFECT ON COMMUNITIES

7.9.10 Option 1 will have a permanent adverse impact on Arundel Riding Centre and Arundel Castle Cricket Club. Options 3 and 5A will have a significant permanent adverse impact on Billycan Camping.

7.9.11 Option 1 is also likely to result in increased severance of Arundel due to increased difficulty crossing the A27.

7.9.12 Option 5A is likely to have a significant adverse impact on Binsted Park and will require the de-registration and compensation of an area of Common Land, known as Broad Green Waste.

7.9.13 No development land is anticipated to be affected as a result of the Scheme.

7.9.14 All options require land take from agricultural land, however Options 3 and 5A require significantly more than Option 1, given their location. A detailed agricultural assessment will be carried out at PCF Stage 3.

7.9.15 Table 7.2 provides an overall summary of the impacts for each option, following mitigation during operation, which is based on the above simple assessment and professional judgement.

Table 7-2 Overall Summary of Impacts for People and Communities

	OPTION 1	OPTION 3	OPTION 5A
Motorised Travellers	Moderate Beneficial	Major Beneficial	Major Beneficial
Pedestrians, Cyclists and Equestrians	Neutral	Moderate Adverse	Moderate Adverse
Community Severance	Negligible	Minor Adverse	Minor Adverse
Tourism and Recreation	Minor Adverse	Minor Adverse	Minor Adverse
Private Property	Moderate Adverse	Minor Adverse	Minor Adverse
Community Land	Negligible Beneficial	Neutral	Moderate Adverse

7.10 ROAD DRAINAGE AND THE WATER ENVIRONMENT

7.10.1 The Scheme Options have the potential to impact the water environment during construction and operation.

7.10.2 Potential impacts to surface water features, groundwater features and flood risk during construction could arise from:

- Increased pollution risks from mobilised suspended solids, spillage of fuels or other harmful substances that may migrate to surface water and groundwater receptors;
- Impacts to the hydromorphological and ecological quality of watercourses associated with works within or in close proximity to watercourses such as the installation and alteration of culverts, bridges and outfalls as well as realignment of watercourses, including longer term changes associated with sediment deposition;
- Increased flood risks associated with temporary works within areas of fluvial flood storage, works to existing watercourse alignments and culverts, and associated with changes to catchment permeability and hydrology; and
- Removal of groundwater from the designated Secondary A aquifers through cutting dewatering, and potentially reducing the overall quantity of water in the aquifer and subsequently impact the quantification status of the designated aquifer.

7.10.3 Potential effects to surface water features, groundwater features and flood risk during operation could arise from:

- Polluted surface water runoff containing silts and hydrocarbons that may migrate or be discharged to surface water features or groundwater resources via the proposed highway drainage system;
- Permanent impact to the hydromorphological and ecological quality of watercourses associated with works within or in close proximity to watercourses such as the installation and alteration of culverts, bridges and outfalls as well as realignment of watercourses;
- Permanent impacts to catchment hydrology caused by the introduction of a barrier to natural overland flow and changes to natural catchment dynamics associated with the proposed highway alignment, highway drainage system and watercourse diversions;
- Increased flood risk to people and property elsewhere as a result of construction within areas identified to be at risk of flooding, thus impacting flood flow conveyance and reducing floodplain storage, and impact to existing flood defences;
- Betterment of flood risk to people and property elsewhere by providing a barrier to the flow of flood waters thereby reducing flood flow conveyance and flood risk;
- Flood risk to the Scheme as a result of construction within areas identified to be at flood risk;

- Increased rates and volumes of surface water runoff from an increase in impermeable area or changes to the existing drainage regime leading to a potential increase in flood risk; and
- Removal of groundwater from the designated Secondary A aquifers through cutting dewatering reducing the overall quantity of water in the aquifer and subsequently impact the quantification status of the designated aquifer.

CONSTRUCTION

7.10.4 Construction of all Scheme Options have the potential to increase pollution risk, impact hydro morphological and ecological quality of local water resources, increase flood risks associated with temporary works within the fluvial flood storage, and removal of ground water from Secondary A Aquifer through dewatering.

7.10.5 Potential construction effects associated with all Scheme Options will be managed and mitigated through the implementation of a Construction Environmental Management Plan.

7.10.6 For Option 1, the greatest risks to water quality will be associated with works within the channel of the River Arun. It is proposed within Option 1 to extend the current River Arun road bridge to allow for the dual carriageway. There will be minimal work over the river and the integrity of the flood defences will be maintained. At this time, the magnitude of the potential risk to the quality of the water environment is considered likely to be negligible to minor adverse. Given the high importance of this feature, the significance of effect is likely to be slight adverse.

7.10.7 For Option 3, it is likely that risks to the quality of the water environment can be largely mitigated during construction through the implementation of a Construction Environmental Management Plan. However, Option 3 will require a new bridge across the River Arun and risks to water quality will be difficult to mitigate entirely. The effect significance of the effect is likely to be moderate adverse.

7.10.8 For Option 5A, it is likely that risks to the quality of the water environment can be largely mitigated during construction through the implementation of a construction environmental management plan. However, Option 5A will require a new crossing across the River Arun to the south of Binsted Wood and this will require works within or in close proximity to the river channel that will be difficult to mitigate entirely. Given the medium importance of these features, the significance of effect is likely to be moderate adverse. Effects associated with construction activities are likely to be temporary.

OPERATION

7.10.9 Option 1 has the potential to have a slight adverse effect on the River Arun and other surface water features as a result of increased risks to ecological, chemical and hydro morphological quality. During the operational phase (with mitigation) neutral effects are expected on the flood plain and the superficial Secondary A Aquifer from the implementation of Option 1. The significance of effects on fluvial and tidal flood flow conveyance east of Arun Valley Railway is considered large to very large adverse. However, with the implementation of mitigation measures the significance of effects is likely to be neutral. Additionally, the works are unlikely to pose significant effects to the hydro morphological and ecological quality of affected watercourses. The crossing of the existing land drains in the vicinity of the Arun Valley Railway may remove ecological habitat and affect connectivity, although the existing A27 and Arun Valley Railway will already provide a barrier to the movement of aquatic species and therefore the effects are likely to be negligible. The resulting significance of effect is likely to be neutral.

7.10.10 Option 3 poses risks to water quality in the River Arun, other watercourses and groundwater that may receive the discharge of runoff from the Scheme will be mitigated by the proposed surface water drainage system that will include appropriate pollution control measures. These measures are likely to require multiple stages of treatment prior to discharge in accordance with best practice and the Sustainable Drainage Systems design manual. The effect magnitude is likely to be negligible, with a significance of effect of neutral. Embedded design mitigation measures addressing the risk of flooding on the Arun floodplain would be required for both the embankment and viaduct options of the scheme. The incorporation of appropriate mitigation measures could reduce the significance of effect to neutral for both options.

7.10.11 For option 5A, the works within Fowler's Copse, Binsted Wood and Tortington Common, and between Ford Road and the Arun Valley Railway, may have an impact to the hydro morphological and ecological quality of the watercourses and drains within this area prior to mitigation by removing sensitive habitats and severing connectivity. The significance of effect is anticipated to be neutral with the application of mitigation measures. Incorporation of design mitigation measures could reduce the significance of flooding on the Arun floodplain from moderate adverse to neutral.

7.11 CLIMATE CHANGE

7.11.1 There is insufficient information to accurately assess the magnitude or significance of greenhouse gas emissions at this early stage in the scheme development and further detailed assessment of greenhouse gas emissions (GHG) is to be undertaken at PCF Stage 3. The following potential impacts have been assessed:

- Greenhouse gas; and,
- Climate resilience.

7.11.2 Based on the information available and the assumptions and limitations described, it is expected that the order of magnitude of greenhouse gas emissions will be as follows;

- Option 5A; greatest magnitude of emissions followed by:
- Option 3; second greatest magnitude of emissions and
- Option 1: lowest magnitude of greenhouse gas emissions (net reduction).

7.11.3 The design of each option is not sufficiently advanced to complete any further assessment of climate resilience at this stage.

7.12 CUMULATIVE EFFECTS

7.12.1 This section provides a summary of the key cumulative effects identified for the Proposed Scheme. The baseline for each environmental topic is described in Sections 2.9 to 2.18.

7.12.2 There is the potential for cumulative effect on built heritage, townscape and visual receptors, resulting from the combination of, or interaction between, the A27 Arundel improvements and the committed Schemes in close proximity to the site. The cumulative impacts associated with these Schemes will be considered in more detail in PCF Stage 3.

7.12.3 As well as cumulative effects, there is a possibility of in combination effects between various disciplines. A full assessment of combined impacts will been to be undertaken at PCF Stage 3.

8 SUMMARY OF OPERATION AND MAINTENANCE ASSESSMENT

8.1 OPERATIONAL ASSESSMENT

8.1.1 Option 3 and 5A would significantly improve the operational performance of the road network by reducing accidents, minimising delays and maintaining traffic flows. Traffic movements would not be subjected to the existing waiting periods at the traffic signals at Crossbush junction or the signalised pedestrian crossing at Arundel Railway Station, or to delays at the Causeway and Ford Road roundabouts. The key operational design criteria applicable to Option 3 and 5A are as follows:

- Dual two lane all-purpose road operating at the national speed limit
- 1m hard strips provided;
- Clearway provided;
- Grade separated junctions;
- No junctions with local roads, thereby reducing delays along the A27;
- No right turning movements;
- No direct public exposure; and
- WCHR will be permitted on scheme facilities but not proposed along the carriageway.

8.1.2 Option 1 would not have a sufficient improvement in operational performance with the layout at Ford Road junction presented at the public consultation due to the operational performance issued reported in Section 6. There would be some improvements as traffic movements would not be subjected to the existing waiting periods at the traffic signals at Crossbush junction or the signalised pedestrian crossing at Arundel Railway Station, or to delays at the Causeway roundabouts. Other key operational design criteria are reduced on the online section of the route to reduce impact on properties and ancient woodland as follows:

- Reduced cross section with no hard strips;
- Left in left out at local accesses;
- Direct access from properties along the existing A27;
- Traffic signal controlled junction at Ford Road roundabout with at grade pedestrian crossing facilities;
- Uncontrolled at grade pedestrian crossing facilities;
- Bus laybys and bus stops;
- WCHR facilities alongside the dual carriageway;
- Reduced alignment standard; and
- Lower speed limits.

8.1.3 Other operational factors relevant to the scheme design include:

- Highways England's upcoming Expressway standards are not proposed to be applied to the scheme;
- Due to its location no laybys are proposed along the route;
- No new technology systems are proposed on the scheme; and

→ The Traffic Officer Service (TOS) do not operate on the A27.

8.2 MAINTENANCE REPAIR STRATEGY STATEMENT

8.2.1 A Maintenance and Repair Strategy Statement has been prepared which identifies the key maintenance issues for the proposed scheme.

8.2.2 Maintenance requirements for the A27 Arundel Bypass would lead to a change in the workload for Highways England and it's Maintenance Service Providers (MSPs), due to the construction of a new route. However, it is not anticipated that scheme would have an impact on the Highways England maintenance methods of the A27. New and existing maintainable assets will be of familiar form to MSPs.

8.2.3 Each option would cross a Zone 3 floodplain at the River Arun. Proposals include either a shallow embankment or, for Options 3 and 5A, a 1.5km long viaduct. The floodplain is known to be underlain with soft soils which would require ground treatment to reduce settlement and any risk of ongoing maintenance problems. An embankment would require protection against flooding which would require regular inspection for possible damage.

8.2.4 The impact of the scheme on maintenance responsibilities of the Local Highway Authority in the surrounding areas would also need to be considered, as a result of the de-trunking of the bypassed section of the existing A27. The length of the existing A27 to be de-trunked would vary with the different route options.

8.2.5 The primary distinguishing aspect identified at this stage between the three options is that for Option 3 and Option 5A the existing A27 could be used as an alternative route for planned and unplanned events providing greater resilience. This would not be the case for Option 1, and any diversion would be longer in order to keep traffic on major county roads thus avoiding minor roads. Further consultation with MSPs will take place as detail becomes available during preliminary design of the preferred route.

8.2.6 The existing A27 would still be required to be maintained but with responsibility transferred to West Sussex County Council. As part of the handover process the condition of the existing assets would be considered and provisions made where necessary. The length of the existing A27 to be transferred would vary with the different route options.

