national highways

A27 Worthing and Lancing improvements scheme

Environmental Assessment Report (EAR)

February 2023

Table of contents

List of figures

List of tables

1 Introduction

1.1 Purpose of the report

This Environmental Assessment Report (EAR) has been prepared during National Highways' Project Control Framework (PCF) Stages 1 and 2 (Option Identification and Selection), which will progress concurrently. This document presents the environmental assessment that has been prepared to date for the proposed A27 Worthing and Lancing Improvement scheme (hereafter referred to as 'the scheme'). The objective of this assessment is to ensure that any adverse and/or beneficial effects of the scheme on the environment are identified and assessed accordingly and that any adverse effects are minimised or mitigated where possible. The scheme options are described in Chapter 2 of this report.

The EAR has been completed in accordance with the Design Manual for Roads and Bridges (DMRB) LA 104 Environmental assessment and monitoring[1]. It has also been informed by the information gathered through desktop studies. The environmental constraints identified within this EAR have been mapped and are included in Appendix A.

1.2 Overview of the project

The A27 corridor is the only east to west trunk road south of the M25, running between the A36 at Whiteparish (near Salisbury) in the west and Pevensey (near Eastbourne) in the east. Between Portsmouth and Lewes, it is one of the busiest trunk roads in the UK.

Although the A27 is mostly dual carriageway, it is one of the most unreliable all-purpose trunk roads in England due to bottlenecks and sections of single carriageway. The scheme area extends along the A27 from Offington roundabout in Worthing through to Busticle Lane in Lancing. The A27 corridor is bordered in part by the South Downs National Park to the north, the English Channel to the south and predominantly built-up areas along the route, resulting in limited infrastructure options that are possible and viable.

A long list of options was developed and refined during PCF Stages 1 and 2. This involved improvements along the A27 corridor between Offington roundabout and Busticle Lane along the Worthing A2032/A259 corridor.

[1] National Highways (2020) LA 104 – Environmental assessment and monitoring [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/0f6e0b6a-d08e-4673-8691-cab564d4a60a (last accessed January 2022).

Following the sifting process, three short-listed options were then taken forward for assessment during PCF Stages 1 and 2, and these have been considered within section 3.

1.3 Legislative and policy framework

It is likely that the scheme would comprise 'improvement works', as defined by Part V of the Highways Act 1980. As such, the assessment has been undertaken in accordance with the Environmental Impact Assessment (EIA) (Miscellaneous Amendments Relating to Harbours, highways and Transport) Regulations 2017[2] (hereafter referred to as 'the EIA Regulations'), which are the relevant EIA Regulations for schemes progressed through the Highways Act 1980.

It is anticipated that the scheme will cover an area in exceedance of one hectare and has the potential to impact sensitive environmental areas. As such, the scheme will be classed as an Annex II project and it is therefore deemed necessary to undertake screening for EIA.

To ascertain whether an EIA is required, National Highways will inform the Secretary of State of the conclusions of any environmental assessment undertaken to confirm whether significant effects are anticipated as a result of the scheme. The determination regarding EIA will be documented within the EIA Screening (Determination) PCF product, which will be completed at the end of PCF Stage 2 following the preparation of this report.

1.3.1 National Transport Policy and Planning Guidance

In accordance with the Transport Analysis Guidance[3] (TAG), it is important to first understand the current situation to inform the development of the scheme objectives and ultimately the generation of options. Therefore, the scheme has been considered in the context of relevant national, regional and local transport policy and planning guidance as set out below.

1.3.1.1 Road Investment Strategy

The Government developed the Road Investment Strategy[4] (RIS), which set out a long-term programme of improvements to the SRN with funding allocated accordingly. The RIS comprises of:

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[2] UK Parliament (2017). The Environmental Impact Assessment (Miscellaneous Amendments Relating to Harbours, Highways and Transport) Regulations 2017. Available at: The Environmental Impact Assessment (Miscellaneous Amendments Relating to Harbours, Highways and Transport) Regulations 2017 (legislation.gov.uk). [Accessed 06/04/22].

[3] Department for Transport (2013). Transport Analysis Guidance. Available at: Transport analysis guidance - GOV.UK (www.gov.uk). [Accessed 01/03/22].

[4] Department for Transport and National Highways (2014). Road investment strategy: 2015 to 2020. Available at: Road investment strategy: 2015 to 2020 - GOV.UK (www.gov.uk). [Accessed 06/04/22].

- a long-term vision for the SRN, outlining how the Department for Transport (DfT) and National Highways will create smooth, smart and sustainable roads
- a multi-year investment plan that will be used to improve the network and create better roads for users
- high level objectives for Road Period 1 (2015/16 to 2019/20)

1.3.1.2 National Highways' Strategic Business Plan

In order to meet the requirements of the RIS, National Highways produced the Strategic Business Plan, which describes how National Highways will deliver the investment plan and achieve the Performance Specification. The Performance Specification outlines the following eight areas that will be National Highways' focus:

- making the network safer
- improving user satisfaction
- supporting the smooth flow of traffic
- encouraging economic growth
- delivering better environmental outcomes
- helping cyclists, walkers, and other vulnerable users of the network
- achieving real efficiency
- keeping the network in good condition

This scheme is being considered for inclusion within the RIS 2 period. This is, however, subject to developing a successful business case in comparison to other schemes and the available budget for the RIS period as a whole.