8.3 SAFETY MANAGEMENT

8.3.1 A Project Safety Plan has been prepared for this scheme. The key outcomes of this plan are reproduced below.

8.3.2 Interim Advice Note (IAN) 191/16 Safety Governance for Highways England (Highways England, March 2016) provides guidance on the selection and implementation of the appropriate safety management system for a scheme based on several criteria. The types of Safety Management System referred to in IAN 191/16 are:

→ Type A – Basic. This is likely to apply to projects/interventions that are routine, familiar and without operational implications. As such, these will be largely satisfied by the application of existing standards and guidance.

→ Type B – Moderate. This is likely to apply to:

- Projects/interventions that could have some significant operational impacts.
- Those which may lead to an increased level of stakeholder interest (specifically in terms of how safety will be addressed or managed).
- This will include the application of existing standards and guidance.

- Type C – Complex. This is likely to apply to:
  - Complex, infrequent projects/interventions which may have major implications for the strategic road network.
  - This will include the application of existing standards and guidance.

8.3.3 The result of the classification process for the A27 Arundel Bypass scheme deems that whichever route option is chosen, the scheme should be subject to a Type A Safety Management System (SMS), with two Type B features.

8.3.4 The preferred A27 Arundel Bypass scheme will satisfy the road user safety objective if it is demonstrated from the Post Opening Performance period that:

- The average number of Fatalities and Weighted Injuries (FWI) casualties per year is less than the safety baseline,
- The rate of FWI per billion vehicle-miles per annum is no more than the safety baseline.
- For each link, no population (eg car drivers, pedestrians, HGV drivers and motorcyclists) is disproportionately adversely affected in terms of safety and risk to each population remains tolerable.

9 SUMMARY OF PUBLIC CONSULTATION

9.1 SCOPE AND OBJECTIVES

9.1.1 As part of PCF Stage 2, a non-statutory public consultation is typically carried out in order to allow for members of the public, statutory stakeholders and other bodies to express their views at an important stage in the scheme development process.

9.1.2 A non-statutory public consultation ran for 8 weeks, from Tuesday 22 August to Monday 16 October 2017 .

9.1.3 The objectives of the consultation were to :

- raise awareness and inform local residents, businesses and stakeholder organisations about the A27 Arundel Bypass public consultation
- raise awareness of the wider A27 improvements programme
- encourage participation from all local groups, including vulnerable and hard-to-reach groups
- provide fully accessible public consultation events and materials so that people are able to understand the proposals and make informed comments on them
- provide the public with the necessary information to understand the options, the process through which the scheme must follow and how the project team has arrived at the options. Present the options clearly including the perceived benefits and / or dis-benefits of each option.
- provide sufficient opportunities for all people who may have an interest in, or may be impacted by, the scheme to provide feedback
- facilitate feedback on the proposals by providing people with the opportunity to have their say
- produce an informal non-statutory Public Consultation Report. The report will be used to help determine a preferred route

9.1.4 Within the eight week public consultation period, eight public exhibitions were held at venues across the Arundel area. The exhibitions were drop in sessions, with experts on hand to address queries raised. There were also unmanned exhibitions that ran for two weeks in various locations in the scheme area. In addition, three invite-only events were held for the media, MPs/Councillors, key stakeholders, landowners and businesses.

9.1.5 Brochures and questionnaires on the scheme were available at deposit points (located in local public and community venues), at the public consultation exhibitions, at the unmanned exhibitions, and online.

9.1.6 Questionnaires were made up of both open (free-text format) and closed questions (where respondents select their answer from a pre-defined list).

9.2 QUESTIONNAIRE RESPONSES

9.2.1 A total of 2821 questionnaires were received during the consultation period. The majority (72%; 2029 responses) were responded to online, with just over one-quarter (28%; 792 responses) completed on paper.

9.2.2 As not all respondents answered each question, and some selected more than one answer, the figures in the tables and text below are based upon the number who responded to the question.

9.2.3 Most of the respondents are local residents in the Arundel area, accounting for 75% of responses. This was followed by those who just travel through the area at 21%, those that work in the area at 7%, visitors to the area at 5%, those who are acting on behalf of a local business at 4%, those who are acting on behalf of a community organisation at 2%, those who selected other at 5% and those who preferred not to say at 1%.

9.2.4 Respondents were asked how they currently use the A27, to provide an understanding of the length and type of journeys that are undertaken on the road. The majority of respondents stated they use the A27 for local trips (up to 10 miles), however this was only a 5% difference to the longer distance trips (over 10 miles). Table 9-1summarises these findings. The closeness between local and long distance trips reinforces the importance this section of A27 has for a wide range of journeys .

Table 9-1 Number and % of respondents by typical trip distance

RESPONSE	FREQUENCY	PERCENTAGE
Local (up to 10 mile trip)	1420	52%
Longer distance (more than 10 miles trip)	1298	47%
Both	22	1%
TOTAL	2740	100 %

9.2.5 The mode in which respondents travel through the area is mainly by driving in a car or van at 90%, this was followed by 45% walking, 30% using the train, 28% a passenger in a car or van, 21% cycling, 9% travelling by bus, 3% by motorcycle, and 3% by other means. Respondents were allowed to select more than one answer so the sum of percentages exceeds 100%. These results highlight the importance of the car or van to travel through the area. However, there is also a notable proportion of WCHRs, despite the limited availability of infrastructure and the dispersed locations of urban areas.

9.2.6 Respondents were asked how concerned they are on a number of existing issues on the A27 at Arundel. Table 9-2 summarises the numbers that had a degree of concern (either very concerned or slightly concerned) to the issues that were listed in the questionnaire.

Table 9-2 Concerns in relation to existing issues on the A27

ISSUE	FREQUENCY	PERCENTAGE
Effects of A27 traffic on environment	2388	90%
Accommodating traffic from development	2342	89%
Congestion/ delays at junctions	2350	88%
Journey times/journey time reliability	2235	85%
Displacement of traffic onto local roads	2260	86%
Road safety	2212	85%
Connections along coast and to other parts of the country	2075	79%
Ease of turning onto or off the A27 from local roads	2045	78%
Crossing the A27 on foot or cycle	1904	72%

9.2.7 Table 9-2 shows that respondents are most concerned with the effects the traffic on the A27 has on the environment, accounting for 90% of responses. This was closely followed by concerns with the A27 accommodating extra traffic from housing and economic development at 89%. Crossing the A27 on foot or cycle sees a lower number with concerns, however the percentage is still high at 73%. This illustrates the broad range of concerns in relation to the A27 in this area.

Table 9-3 Need for a scheme to upgrade the A27 at Arundel to a dual carriageway

RESPONSE	FREQUENCY	PERCENTAGE
Strongly agree	1840	66%
Agree	360	13%
No feeling either way	108	4%
Disagree	176	6%
Strongly disagree	279	10%
Don't know	12	<1%
TOTAL	2775	100%

9.2.8 Respondents were asked whether they believe there is a need for a scheme to upgrade the A27 at Arundel to a dual carriageway.

9.2.9 Table 9-3 shows that 79% agree to some degree that the A27 should be upgraded to dual carriageway, compared to 16% who disagree to some level. 1% responded as not knowing.

9.2.10 Respondents were asked which option they support out of the three that were taken forward to consultation. They also had the option to say they didn't support any option, but there were still issues to address, or that they didn't support any option and that nothing should be done. Table 9-4 summarises these figures. As it can be seen, the majority of respondents support Option 5A, at 48%, followed by Option 1 at 27% and Option 3 at 23%. 16% of respondents think that no option is suitable. Some respondents ticked more than one option.

Table 9-4 Option support

RESPONSE	FREQUENCY	PERCENTAGE
Option 1	764	27%
Option 3	662	23%
Option 5A	1357	48%
None of these options, but there are issues that need to be solved	330	12%
No option; nothing should be done	104	4%
TOTAL RESPONSES	2821	100%

9.3 STAKEHOLDER RESPONSES

9.3.1 There were a total of 134 stakeholder responses, 52 of these were via letter or email, and the remaining 82 were identified from the questionnaires.

9.3.2 Stakeholders have been categorised into a series of groups as part of the analysis of these responses. Table 9-5 outlines the numbers within each stakeholder group who show their support or objection to the need for the scheme.

Table 9-5 Stakeholder categories and level of support for the need for a scheme

GROUP	TOTAL	SUPPORT	%	OBJECT	%	NEUTRAL	%
Local Authority	7	7	100%	0	0%	0	0%
Political / Elected Member	10	7	70%	3	30%	0	0%
Parish Councils	13	13	100%	0	0%	0	0%
Environmental Groups	22	2	9%	18	82%	2	9%
Businesses & Business Organisations	43	38	88%	5	12%	0	0%
Education Centres	6	6	100%	0	0%	0	0%
Emergency	2	1	50%	0	0%	1	50%

GROUP	TOTAL	SUPPORT	%	OBJECT	%	NEUTRAL	%
Services							
Transport / User Groups	15	7	47%	6	40%	2	13%
Community Groups	10	8	80%	2	20%	0	0%
Religious Groups	4	3	75%	1	25%	0	0%
TOTAL	132	92	70%	35	26%	5	4%

9.3.3 Table 9-5 shows that the majority of stakeholders support the need for a scheme, with 69% of responses. In contrast, there are 27% who object, and only 3% who are neutral. The groups that are the most supportive are the Local Authorities, Parish Councils, and Education Centres, with all of their responses (100%) agreeing that there is a need for a scheme. In contrast, the only group who disagrees more than supports that a scheme is needed are the Environmental Groups, with 82% of respondents objecting. Engagement with Environmental Groups has been a key focus during PCF Stages 1 and 2 are these key issues will inform the continued development and selection of the preferred scheme.

9.3.4 Table 9-6 summarises the number of stakeholders within each group who have stated their support for one or more of the three options.

Table 9-6 Stakeholders who show support for one or more of the options

GROUP	SUPPORT OPTION 1	%	SUPPORT OPTION 3	%	SUPPORT OPTION 5A	%
Local Authority	0	0%	0	0%	6	86%
Political / Elected Member	0	0%	5	50%	5	50%
Parish Councils	1	8%	4	31%	10	83%
Environmental Groups	2	9%	0	0%	0	0%
Businesses & Business Organisations	5	12%	14	33%	25	58%
Education Centres	3	50%	1	17%	3	50%
Emergency Services	0	0%	1	50%	1	50%
Transport / User Groups	2	13%	0	0%	5	33%
Community Groups	3	30%	1	10%	5	50%
Religious Groups	1	25%	1	25%	2	50%
TOTAL	17	13%	27	20%	62	47%

9.3.5 Nearly half of the stakeholders (47%) support Option 5A. The group that is the most supportive of this option are the Local Authorities with 86% of responses. This was closely followed by Parish Councils (83%). There are 20% of stakeholders that show support for Option 3, with the most supportive groups being Political/ Elected Members and Emergency Services, each with 50% of responses. Option 1 sees the least amount of support, with only 13% of responses. The most supportive of this option are the Education Centres, with 50% of their responses supporting this option .

9.3.6 The proportion of support between the stakeholder feedback and questionnaire responses differs slightly, with the exception of Option 5A. Both stakeholders and questionnaire respondents expressed the most support towards Option 5A. However, stakeholder's second highest level of support was towards Option 3, whereas for questionnaire respondents, it was Option 1.

9.3.7 In contrast, Table 9-7 summarises the number of stakeholders within each group who object to one or more of the three options.

Table 9-7 Stakeholders who object to one or more of the options

GROUP	OPPOSE OPTION 1	%	OPPOSE OPTION 3	%	OPPOSE OPTION 5A	%
Local Authority	0	0%	0	0%	0	0%
Political / Elected Member	6	60%	3	30%	3	30%
Parish Councils	0	0%	0	0%	2	15%
Environmental Groups	17	77%	19	86%	19	86%
Businesses & Business Organisations	8	19%	6	14%	7	16%
Education Centres	0	0%	2	33%	3	50%
Emergency Services	0	0%	0	0%	0	0%
Transport / User Groups	5	33%	5	33%	5	33%
Community Groups	1	10%	2	20%	3	30%
Religious Groups	2	50%	3	75%	1	25%
TOTAL	39	30%	40	31%	43	33%

9.3.8 Almost one third of stakeholders oppose one or more of the options, with only a 3% difference in opposition between the three options. 33% of the responses expressed opposition towards Option 5A, with the Environmental Groups voicing the most objection with 86% of their responses. Option 3 receives objection from 31% of responses. Similarly, the Environmental Groups voice the most opposition (86%). Option 1 sees 30% of stakeholders objecting, with the Environmental Group again expressing the most objection with 77% of responses.

9.4 OTHER RESPONSES

9.4.1 There were a total of 518 responses that are classified as ‘other responses’, predominantly comprising those from local residents. These responses were coded in order for analysis to take place. Table 9-8 summarises and compares the most common codes for each option. A total of 465 comments were received for Option 1, 428 comments on Option 3, and 820 comments on Option 5A. The percentages are worked out based on the totals for each option, rather than the overall written response total.

Table 9-8 Other responses

DESCRIPTION	OPTION 1 %	OPTION 3 %	OPTION 5A %
Support this option / will improve the current situation / provides a solution	5%	4%	7%
Second preference	-	3%	-
Do not support this option / the worst option	17%	34%	23%
Consider alternative route / location / timing	13%	-	-
Less environmental impact (general)	8%	-	-
Concerns about environmental impact (general)	5%	5%	5%
Concerns about environmental impact (biodiversity, habitats & animals etc.)	2%	25%	17%
Concerns about environmental impact (South Downs National Park)	-	3%	4%
Concerns about environmental impact	-	2%	2%

DESCRIPTION	OPTION 1 %	OPTION 3 %	OPTION 5A %
(archaeology & cultural heritage)			
Concerns about environmental impact (landscape – visual)	-	2%	3%
Concerns about environmental impact (Binsted Woods)	-	2%	2%
Concerns about environmental impact (noise)	-	-	3%
Less of a negative impact / least disruptive compared with the others	3%	-	-
More information is required	8%	-	-
Offers the best value for money / most cost effective	8%	-	-
Should be single carriageway (particularly through Arundel)	2%	-	-
Minimises the impact on local villages	-	2%	-
Concerns about impact on local villages	-	-	2%
Concerns about impact on Arundel (general)	2%	-	-
Concerns about impact on Arundel (severance / splits Arundel)	3%	-	-
Concerns about impact on Walberton	-	-	2%
Concerns about impact on Binsted	-	3%	9%

9.4.2 The most supportive remarks were received for Option 5A with 58 comments (7%), compared to 23 comments (5%) for Option 1, and 17 comments (4%) for Option 3.

9.4.3 Conversely, Option 3 saw the highest quantity of comments that do not support the option, receiving 145 comments (34%), followed by Option 5A with 186 comments (23%), and lastly Option 1 with 80 comments (17%).

9.4.4 Environmental concerns feature heavily with all three options. General concerns about the environmental impact are spoken about in relation to Option 1 (23; 5%), Option 3 (20; 5%) and Option 5A (45; 5%). More specifically, there are a large quantity of concerns on the environmental impact on biodiversity, habitats and animals, which featured in relation to Option 3 (107; 25%) and Option 5A (142; 17%). Other environmental concerns include the impact on archaeology and cultural heritage, landscape, Binsted Woods, and noise. In contrast, Option 1 received comments on the option having the least environmental impact with 37 comments (8%), as well as being the least disruptive in comparison to Option 3 and Option 5A, with 16 responses (3%).

9.4.5 There are concerns with all three options on the impacts they have with nearby towns and villages. Specifically, the impact on Binsted was made in relation to Option 3 (14; 3%) and Option 5A (73; 9%). There were also concerns on the impact on Walberton with Option 5A, with 16 comments (2%). Option 1 saw comments on the concerns the option had with the impact on Arundel (8; 2%), and specifically causing severance of the town (16; 3%). On the other hand, there were 8 comments (2%) on Option 3 minimising the impact on local villages.

10 SUMMARY OF POST CONSULTATION DEVELOPMENT

10.1 INTRODUCTION

10.1.1 Following the conclusion of the public consultation various modifications to the three route options were developed and considered for inclusion within a preferred route. This review was informed by the concerns raised at the public consultation summarised in Chapter 9 and by additional environmental surveys carried out in 2017. Importantly, these modifications include options that would avoid or reduce impact on Ancient Woodland in the light of the responses received from Natural England and Forestry Commission along with consultation feedback from others about potential impacts on Ancient Woodland.

10.1.2 A series of workshops were held at which the modifications were reviewed and their performance against key selection criteria were assessed including compliance with key policy tests contained within the NNNPS, the project objectives and environmental, economic, social and engineering factors.

10.1.3 This review was not informed by the changes to the layout to the junction at Ford Road in Option 1 from the operational modelling described in 6.2.22 as this was not yet completed.

10.1.4 Due to the alignment of Option 3 through Tortington Common it was concluded that there is very limited opportunity with Option 3 to reduce the environmental impacts on the Ancient Woodland to levels comparable to the other options and so the further design development focused on Option 1 and Option 5A.

10.2 MODIFICATIONS TO ROUTE OF OPTION 1

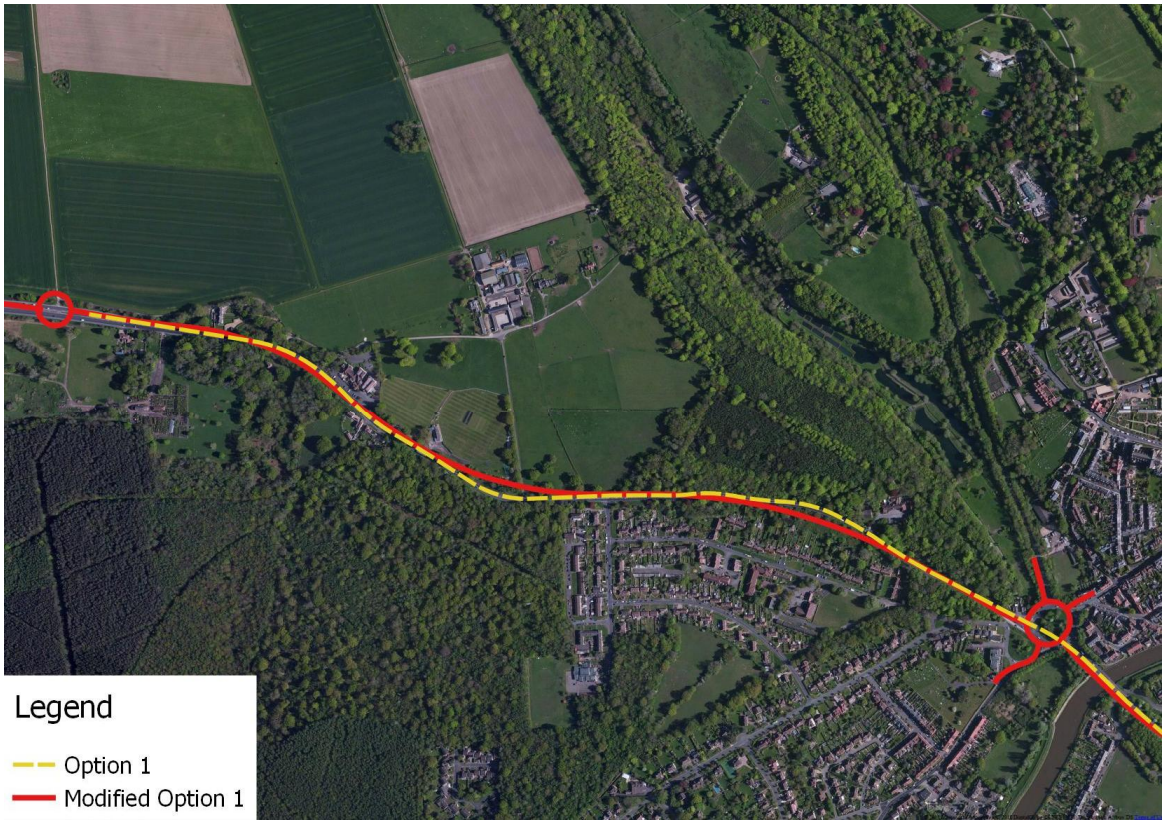
10.2.1 Various modifications to Option 1 were developed to reduce the impact on Ancient Woodland and to improve the operational performance of the route. The modifications developed are summarised below:

Table 10-1 Modification to Public Consultation Option 1

OPTION	LOCATION	CHANGE
Option 1(V)	Ford Road roundabout to western tie -in	The alignment of the route between the Arundel District and Community Hospital and the White Swan Public House was moved away from the Ancient Woodland located alongside the existing A27. This would result in additional land take from the White Swan Hotel and Arundel Cricket ground and the route moving closure to properties located along DD.
Option 1(V)	Ford Road roundabout to western tie-in	Gaps in the central reserve where removed. An additional at grade roundabout would be provided in the vicinity of the existing transition from single carriageway to dual carriageway to provide for the local traffic movements that would be affected. This would increase the length of some local movements but would improve the safe operation of the route. Removing the central reserve gaps and right turning facility would also reduce the impact on the Ancient Woodland.

10.2.2 The centre line of the revised alignment compared to the public consultation route alignment is shown in Figure 10-1.

Figure 10-1 Centre Line of Modified Route Option 1(V)



10.3 MODIFICATIONS TO ROUTE OF OPTION 5A

10.3.1 A number of modifications to Option 5A were developed following the public consultation with the aim of both improving the options performance against key policy tests in the NNNPS and developing modification to the proposed junction at the western end of the scheme to address comments received during the public consultation. These are summarised below:

Table 10-2 Modification to Public Consultation Option 5A

OPTION	LOCATION	CHANGE
5A(V3)	River Arun Crossing and Tortington Priory	The alignment of Option 5A was moved away from Tortington Priory scheduled monument to reduce the scale of the infrastructure adjacent to the site while still maintaining appropriate design standards and limiting the extent of the change in alignment The revised alignment would bring the route closer to Broad Green Cottages. The revised centre line is shown in Figure 10-2
5A(V3)	Western tie-in Junction with existing A27	The junction at the western tie in was modified to provide separate two way local roads to Yapton Lane and Shellbridge Lane from the junction. This would remove the conflicts with traffic entering and leaving the A27 that could occur with the public consultation layout. To reduce impacts on Ancient Woodland at Hundred Acre Copse the layout would be made more compact using retaining walls. The revised junction layout is illustrated in Figure 10-3
5A+	Western tie-in Junction with existing A27	The alignment at the western end of Option 5A was moved away from the Ancient Woodland at Hundredhouse Copse to form an at grade roundabout junction located nearer to the existing junction at Binsted Lane. Operational assessment of the roundabout showed that it would need to be partially controlled by traffic signals. The centre line of the revised layout is shown in Figure 10-4
5A+	River Arun Crossing and Tortington Priory	As 5A(V3). The revised centre line is shown in Figure 10-2

Figure 10-2 Centre Line of Modified Route Option 5A(V3)

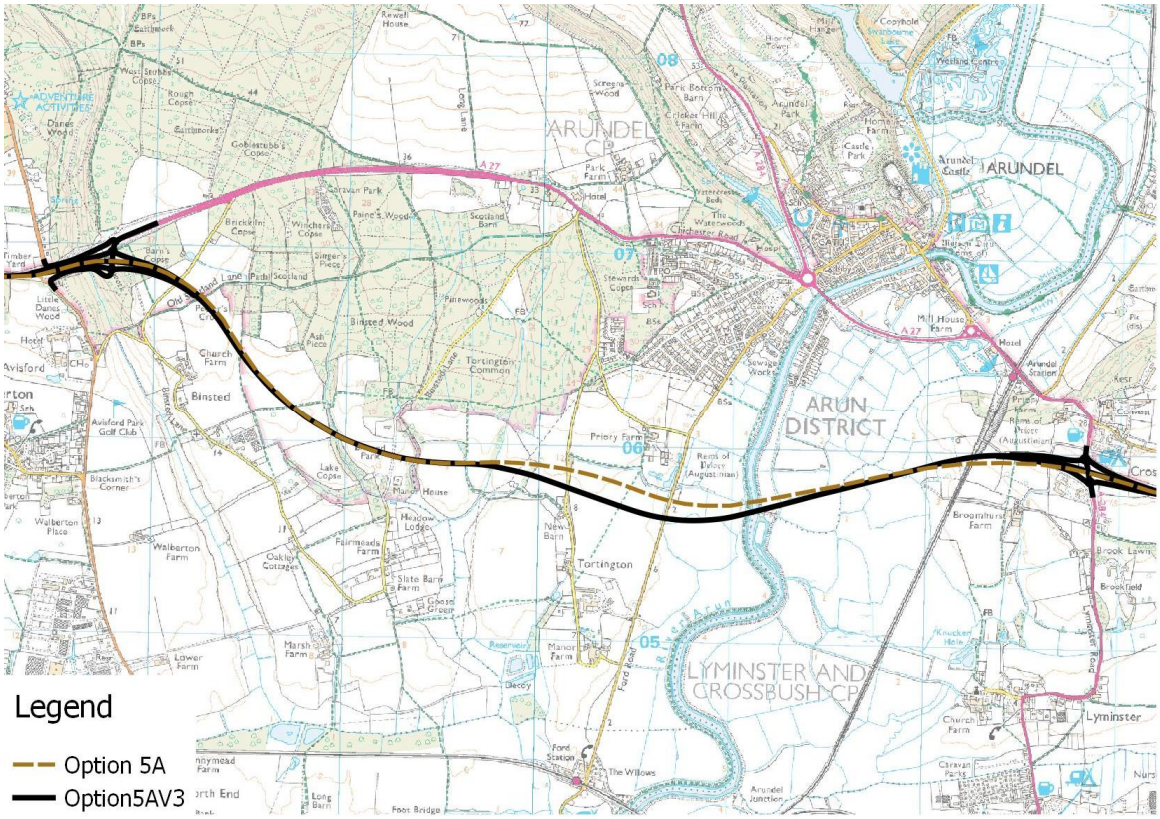


Figure 10-3 Centre Line of Modified Route Option 5A+

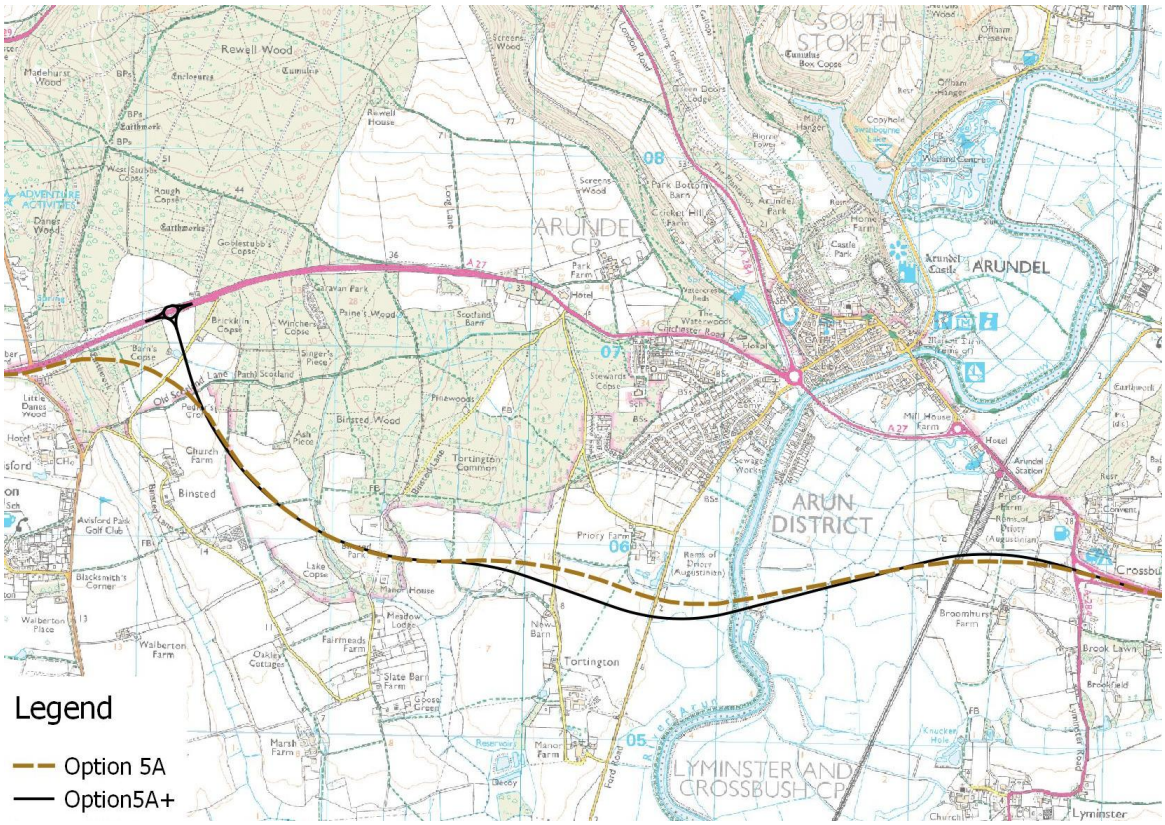
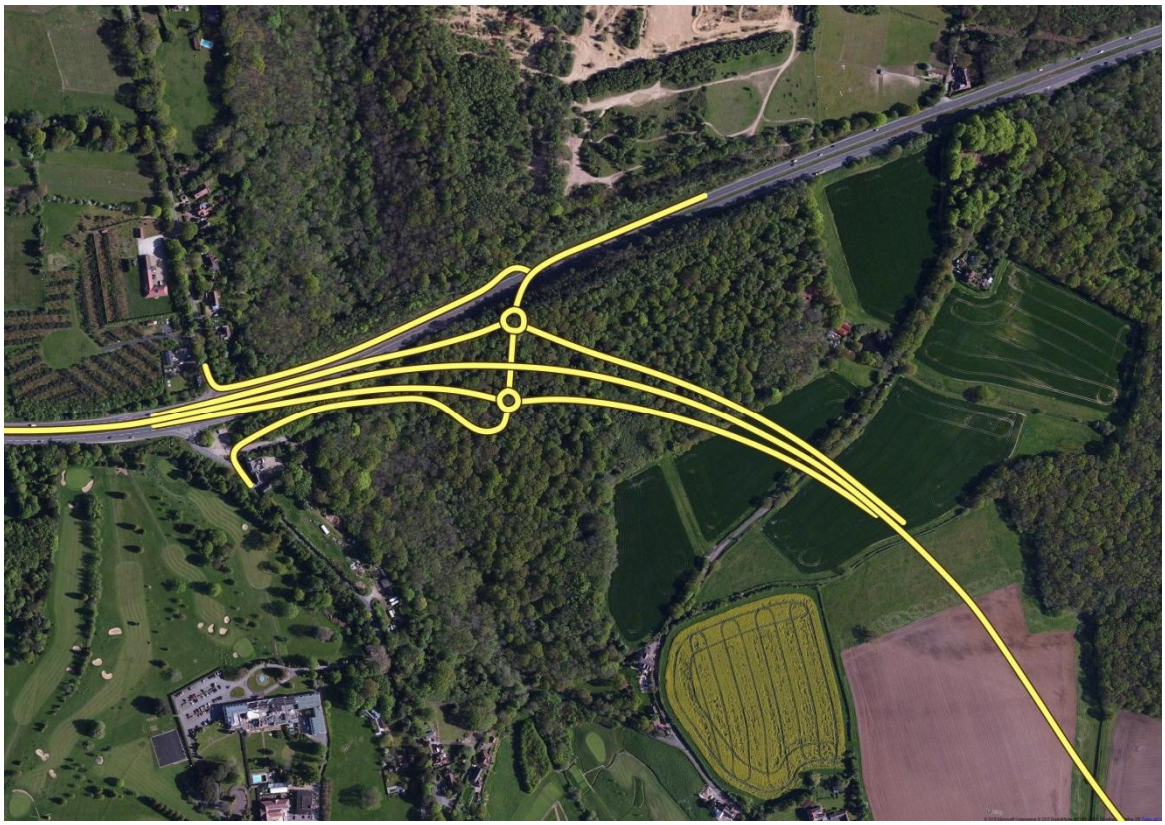


Figure 10-4 Modified Option 5A(V3) Western Tie in Junction



10.4 REVIEW OF MODIFIED OPTIONS

10.4.1 The modified route options were compared using a pairwise comparison process with the equivalent public consultation option. The comparison was made based on an assessment of the performance of the routes on a number of key selection criteria including compliance with key policy tests contained within the NNNPS, the project objectives and environmental, economic, social and engineering factors. This included an initial economic assessment of the modified routes and an assessment of the implications of the modified route on the environmental assessment of the public consultation options which had been developed through Stage 2. To ensure that relevant consideration in the NNNPS were included in the process the Planning Statement & National Policy Statement Accordance table was completed and used to inform the process. More details can be found in the Value Management Workshop Report[41].

10.4.2 The findings of the comparisons were then reviewed at a Value Management Workshop. The conclusions of the workshop are summarised below:

- Option 1(V) performed better than the public consultation option due to the significantly reduced impact on Ancient Woodland, improved NNNPS compliance and improved safety performance. Nevertheless, it still results in the loss of Ancient Woodland
- Option 5A+ performed better because it avoided direct impact on Ancient Woodland but it still had significant problems with compliance with NNNPS and the drop in economic performance was significant. The operational performance of the roundabout junction was also not satisfactory and would not meet the project objectives in terms of improving capacity and reducing congestion. This change was therefore not recommended to be adopted.
- Option 5A(V3) – The revised alignment at Tortington Priory performed better than the alignment showed at public consultation due to a reduced impact on the site of the Priory. The change in alignment was therefore recommended to be adopted. The review concluded that modifications to the western tie in junction public consultation layout would be needed. Option 5A(V3) was preferred from an operational perspective and addressed the concerns raised at the public consultation and would reduce the impact on the Ancient Woodland.

10.4.3 Option 1(V) would still result in some loss of Ancient Woodland. It would have the same impacts as Option 1 for cultural heritage (large adverse) and landscape (moderate adverse).

10.4.4 Option 5A(V3) would still have significant impacts including loss of Ancient Woodland. Further Option 5A(V3) would require extensive use of retaining wall to achieve this reduction. Further work would therefore be needed in Stage 3 on the type, layout and location of the junction to reduce the impact of the route further.

10.4.5 General layout drawings for Option 1(V) and Option 5A(V3) are given in Appendix C contained in Volume B.

10.5 FURTHER DEVELOPMENT OF OPTION 1 FORD ROAD JUNCTION

10.5.1 The operational modelling results reported in Section 6 indicate that, with Option 1, the proposed Ford Road Junction does not operate within capacity in 2041. The junction exceeds capacity as a result of a marked increase in forecast traffic volume at the junction in PCF Stage 2 when compared with the forecast flows in PCF Stage 1.

[41] HE551523-WSP-GEN-A27A-PCF2-ZM-0014

10.5.2 The PCF Stage 2 SATURN model currently under-represents the delays which may potentially remain on the scheme section of the A27 - specifically at Ford Road Roundabout - for the current Option 1 scheme design. Consequently, the consulted on A27 Arundel Bypass (Option 1) scheme, as currently designed, is not likely to accrue the benefits currently suggested by the strategic SATURN modelling and the subsequent economic assessment of the scheme. This has implications not only for journey time and vehicle operating cost impacts, but also for other impacts which take the SATURN modelling results as their input. These include air quality, noise and greenhouse gas impacts as well as accidents and wider economic impacts which would be all affected.

10.5.3 As a result of the aforementioned issues, further work was undertaken following the public consultation to identify alternative solutions at the Ford Road Junction that would provide sufficient capacity. These included both an enlarged traffic signal control gyratory with a “through about layout” and provision of a flyover for the mainline A27 with different slip road configurations. The alternative options are outlined in the subsequent sections.

10.5.4 Details of the strategic and operational modelling assessments of the alternative design solutions, for the Ford Road roundabout, are presented in the technical note titled A27 Arundel Bypass PCF Option Stage 2 – Option 1 Assessment: Technical Note, April 2018. The relevant sections from this technical note have been presented below for ease of reference. Environmental impacts of the alternative design options for the Ford Road roundabout are explored in the technical note titled Option1 Variants – Preliminary Environmental Assessment, April 2018.

FLYOVER WITH FOUR SLIP ROADS (OPTION 1E)

10.5.5 The concept drawing of the junction arrangement with all eastbound and westbound slip roads is presented below in Figure 10-5.

Figure 10-5 Concept layout - flyover with all slip roads

10.5.6 The key points to note in relation to this layout include:

- This arrangement will allow all movements to be made at the Ford Road junction
- The junction will have an at-grade circulatory carriageway with slip roads ramping up and down to tie in to the A27 eastbound and westbound sections. The footprint of the existing roundabout has been expanded to accommodate the design concept.
- The eastbound off-slip and the westbound on-slip will encroach on an area of approximately 0.6 ha designated as Ancient Woodland
- The A27 eastbound off-slip would interact with the Arundel and Community Hospital access. This access would need to be closed due to its proximity to the junction slip roads and an alternative access provided via a service road.
- Access to the residential area in the South-West of Arundel will be affected, and will include the closure of Torton Hill Road

- The existing access from Fitzalan Road and the A27 would need to be closed. Traffic from Fitzalan Road residential catchment would have to use the alternative access that meets with The Causeway. This route is substandard with height restrictions under the existing A27 bridge and width constraints as a result of residential properties abutting the carriageway along majority of its length. Width constraints are compounded by on street parking at many locations. Queens Lane (which the Fitzalan Road ties into) junction with The Causeway suffers from geometric constraints including poor visibility.
- Fitzalan Road alignment under the bridge would also potentially clash with the A27 westbound off-slip and eastbound on-slip.
- This option assumes that the existing A27 between Ford Road roundabout and the Causeway roundabout will become redundant and closed to traffic. There will be no diverge from the A27 eastbound carriageway to the existing road as the substandard weaving length between the eastbound on-slip and the diverge could pose a potential safety and operational hazard. A27 eastbound traffic destined for Arundel railway station will continue along the new A27 bypass section and exit at the Crossbush junction as this represents the most direct route.

FLYOVER WITH EAST FACING SLIP ROADS (OPTION 1A)

10.5.7 The concept drawing of the junction arrangement with only east facing slip roads, the eastbound onslip and westbound offslip, is presented below in Figure 10-6.

Figure 10-6 Concept layout - flyover with two slip roads

10.5.8 The key points to note in relation to this layout include:

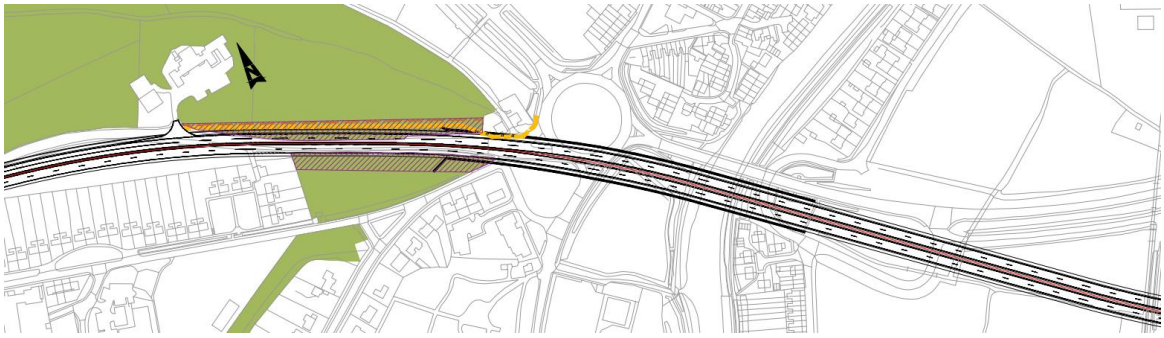
- The concept layout will be similar to the all-slips option with the exception that there will not be any west facing slip roads. This would remove or minimise the impact on the Ancient Woodland.
- Retaining the eastbound on-slip and the westbound off-slip would ensure that the predominant movements between the A284 and the A27 east as well as between Ford Road and the A27 east are catered for at the Ford Road junction.
- In order to prevent non-local traffic on Ford Road from using the residential streets within the south-western quadrant of Ford Road roundabout (including Jarvis Road, Canada Road and Torton Hill Road) to access the A27 westbound carriageway, Jarvis Road junction with the A27 may be closed to all traffic.
- In the absence of a westbound on-slip, local trips from Arundel wishing to travel westbound on the A27 towards destinations including Chichester would first have to travel eastbound on the new A27 bypass section and make a U-turn at Crossbush junction. Lack of an eastbound off-slip would require these local trips, travelling in the reverse direction, to turn around at Crossbush junction and utilise the westbound off-slip at the Ford Rd junction to exit on to Ford Road or Maltravers Street.
- All issues identified with regards to Fitzalan Road, under an all-slips options apply to this option as well.

- The existing A27 between Ford Road and the Causeway roundabouts will be closed to traffic.
- Option 1A would result in the loss of 0.3ha of Ancient Woodland to the west of Ford Road Roundabout.

FLYOVER WITH NO SLIP ROADS (OPTION 1B AND 1C)

10.5.9 The concept drawing of the junction arrangement with no slip roads at the Ford Rd junction, and therefore no access to or from Arundel, is presented below in Figure 10-7.

Figure 10-7 Concept layout - flyover with no slip roads



- This concept layout assumes that the existing Ford Road roundabout will retain its current layout with the existing A27, maintaining its access function. The existing A27 will provide a route for the predominant movements between the A284 and the A27 (including the north-south movement between A284(N) and A284(S) as well as Ford Road and the A27 east via Crossbush junction. These movements will continue to take place as per existing arrangements.
- As with the option with the eastbound on-slip and the westbound off-slip, there will be no access provision for local trips heading westbound on the A27 from Ford Road. These movements will have to make a U-turn at Crossbush junction. Jarvis Road will also have to be closed to prevent non-local traffic from using the residential streets as a rat-run route to access the A27 westbound carriageway.
- In order to prevent non-local traffic on Ford Road from using the residential streets within the south-western quadrant of Ford Road roundabout (including Jarvis Road, Canada Road and Torton Hill Road) as well as Priory Lane/Tortington Lane to access the A27 westbound carriageway, Jarvis Road junction with the A27 may be closed to all traffic.
- Option 1B and 1C would result in the loss of 0.3ha of Ancient Woodland to the west of Ford Road Roundabout.

THROUGHABOUT (OPTION 1D)

10.5.10 The concept drawing of the at-grade junction arrangement in the form of a through-about is presented below in Figure 10-8. The operational performance of a through-about at that time indicated the junction would operate without Practical Reserve Capacity (PRC), and a Degree of Saturation (DoS) in excess of 90%. The further development of the concept design has sought to improve its performance, including in relation to the risk of excessive internal circulatory queues. The further development of the concept has involved:

- Adding a third lane on the A27 westbound approach to minimise the interaction between the left turning movement and the ahead-movements well in advance of the start of the left turning lane. The third lane would effectively operate as a lane drop for the left turning movements into Ford Road with two full lanes on the A27 continuing westbound.

→ Converting the A284 entry on the north side of the roundabout, from signal control to a give-way entry operation. This has been made possible by configuring the pedestrian route so that it does not pass through this node.

Figure 10-8 Concept layout – Through-about

10.5.11 This concept layout will affect access to the residential area in the South-West of Arundel and the closure of Torton Hill Road would need to be considered.

10.5.12 There would be no additional impact on Ancient Woodland as a result of this option compared to the layout presented at the public consultation.

STRATEGIC MODEL ASSESSMENT

10.5.13 The scheme results are presently only for the 2041 AM and PM peak scenarios, as they represent the highest level of traffic flow. The A27 Arundel bypass Option 1 strategic model has been used as a reference case to prepare and contrast the differences between the alternative layouts and Option 1.

NETWORK SUMMARY STATISTICS

10.5.14 The network wide statistics, total travel time and total distance travelled, have been extracted for the 2041 AM and PM peak periods, and presented in Table 10-3. It should be borne in mind that the SATURN model currently underrepresents the delays which may potentially remain on the scheme section of the A27 – specifically at Ford Road Roundabout - for the public consultation Option 1 scheme design.

Table 10-3 Network summary statistics – 2041

Peak Period	Period	Units	Public Consultation Option 1	Flyover - all slips	Flyover – two slips	Flyover - no slips	Through-about
AM	Total time	PCU-Hrs	15149	15093	15118	15150	15103
	Difference			-57	-32	1	-46
	Total distance	PCU-Kms	744034	743947	745048	745575	744084
	Difference			-87	1014	1541	50
PM	Total time	PCU-Hrs	16092	16016	16006	16107	16081
	Difference			-76	-86	15	-11
	Total distance	PCU-Kms	763619	761958	764171	764409	761949
	Difference			-1660	553	791	-1670

10.5.15 The results indicate that, during the AM and PM peak periods, the all slip and the two slip flyover options would provide benefit relating to a decrease in overall total travel time compared to Option 1. However, there is a small increase in total travel time for the no slips flyover option due to the restricted access at the Ford Rd junction for traffic associated with the A27.

10.5.16 The all slips flyover option would see a marginal decrease in total travel distance in the AM peak and a notable decrease in the PM peak. However, the two-slips and the no-slips option would result in an increase, with the latter incurring higher travel distances. Lack of a westbound on-slip at the Ford Road junction would mean that local traffic from the Arundel area heading westbound on the A27 would have to travel to Crossbush and make a u-turn. The exclusion of an eastbound off-slip would result in local trips travelling eastbound on the A27, especially those destined towards Ford Road, having to travel to Crossbush to make a u-turn.

TRAFFIC FLOWS

10.5.17 The all slip road option would cause an increase in traffic on the new bypass in the AM peak, due to reduced delays to the A27 traffic at the junction with Ford Road. There would be increases in flows on Ford Road in both directions in the AM peak, and northbound in the PM peak, of between 10 and 20%. However, travelling southbound in the PM would see reduced flows of around 15%. The flows through Storrington and the A259 would both see a decrease.

10.5.18 The two slips option would result in an increase in traffic flows on the new bypass in the eastbound direction. This is partly caused by local trips at Ford Road roundabout wishing to travel westbound, needing to travel eastbound at Crossbush to make a U-turn. Ford Road would see an increase in flows in the AM, but a marginal reduction in the PM due to lack of access to and from the A27 west. This potentially reduces its attractiveness as a local distributor road. There is again a reduction in trips through Storrington.

10.5.19 The flyover with no slip roads would result in a significant reduction in traffic flows on the new A27 Arundel Bypass. This is primarily a result of the continued use of the existing route past Arundel Railway Station by north-south traffic to and from the A284. Of the three flyover options, the one without any slip roads would offer the greatest potential for discouraging non-local trips using Ford Road as a distributor road to connect with the A27. This is seen with reduced flows southbound in the AM and northbound in the PM.

10.5.20 The throughabout option would bring a slight decrease in flows on the new bypass, with the exception of westbound in the AM. This is due to the decrease in vehicles using this route to access Fitzalan Road, as this road is now to be accessed via the Causeway. There would be a slight increase in traffic on Ford Road in both directions in the AM peak, and an increase in the northbound direction in the PM peak. There is a general modest decrease in flow through Storrington and along the A259.

JOURNEY TIME COMPARISON

10.5.21 Journey times along the A27 between Crossbush junction and Long Lane have been extracted for the 2041 AM and PM peak periods. The results of this can be found in Table 10-4. It should be borne in mind that the SATURN model currently underrepresents the delays which may potentially remain on the scheme section of the A27 – specifically at Ford Road Roundabout - for the public consultation Option 1 scheme design.

Table 10-4 Travel time (seconds) – 2041

Peak Period		Public Consultation Option 1	Flyover – all slips	Flyover – two slips	Flyover – no slips	Through-about
AM	Eastbound	277	210	210	207	259
	Difference		-67	-67	-70	-18
	Westbound	290	227	226	234	253
	Difference		-63	-64	-57	-39
PM	Eastbound	420	210	210	207	268
	Difference		-210	-210	-213	-152
	Westbound	275	226	225	224	262
	Difference		-49	-50	-51	-13

10.5.22 Table 10-4 demonstrates that a flyover option, regardless of the slip road configuration, would provide journey time savings along the A27 Arundel scheme extents, in either direction, during both peak periods.

ECONOMIC ASSESSMENT RESULTS

10.5.23 The Option 1 scheme concepts have been subject to Transport User Benefits Appraisal (TUBA) and the results are presented in Table 10-5. The results show the transport economic efficiency for commuting, other and business user purposes alongside the impact of each concept on wider public finances. As discussed in chapter 6 of this report, it should be borne in mind that the benefits for public consultation Option 1 are likely to be over-estimated.

Table 10-5 Analysis of Monetised Costs and Benefits (£000m)

	Public Consultation Option 1	Variant	Flyover All Slips	Flyover Two Slips	Flyover No Slips	Through-about
Economic Efficiency: Consumer Users (Commuting)	40,177	49,274	52,356	47,954	37,392	44,640
Economic Efficiency: Consumer Users (Other)	63,516	64,620	79,385	73,759	66,945	64,876
Economic Efficiency: Business Users and Providers	55,722	50,287	70,848	63,952	59,898	60,341
Wider Public Finances (Indirect Taxation Revenues)	17,056	15,732	17,039	19,557	19,653	17,177
Present Value of Benefits (PVB)	176,471	179,913	219,628	205,222	183,888	187,034

10.5.24 The economic assessment results indicate all concept options improve the overall level of benefit relative to the Option 1 reference case.

OPERATIONAL ASSESSMENT

10.5.25 Each of the three flyover concepts has been tested using Junctions 8, which allows the queueing and delays at the roundabouts (Ford Road and Crossbush) to be determined. They have been tested with 2041 flows for the AM and PM peak periods.

Table 10-6 All Slip Roads

Junction	Arm	Queue (PCU)	Ratio of Flow to Capacity (RFC)	Queue (PCU)	Ratio of Flow to Capacity (RFC)
		2041 AM Peak	2041 PM Peak		
Ford Road Roundabout	A (A284)	0.82	0.45	1.20	0.54
	B (Maltravers Street)	0.12	0.10	0.21	0.17
	C (A27 Westbound Off-slip)	1.03	0.51	1.33	0.57
	D (Ford Road)	0.54	0.35	0.84	0.46
	E (A27 Eastbound Off-slip)	0.53	0.31	1.01	0.49
Crossbush – Roundabout 1	A (Causeway)	0.49	0.32	0.51	0.34
	C (to roundabout 2 Crossbush)	0.61	0.38	0.47	0.32
	D (A27 eastbound off-slip)	2.55	0.72	0.66	0.39
Crossbush – Roundabout 2	A (to roundabout 1 Crossbush)	0.85	0.45	0.12	0.10
	B (A27 westbound off-slip)	0.32	0.24	0.35	0.26
	C (A284)	1.99	0.66	1.24	0.55

10.5.26 For the all slip road option Table 10-6 shows that both Ford Road roundabout and Crossbush would operate within capacity in both the AM and PM peak periods. The A27 eastbound off-slip at Crossbush has an elevated RFC of 0.72, albeit with modest queueing. This is due to the high volume of A284 traffic, exiting the A27 eastbound carriageway at Crossbush junction to continue their journey south on the A284, giving way to the circulating A284 traffic heading east on the A27.

Table 10-7 Two Slip Roads

Junction	Arm	Queue (PCU)	Ratio of Flow to Capacity (RFC)	Queue (PCU)	Ratio of Flow to Capacity (RFC)
		2041 AM Peak	2041 PM Peak		
Ford Road Roundabout	A (A284)	0.61	0.38	1.55	0.60
	B (Maltravers Street)	0.03	0.02	0.06	0.05
	C (A27 Westbound Off-slip)	0.85	0.45	0.81	0.45
	D (Ford Road)	0.46	0.31	0.49	0.33
	E (A27 Eastbound Off-slip)	0.61	0.38	1.55	0.60

Junction	Arm	Queue (PCU)	Ratio of Flow to Capacity (RFC)	Queue (PCU)	Ratio of Flow to Capacity (RFC)
Crossbush – Roundabout 1	A (Causeway)	1.73	0.62	0.80	0.44
	C (to roundabout 2 Crossbush)	0.59	0.37	0.47	0.32
	D (A27 eastbound off-slip)	25.23	0.99	1.32	0.56
Crossbush – Roundabout 2	A (to roundabout 1 Crossbush)	0.36	0.25	0.12	0.10
	B (A27 westbound off-slip)	0.22	0.18	0.33	0.25
	C (A284)	2.07	0.67	1.27	0.56

10.5.27 Table 10-7 shows that the two slip road option would allow Ford Road roundabout to operate within capacity in both the AM and PM peak periods. However, at Crossbush, the eastbound off-slip would operate above the 0.85 threshold in the AM peak. This is because of an increase in vehicles using the slip road, mainly the local trips at Ford Road roundabout wishing to travel westbound on the A27, exiting at Crossbush to travel back on the A27 in the westbound direction. This arm would operate within capacity in the PM peak.

Table 10-8 No Slip Roads

Junction	Arm	Queue (PCU)	Ratio of Flow to Capacity (RFC)	Queue (PCU)	Ratio of Flow to Capacity (RFC)
		2041 AM Peak	2041 PM Peak		
Ford Road Roundabout	A (A284)	1.24	0.55	2.13	0.68
	B (Maltravers Street)	0.03	0.03	0.15	0.13
	C (A27 Westbound Off-slip)	0.62	0.38	0.87	0.46
	D (Ford Road)	1.09	0.52	0.56	0.36
	E (A27 Eastbound Off-slip)	1.24	0.55	2.13	0.68
Crossbush – Roundabout 1	A (Causeway)	0.96	0.47	1.05	0.50
	C (to roundabout 2 Crossbush)	0.59	0.37	0.59	0.37
	D (A27 eastbound off-slip)	0.40	0.26	0.53	0.33
Crossbush – Roundabout 2	A (to roundabout 1 Crossbush)	0.36	0.25	0.32	0.24
	B (A27 westbound off-slip)	0.46	0.31	0.85	0.46
	C (A284)	2.49	0.71	2.00	0.66

10.5.28 With no slip roads Table 10-8 shows that Ford Road roundabout would operate within capacity in both the AM and PM peak periods, with RFCs of less than 0.85. At Crossbush, the A27 eastbound off-slip performs the best of the three concepts, having low RFC figures in both the AM and PM peaks. However, there is greater pressure on the A284, particularly in the AM.

10.5.29 Results of the signalised throughabout operational assessment using LINSIG are presented in Table 10-9.

Table 10-9 Ford Road junction performance - Throughabout

ARM	LANE	DOS (%)	MMQ (PCU)	DELAYS (S/PCU)	DOS (%)	MMQ (PCU)	DELAYS (S/PCU)
		2041 AM Peak	2041 PM Peak				
A284 SB give-way entry	1/2+1/1	68	2	6	79	3	10
Maltravers Road give-way	2/1	16	0	4	25	0	6
Southbound A27 EB Crossing	3/1	28	2	13	62	5	16
Southbound A27 EB Crossing	3/2	10	1	13	16	1	12
A27 EB on-slip	4/1	81	7	36	86	9	40
A27 EB on-slip	4/2	81	7	36	86	9	40
A27 EB Internal Ahead	5/1	85	4	15	89	5	19
A27 EB Internal Ahead	5/2	85	4	15	89	5	19
SB A27 WB Crossing	6/1	49	1	20	88	4	32
SB A27 WB Crossing	6/2	17	0	15	23	0	10
A27 WB LT entry into Rbt	7/2+7/1	64	4	10	76	5	14
A27 WB ahead through Rbt	7/4+7/3	86	12	14	81	11	14
Ford Rd Circulatory	8/1	27	1	6	28	2	9
Ford Rd Circulatory	8/2	46	1	6	57	2	9
Ford Rd Entry	9/2+9/1	56	3	18	62	4	16
NB A27 EB & WB Crossing	10/1	61	3	24	43	2	15
NB A27 EB & WB Crossing	10/2	85	7	44	71	6	25
NB A27 EB & WB Crossing	10/3	75	3	23	85	5	29
A27 WB internal link	11/1	77	2	8	78	3	11
A27 WB internal link	11/2	77	2	8	78	3	11
A27 WB give-way on-slip	12/1	29	1	15	43	2	14
A27 EB ahead through Rbt	13/1	74	9	14	81	11	19
A27 EB ahead through Rbt	13/2	74	9	14	81	11	19
A27 EB give-way off-slip	14/1	48	2	8	71	4	15
Practical Reserve Capacity (PRC)			4.9			1.0	

10.5.30 Table 10-9 demonstrates that the revised layout would operate close to but within capacity in both peak periods. The predicted lane queues are starting to extend in both peak periods, and could pose a risk of periodically blocking other movements. It would be expected that the junction would reach its PRC within the next 2 years, should traffic levels continue to grow after 2041.

SENSITIVITY TESTS

10.5.31 The operational performance of the Ford Road junction under a throughabout configuration were identified as being very close to a DoS of 90%, with limited PRC. The performance of a junction can deteriorate exponentially beyond its capacity and this presents a risk relating to operational performance of the wider route. To determine whether the Ford Road junction would operate within capacity under different traffic flow scenarios, sensitivity tests were considered. These included:

- A seasonal peak scenario - reflecting peak during summer months that corresponds to high tourist / leisure-related demand
- A typical forecast weekday peak hour scenario
- A scenario to include the effects of the inclusion of the A27 Worthing and Lancing improvements scheme on the level of traffic flow through the Ford Road junction

10.5.32 The sensitivity tests concluded that there would be increased levels of queueing at Ford Road roundabout. A number of arms would operate above the usual DoS (90%) in both the AM and PM peak, including both lanes of the A27 eastbound internal ahead and the A27 westbound ahead through the roundabout. A number of arms also operate above the 90% DoS just in the PM peak, including the A284 southbound give-way entry, A27 eastbound on-slip (both lanes), the northbound A27 eastbound and westbound crossing (lane 3), and both lanes of the A27 eastbound ahead through the roundabout.

ACCIDENT ASSESSMENT

10.5.33 Table 10-10 sets out the total number of accidents along the proposed scheme between Mill Road/Tye Lane and Crossbush junction over the 60 year assessment period, as extracted from the COBALT programme. The accident benefit for Option 1 flyover with all slips is presented to illustrate the effect of grade separation on accident benefits. Options 3 and 5A are presented for comparison with Option 1 and its variant. These are then compared with Do Nothing to show how the scheme influences the number of accidents.

10.5.34 The accident analysis, in COBALT, for the A27 Arundel Bypass scheme options are based on traffic flows from strategic SATURN modelling. Due to the issues with the A27 Arundel Bypass (Option 1) scheme, the accident analysis for Option 1 are likely to be different. However, it is not known whether more delays at the junction would translate to fewer vehicles being able to get through the junction and, consequently, fewer accidents.

Table 10-10 Total accidents between Mill Road/Tye Lane and Crossbush junction

	DN	Option 1	Option 1 (Flyover – all slips)	Option 3	Option 5A
Total number of accidents	346	538	229	219	191
Difference in accidents compared with DN	-	+196	-117	-127	-155

10.5.35 Table 10-10 demonstrates that Option 1 would result in a net increase in accidents compared with a Do Nothing scenario. All other options would result in a net decrease in accidents, with Option 5A saving the most number of accidents and 'Option 1 flyover with all slips' the least, in relative terms.

10.5.36 The monetised accident benefits of each option across the entire model network are presented in Table 10-11. All options provide an overall benefit related to accident savings, with Option 1 and 'Option 1 flyover with all slips' having a similar scale of accident benefits over the assessment period.

Table 10-11 Monetised accident benefits (£m)

	Monetary value of safety benefit (during 60 year period 2023-82) across the whole model area (£M)
Option 1	£16.008
Option 1 Flyover with all slips	£19.679
Option 3	£34.780
Option 5A	£30.042

ENVIRONMENTAL ASSESSMENT

10.5.37 A high level environmental assessment has been carried out on the alternative solutions for the Ford Road Junction. This is reported in detail in the "A27 Arundel Bypass, Option 1 Variants – Preliminary Environmental Assessment Techncial Note". This assessment has been based on the work conducted for the EAR prepared for the three public consultation options and summarised in Chapter 7 of this report.

10.5.38 As the different solutions pass through the same geographical and baseline environment area around Arundel there are, inevitably, a number of similarities in the effects experienced between the them. Similarities in the engineering design of each solution also contribute to the similar effects experienced by the various receptors. At this preliminary stage of the assessment a solution that reduces the amount of additional land take and impact on Ancient Woodland, to the greatest extent possible would be recommended. Additionally, options that reduce the total number of large/very large adverse effects are recommended. Given these parameters, the At-Grade Through-about (Option 1D), followed by the Grade Separated No Slips (Option 1B), would be the recommended options. Nevertheless, caution should be exercised when interpreting this recommendation due to the early stage of assessment and the lack of air quality and noise modelling.

10.6 CONCLUSION

10.6.1 A number of design developments have been explored after the public consultation.

10.6.2 A high level assessment of proposed alignment changes for Option 1 and Option 5A concluded that these would be adopted as part of any preferred route announcement due to improved compliance with key clauses of the NNNPS. The further design development of the western tie in for Option 5A has concluded that range of alternative solutions would be possible. Option 5A(V3) provides improved safety but would need further consideration in Stage 3 to reduce impacts on Ancient Woodland.

10.6.3 The further assessment of the traffic implication of a range of additional solutions at the Ford Road Junction for Option 1 has shown that a range of solutions could be developed that would achieve suitable levels of practical reserve capacity. A high level environmental assessment of the options shows that significant concerns would remain. Further work on the junction proposal would be required.

10.6.4 A number of design developments have been explored after the public consultation informed by the NNNPS policy tests which would need to be met particularly in terms of impacts on Ancient Woodland, results of the public consultation and assessment of the operational performance of Option 1. This further design work showed:

- → Modifications to the alignment and design of option 1 (Option 1V) would reduce the amount of Ancient Woodland loss and improve the safe operation of the route through the removal of gaps in the central reserve. However not all safety concerns would be addressed and specific mitigation measure such as enforced speed limits of 40mph and 50 mph would still be required.
- → A range of solutions would be possible at Ford Road Junction that would allow Option 1 to achieve practical levels of reserve capacity but further work would be needed in stage 3 to identify the best form of junction
- → There is limited opportunity to reduce the impact of Option 3 and improve its performance against key NNNPS clauses.
- → Modification to the alignment of Option 5A (Option 5AV3) at Tortington Priory would be favoured as it moves the scheme away from the Scheduled Monument.

→ Modification to the alignment of Option 5A (Option 5AV3) to reduce the impact on Ancient Woodland could be achieved through modifying the design of the western tie in junction but further work would be needed in stage 3 to identify the best form and location of any junction to satisfy the traffic turning demand in the area.

11 APPRAISAL SUMMARY

11.1 APPRAISAL SUMMARY TABLE (AST)

11.1.1 The assessment reported in Chapter 6, 7 and 8 have been based on the three options as presented at the public consultations (Option 1, Option 3 and Option 5A). Appraisal summary tables have been produced for these options in accordance with the DfT's Transport Analysis Guidance (WebTAG). The summary tables are reproduced in Appendix E of this report. To assist the comparison of the public consultation route options, a summary of the quantitative and qualitative assessments from the ASTs is presented below in Table 11-1.

11.1.2 The results for Option 1 are presented for completeness, but it should be borne in mind that the benefits are likely to be over-estimated. This is because the SATURN model currently under-represents the delays which may potentially remain on the scheme section of the A27 - specifically at Ford Road Roundabout - for the current A27 Arundel Bypass (Option 1) scheme design.

Table 11-1 Summary of AST

	IMPACT	OPTION 1	OPTION 3	OPTION 5A
Economy	Business users & transport providers	£54.489M	£51.858m	£66.889m
	Reliability impact on Business users	Moderate beneficial	Moderate beneficial	Moderate beneficial
	Regeneration	Not Applicable	Not Applicable	Not Applicable
	Wider Impacts	£54.8m	£25.90m	£22.90m
Environment	Noise	-£9,966,530	-£1,334,042	-£1,518,992
	Air Quality	£9,251,942	£9,016,356	£9,465,240
	Greenhouse gases	-£19,144,931	-£25,180,794	-£23,899,268
	Landscape	Moderate Adverse	Large Adverse	Large Adverse
	Townscape	Moderate Adverse	Neutral	Neutral
	Historic Environment	Large Adverse	Large Adverse	Large Adverse
	Biodiversity	Moderate Adverse	Very Large Adverse	Very Large Adverse
	Water Environment	Low significance	Low significance	Low significance
Social	Commuting and Other users	£98.404m	£113.515m	£141.410m
	Reliability impact on Commuting and Other users	Moderate beneficial	Moderate beneficial	Moderate beneficial
	Physical activity	Slight Beneficial	Slight Beneficial	Slight Beneficial
	Journey quality	Slight Beneficial	Slight Beneficial	Slight Beneficial
	Accidents	Moderate beneficial £16.008m	Large Beneficial £34.778m	Large Beneficial £30.042m
	Security	Slight Beneficial	Slight Beneficial	Slight Beneficial
	Access to services	Not applicable	Not Applicable	Not Applicable
	Affordability	Slight Beneficial	Slight Beneficial	Slight Beneficial
	Severance	Slight Adverse	Slight Beneficial	Slight Beneficial
	Option and non-use values	Not Applicable	Not Applicable	Not Applicable
Public Accounts	Cost to Broad Transport Budget	£87.190m	£166.997m	£162.005m
	Indirect Tax Revenues	£17.056m	£23.821m	£21.461m

12 CONCLUSION AND RECOMMENDATIONS

12.1 INTRODUCTION

12.1.1 Proposals for the 'A27 Arundel Bypass scheme were included in the 2014 Road Investment Strategy following the A27 Corridor Feasibility Study. In PCF Stage 1 ten options where shifted to produce a short list of 5 options for detailed appraisal to produce three options that were taken to a public consultation in August - October 2017, Option 1, Option 3 and Option 5A.

12.1.2 The responses from the public consultation showed that 79% of people who responded agreed that the A27 needs to be improved and that there was greater support for Option 5A. However there are concerns over the environmental impact of the scheme, and of the environmental groups that responded to the consultation, 82% were opposed to the scheme. A key concern was the impact on Ancient Woodland and the impact on different local communities from each of the route options.

12.1.3 Following the public consultation further detailed economic and environmental assessments have been carried out on each of the option presented at the consultation. The assessments have been carried out in line with WebTAG requirements. The economic assessment has been informed by a new traffic model, developed in 2017 using the South East Regional Traffic Model (SERTM) and the environmental assessment by ongoing detailed ecology surveys carried out in 2017.

12.1.4 In addition there has been further development of the route options taking into account feedback received during the consultation and from the traffic assessment undertaken following the consultation.

12.2 OVERALL COMPARISON OF OPTIONS

12.2.1 A comparison of the main differences between the three route options presented at the public consultation is provided below based on:

- → A review of performance of the route options against the project objectives
- → A review against key clauses in the NNNPS
- → The assessments undertaken in Stage 2 and summarised in Chapters 6 – 8 of this report

PROJECT OBJECTIVES

12.2.2 An assessment of the performance of each against the project objectives is given in Table 12-1

12.2.3 The results for A27 Arundel Bypass (Option 1) are presented for completeness, but it should be borne in mind that the benefits are likely to be over-estimated. This is because the SATURN model currently under-represents the delays which may potentially remain on the scheme section of the A27 - specifically at Ford Road Roundabout - for the current A27 Arundel Bypass (Option 1) scheme design.

Table 12-1 Summarised Performance of Options against the Project Objectives

MEASURE	OPTION 1	OPTION 3	OPTION 5A
Project Objective - Improve Capacity of the A27 whilst supporting local planning authorities to manage the impact of planned economic growth			
Mins saved per vehicle on A27 through Arundel (Eastbound PM Peak)	07:54	11:42	12:37
Mins saved per vehicle on A27 through Arundel (Westbound PM Peak)	05:42	06:40	07:19
Average	06:48	09:11	09:58
Do nothing Vs do something total travel time (pcu hours) across the whole network.	43	47	15
No. of new households in traffic growth forecast	28,750 households	28,750 households	28,750 households
No. of new jobs in traffic growth forecast	13,638 new jobs	13,638 new jobs	13,638 new jobs
Wider Economic Benefits	£47.5m	£20.8m	£19.3m
Project Objective - Reduce congestion, reduce travel time and improve journey time reliability along the A27			
Difference in volume over capacity (VoC) for links and nodes a) Node - Ford Road Roundabout	83%	46%	43%
b) Link - Existing A27 East of Ford Road roundabout	64%	72%	69%
c) Link - On new A27 (proposed bypass)	65%	47%	50%
Improvements - highway benefits - transport user benefits appraisal (TUBA) ((total over a 60 year appraisal period)	£176.7m	£200.9m	£231.5m
Increases in total travel distance (sum of AM, IP and PM in 2041, pcu kms per hour)	33460	43817	41243

MEASURE	OPTION 1	OPTION 3	OPTION 5A
Increases in overall average network speed (AM peak 2041 in kph)	0.7	0.97	0.93
Project Objective - Improve the safety of travellers along the A27 and consequently the wider local road network			
Accident benefits (£m) calculating using the COBALT program (total over a 60 year appraisal period)	£16m	£34.8m	30m
Casualty savings relating to fatal, serious or slight injuries (no. of people)	346	906	779
Reduce accidents on the A27 at Arundel	+203	-127	-156
Project Objective - Improve accessibility for all users to local services and facilities.			
Qualitative assessment	Existing PRoW network would largely remain unchanged. Accessibility for all users would be impacted by provision of dual carriageway within Arundel. Improvements to walking and cycle facilities would improve accessibility Existing access and minor junctions on the existing single carriageway section of the A27 will be restricted.	Facilitates new east / west movements on PRoW network in SDNP through provision of new WCHR route on bypassed section of A27. Impacts existing north / south connections requiring PRoW users to divert, use underpass or bridges. Improves accessibility for all users within Arundel by reducing traffic levels on existing A27. Existing local road connections and accesses on existing A27 retained	Facilitates new east / west movements on PRoW network in SDNP through provision of new WCHR route on bypassed section of A27. Impacts existing north / south connections requiring PRoW users to divert, use underpass or bridges. Improves accessibility for all users within Arundel by reducing traffic levels on existing A27. Existing local road connections and accesses on existing A27 retained
Project Objective - Deliver a scheme that minimises environmental impact and seeks to protect and enhance the quality of the surrounding environment through its high quality design.			
Qualitative assessment	AST for Option 1 shows large adverse impacts on Historic Environment	AST for Option 3 shows very large adverse impacts on Biodiversity and large adverse impacts on landscape	AST for Option 5A shows very large adverse impacts on biodiversity and large adverse impacts on landscape and historic environment
Project Objective - Respect the South Downs National Park and its special qualities in our decision making.			

MEASURE	OPTION 1	OPTION 3	OPTION 5A
Qualitative assessment	Significant impact on the setting and views of the park, but less than Options 3 and 5A(V3) as less land take is required. Much lower impact on wildlife, natural beauty and recreation opportunities than 3 and 5Av3.	Significant impact on this part of the South Downs National Park and the park's setting. The bypass would cause harm to wildlife, natural beauty and recreation opportunities in this part of the National Park.	Significant impact on this part of the South Downs National Park and the park's setting. The bypass would cause harm to wildlife, natural beauty and recreation opportunities in this part of the National Park, of different types but similar magnitude to Option 3.
a) Reductions in flow on A283 at Storrington in 2041 relative to Do Minimum	5631	5305	5846
b) Reductions in flow on A29 east of Slindon in 2041 relative to Do Minimum	4879	6666	7437

12.2.4 Options 3 and 5A align well with the project objectives for improving capacity, reducing congestion, improving safety and accessibility. Option 1, as presented at the public consultation, would not meet the project objectives for improving capacity, reducing congestion and improving safety. However the design changes outlined in Chapter 10 would improve the performance of option 1 when considered against the project objectives. Option 1 does not align well with the objective for reducing severance. Option 1 performs better for the objective for minimising environmental impacts.

12.2.5 All three options are not aligned with the project objective for Respect the South Downs National Park and its special qualities as currently all three are assessed to have significant impact on the SDNP and none are supported by SDNP. In their response to the consultation SDNP indicate that they will continue to work with HE in developing appropriate mitigation for the scheme. All options would reduce the level of traffic through the SDNP.

PLANNING POLICY

12.2.6 A high level comparison of the three public consultation options against the key relevant considerations in the NNNPS and other key policy tests is included in Appendix 6. The scheme objective is to address the need set out under paragraphs 2.1 to 2.11 of the NNNPS and the three options assessed meet the objectives set out in the NNNPS.

12.2.7 The key findings are summarised below:

- → Option 1 has the potential for compliance risks with NNNPS policy; .
- → Option 3 has the potential for compliance risks with NNNPS policy .
- → Option 5A has the potential for compliance risks with NNNPS policy.

ENGINEERING, MAINTENANCE AND BUILDABILITY

12.2.8 Chapter 5 sets out the engineering characteristics of the public consultation options (Options 1, 3 and 5A) and Chapter 8 outlines the Operational and maintenance assessments.

12.2.9 The design of the route options has been based on different design criteria. Option 1 has been designed to both DMRB requirements for an urban all-purpose road with a design speed of 85 kph for the online section and a rural all-purpose road with a 120 kph design speed for the offline section. Options 3 and 5A have been designed to DMRB requirements for an all-purpose road with a 120kph design speed.

12.2.10 Option 1 requires specific safety mitigation measures to be implemented to mitigate safety concerns resulting from level of standard provided. These measures would need to include enforced speed limits of 40mph and 50 mph. Even with design speeds adopted to reflect these speed limits departures from standard would still be required.

12.2.11 Option 3 and 5A both would require departures from standard for combinations of curves below desirable minimum at the vicinity to the western tie in junctions.

12.2.12 Option 1 offers a shorter construction programme duration than Options 3 and 5A, with less demand on imported materials and reduced land take. However it would be more difficult to construct due to being partly on the same alignment of the existing road and there being more statutory undertakers' utilities that would require diversion and local accesses to be maintained. There would also be more disruption to traffic during construction as there would be no alternative route available and the overall construction period is likely to be longer as a result

12.2.13 The construction of Option 3 and 5A would result in a much reduced impact on the operation of the existing road network as they are both largely off line and therefore traffic disruption and traffic management would be minimal through construction.

12.2.14 The costs for the three route options are:

- Option 1 - £134.47m
- Option 3 - £260.00m
- Option 5A - £249.34m

12.2.15 Option 3 and 5A have the benefit of a diversion route via the existing A27 road during maintenance activities and emergency closures of the new road as necessary.

TRAFFIC MODELLING

12.2.16 Chapter 6 sets out the traffic modelling which has been carried out to understand the impact of each option on the existing road network.

12.2.17 Compared to the without scheme situation all options would result in an increase in traffic flow on the A27 as a result of the provision of additional capacity and would reduce traffic flows on the local road network.

12.2.18 With Option 1 average daily traffic flows would be reduced by 87%on the existing A27 from Crossbush to the Causeway Roundabout Traffic flows would increase on the section of the widened section of the existing A27 west of Arundel by 57%. There would be reduction in flows on the A283 and A29 of 37% and 19% respectively.

12.2.19 Traffic forecasting results presented in Section 6 show that for Option 1 the Ford Road Junction would operate in excess of capacity resulting in long queues. The forecast performance of this junction has deteriorated since the earlier assessments undertaken in PCF Stage 1. This is due to the significant increase in forecast traffic volumes at the junction. Further assessment work has indicated a range of alternative solutions, including at grade through about and grade separated flyovers, which could provide practical levels of reserve capacity but further work would be needed in stage 3 to identify the best form of junction

12.2.20 Option 3 and 5A have a similar impact on traffic flows. On the existing A27 average daily traffic flows would reduce by 44% and 45% respectively on the existing A27 from Crossbush to the Causeway Roundabout and by 80% and 82% respectively on the existing single carriageway section west of Arundel. There would be reduction in flows on the A283 of 36% and 41% and on the A29 of 26% and 30% respectively. Option 3 and 5A would not have the capacity and network resilience issues associated with Option 1.

12.2.21 Each option is predicted to result in journey time savings compared with a scenario without the scheme in all time periods. Option 1 would reduce journey times across all time period from between 3 to 8 minutes with an average reduction of 5 minutes. Consultation Option 1 would still produce journey time savings, however the design changes would be required to deliver an improved level of time saving that would be approaching but not as great as that of options 3 and 5A.

12.2.22 Option 3 would reduce journey times across all time period from between 6 to 12 minutes with an average reduction of 7 minutes. Option 5A would reduce journey times across all time period from between 5 to 12 minutes with an average reduction of 8 minutes.

ACCIDENTS

12.2.23 All the public consultation options would reduce the total number of accidents (network wide) compared to the without scheme scenario. However Option 1 performs significantly worse than Option 3 or 5A:

- → Option 1 - 245
- → Option 3 - 642
- → Option 5A - 548

12.2.24 A comparison of the total number of accidents on the section of the A27 at Arundel from Crossbush to the junction with Mill Lane has also been carried out. The total number of accidents on the A27 would increases with Option 1 with the public consultation design but decreases with Option 3 and Option 5A. Option 5A would have the largest decrease.

12.2.25 Option 1 would result in a net decrease in accidents on the A27 with the provision of a grade separated junction at the Ford Road junction to the concept designs shown in Chapter 10. However, Option 1 would still provide the least improvement relative to the Option 3 and 5A which provides the largest decrease.

ECONOMY

12.2.26 Chapter 6 summaries the economic assessment which has been carried out on the three public consultation options. The economic assessment has been undertaken in accordance with Webtag guidance..

12.2.27 The initial BCR's for the three options are as follows (including transport economic efficiency wider public finances, greenhouse gases, air quality, noise, accident benefits and construction delay.

- Option 1 – 1.91
- Option 3 – 1.24
- Option 5A – 1.51

12.2.28 The adjusted BCR's (including in addition wider impacts) are:

- Option 1 – 2.45
- Option 3 – 1.36
- Option 5A – 1.56

12.2.29 The results for A27 Arundel Bypass (Option 1) are presented for completeness, but it should be borne in mind that the benefits are likely to be over-estimated. This is because the SATURN model currently under-represents the delays which may potentially remain on the scheme section of the A27 - specifically at Ford Road Roundabout - for the current A27 Arundel Bypass (Option 1) scheme design.

ENVIRONMENT

12.2.30 Chapter 7 sets out the findings of the environmental assessment for each route option and topic. WebTAG assessment scores are included Table 12-2for ease of comparison. WebTAG provides an overall score for each topic rather than prescribing the separate reporting of impacts on individual receptors.

Table 12-2 Summary of Environmental AST

IMPACTS	OPTION 1	OPTION 3	OPTION 5A
Noise	-£9,966,530	-£1,334,042	-£1,518,992
Air Quality	£9,251,942	£9,251,436	£9,465,240
Greenhouse gases	-£19,144,931	-£25,180,794	-£23,899,268
Landscape	Moderate Adverse	Large Adverse	Large Adverse
Townscape	Moderate Adverse	Neutral	Neutral
Historic Environment	Large Adverse	Large Adverse	Large Adverse
Biodiversity	Moderate Adverse	Very Large Adverse	Very Large Adverse
Water Environment	Low Significance	Low Significance	Low Significance

12.2.31 All the route options have a large adverse impact on the historic environment. Option 3 and 5A have a very large adverse impact on biodiversity and large adverse impacts on landscape. Option 1 has the greater noise and townscape impacts. Option 1 is preferred from a biodiversity and landscape point of view.

12.2.32 Based on the environmental assessment, the key distinguishing assessment criteria are noise, air quality, cultural heritage, landscape and biodiversity.

- Noise – Fewer receptors would be exposed to increases in noise levels with Options 3 and 5A. Option 1 would generate a noise impact in areas such as Ford Road Roundabout, where implementation of mitigation may prove challenging.
- Air Quality – Overall all the options have a benefit for air quality. Options 3 and 5A improve air quality in Storrington AQMA more than Option 1.
- Cultural heritage – The alignment of Option 3 and 5A follows a course through the key view from Arundel Castle within Arundel Conservation Area and therefore has the same effect as Option 1 upon the setting of these assets. All options will have a large adverse effect on Priory Farm House. Options 3 and 5A will have a moderate/large adverse permanent effect on Tortington Priory, Tortington Priory Barn and multiple historic landscapes. The modifications to Option 5A have limited mitigation of these effects. All the route options have

the potential for having moderate/large adverse impacts on unknown underground archaeology.

- Biodiversity – Based on appraisal results, Option 1 has the potential for moderate adverse effects on biodiversity. Option 3 and Option 5A have the potential for very large adverse effects on biodiversity.
- Landscape– For landscape Option 1 would have overall less impact but would still have moderate adverse impacts on two landscape areas. Option 3 would have a moderate adverse effect on two character areas and large adverse effects on another. While Option 5A would have a large adverse effect on two landscape character areas and a moderate adverse effect on another.

SOCIAL IMPACTS

12.2.33 The Social Impacts assessment summarised Chapter 11 considered the impact of the scheme on both local residents and users of the transport network.

Table 12-3 Summary of Social AST

	OPTION 1	OPTION 3	OPTION 5A
Reliability impact on Commuting and Other users	Moderate beneficial	Moderate beneficial	Moderate beneficial
Physical activity	Slight Beneficial	Slight Beneficial	Slight Beneficial
Journey quality	Slight Beneficial	Slight Beneficial	Slight Beneficial
Accidents	Moderate beneficial	Large Beneficial	Large Beneficial
Security	Slight Beneficial	Slight Beneficial	Slight Beneficial
Access to services	Not assessed	Not assessed	Not assessed
Affordability	Slight Beneficial	Slight Beneficial	Slight Beneficial
Severance	Slight Adverse	Slight Beneficial	Slight Beneficial
Option and non-use values	Not Applicable	Not Applicable	Not Applicable

* The economic benefit of social impacts relating to commuting and other users is included within the overall economic assessment results presented above

12.2.34 The assessment shows the Option 3 and 5A would provide a significant improvement compared to Option 1 for users of the transport network due to greater accident reduction and through better performance of the network.

PUBLIC CONSULTATION

12.2.35 Key results from the public consultation include:

- 79% of respondents to the consultation agreed that there was a need for a scheme.
- Option 5A received the greatest support (48% compared to 27% for Option 1 and 23% for Option 3
- Option 5A was supported by the majority of local authorities and business groups who responded, including Arun District Council, Arundel Town Council, West Sussex County Council, Arundel Chamber of Commerce and the Coast to Capital Local Economic Partnership.
- Option 5A was widely opposed by environmental groups who responded to the consultation
- All route Options were opposed by the South Downs National Park Authority
- There are concerns over the environmental impact of the scheme, and of the environmental groups that responded to the consultation, 82% were opposed to the scheme.

- There are concerns with all three options on the impacts they have with nearby towns and villages. Particularly the impact on Binsted and Walberton from Option 5A and Arundel from Option 1

12.3 FURTHER DEVELOPMENT OF THE PUBLIC CONSULTATION OPTIONS

12.3.1 Following the public consultation further design work has been carried out on the three public consultation options as summarised in Chapter 10. This has been informed by:

- Assessments of the NNNPS policy tests which would need to be met particularly in terms of impacts on Ancient Woodland,
- Results of the public consultation.
- Assessment of the operational performance of Option 1.

12.3.2 This further design work showed:

- Modifications to the alignment and design of option 1 (Option 1V) would reduce the amount of Ancient Woodland loss and improve the safe operation of the route through the removal of gaps in the central reserve. However not all safety concerns would be addressed and specific mitigation measure such as enforced speed limits of 40mph and 50 mph would still be required.
- A range of solutions would be possible at Ford Road Junction that would allow Option 1 to achieve practical levels of reserve capacity but further work would be needed in stage 3 to identify the best form of junction
- There is limited opportunity to reduce the impact of Option 3 and improve its performance against key NNNPS clauses.
- Modification to the alignment of Option 5A (Option 5AV3) at Tortington Priory would be favoured as it moves the scheme away from the Scheduled Monument.
- Modification to the alignment of Option 5A (Option 5AV3) to reduce the impact on Ancient Woodland could be achieved through modifying the design of the western tie in junction but further work would be needed in stage 3 to identify the best form and location of any junction to satisfy the traffic turning demand in the area.

12.4 CONCLUSIONS

12.4.1 Based on the detailed assessments of the public consultation options Option 3 is not recommended for further consideration. This option has the lowest value for money and overall has the highest environmental impact. From the consultation responses Option 3 has the lowest support from the public.

12.4.2 The further design work carried out of the options since the public consultation shows reductions in the impact on Ancient Woodland would be possible and it is recommended that the preferred route would incorporate these modifications to the route alignments.

12.4.3 The decision by Highways England on which route option to select as the preferred route will be informed by the detailed assessments and appraisals summarised in this report.

12.4.4 The benefits of Option 1 compared to Option 5A in terms of value for money and reduced environmental impact are gained through adopting lower standards of provision compromising the operational performance of the route in terms of both safety and traffic flow. The option also still has significant environmental impacts including loss of Ancient Woodland, large adverse impacts on cultural heritage, the greatest noise impacts and moderate adverse townscape impacts. Significant development would be required to the design presented at the public consultation for this option to achieve the RIS and Project objectives and to realise the economic benefits stated. The potential design changes would also increase the cost of the Option.

12.4.5 Option 5A has significant environmental impacts notable in terms of the impact on Ancient Woodland and protected species, cultural heritage and landscape. It has lower noise impacts and results in less severance. It would provide a higher quality road and would be safer for all road users and provide the greater Present Value of benefits with a benefit to cost ratio of 1.56.

If you need help accessing this or any other Highways England information, please call **0300 123 5000** and we will help you.