A scheme within the study area would align with the objectives of the RIS in a number of ways. The improvement of a key strategic route on the SRN aligns with improving user satisfaction, making the network safer, supporting the smooth flow of traffic thereby facilitating economic growth aspirations.

1.3.1.3 National Infrastructure Plan 2013[5]

The National Infrastructure Plan (NIP) is a long-term sustainable plan for infrastructure planning, funding, financing and delivery from UK government, setting out a plan for the next decade and beyond. The NIP is based around providing the infrastructure that it believes the country needs now and in the future, as discussed below:

[5] HM Treasury (2013). National Infrastructure Plan 2013. Available at: National Infrastructure Plan 2013 (publishing.service.gov.uk) [Accessed: 13/03/22].

- meet current demand through the renewal of existing infrastructure:

extensive use of the UK's infrastructure, some of which is many decades old, means that maintenance and upgrades are essential to ensuring that current and future generations can continue to benefit from it; upgrading infrastructure also keeps running costs low and ensures smooth and efficient operation with minimal disruptions.

- meet future demand:

the Office for National Statistics forecasts that the UK population will grow to over 73 million people by 2035; this will create the need for better and more efficient infrastructure, serving more homes and increasing capacity on existing networks.

- grow a global economy:

the UK is both competing and collaborating with an ever-increasing number of countries around the world, attracting business and skilled labour, and trading in goods and services - if the UK wants to remain and grow as a global player it needs to have modern infrastructure networks, particularly in ports, airports and communications.

- address climate change and energy security:

the UK needs a resilient and secure energy supply that allows it to meet people's energy needs in a sustainable way; the UK will need to get 15 per cent of its energy generation from renewable sources by 2020; the need to meet these environmental targets also has broader knock-on effects for other infrastructure sectors.

A scheme within the study area would align with the NIP 2013 by increasing capacity on the SRN, seeking to reduce congestion, and improving reliability and resilience, encouraging economic growth.

1.3.2 National Highways Policy

1.3.2.1 National Highways Net Zero Highways

National Highways have developed a plan[6] to deliver net zero transport by 2050. There are three main sections to the plan and three associated commitments. These are the 2030 net zero target for corporate emissions, the 2040 net zero target for maintenance and construction emissions, and the 2050 net zero target for road user emissions. All three aspects of the plan are relevant to highways projects such as this scheme. However, the key area for influence will be in relation to the 2040 maintenance and construction emissions target. Within the 2040 target

[6] National Highways (2020). Net Zero Highways: our 2030 / 2040 / 2050 plan. Available at: https://nationalhighways.co.uk/media/eispcjem/net-zero-highways-our-2030-2040-2050-plan.pdf [Accessed 01/03/22].

there are interim targets and focus areas detailed in the plan which need to be considered including the current hotspots and the key actions noted to deliver net zero. The key actions to deliver net zero include: zero carbon construction products, zero carbon material transport, and digital roads.

1.3.3 National Planning Policy Framework

The National Planning Policy Framework (NPPF)[7] sets out the Government's planning policies for England and the requirements for the planning system. It provides a framework within which Local Authorities and residents can produce local and neighbourhood plans reflecting the needs and priorities of communities.

The NPPF seeks to promote a strong and competitive economy with Local Plans identifying 'priority areas for economic regeneration, infrastructure provision, and environmental enhancement'. In addition, the NPPF seeks to promote sustainable transport by encouraging solutions which support reductions in greenhouse gas emissions and reduce congestion.

1.3.4 Local planning policy

The local plans of Adur and Worthing District Councils, and the South Downs National Park Authority have been reviewed and where relevant, local planning policies have been considered for inclusion within this EAR. General policies of relevance to the scheme are summarised below, with topic specific policies summarised in Chapters 5 to 14.

1.3.4.1 Adur District Council Local Plan 2017

A key policy within the Adur District Local Plan[8] which is relevant to the scheme includes:

Policy 1: The Presumption in Favour of Sustainable Development – *'When considering development proposals the Council will take a positive approach that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework. It will always work proactively with applicants jointly to find solutions which mean that proposals can be approved wherever possible, and to secure development that improves the economic, social and environmental conditions in the area.'*

[7] Communities and Local Government (2019) National Planning Policy Framework [online] available at: Title (publishing.service.gov.uk) (last accessed January 2022).
[8] Adur District Council (2017), Adur Local Plan 2017. [online] Available at: https://www.adur-worthing.gov.uk/media/Media,159572,smxx.pdf (last accessed September 2022)

1.3.4.2 Worthing Borough Council Core Strategy 2011

A key policy within the Worthing Borough Council Core Strategy[9] which is relevant to the scheme includes:

- Policy 13: The Natural Environment and Landscape Character – *'…All new development will respect the biodiversity and natural environment that surrounds the development and will contribute to the protection and, where applicable the enhancement of the area…'*

1.3.4.3 South Downs National Park Local Plan

Key policies within the South Downs National Park Local Plan[10] which are relevant to the scheme include:

- SD1: Sustainable Development – *'…The National Park purposes are i) to conserve and enhance the natural beauty, wildlife and cultural heritage of the area; and ii) to promote opportunities for the understanding and enjoyment of the special qualities of the National Park by the public. Where it appears that there is a conflict between the National Park purposes, greater weight will be attached to the first of those purposes. In pursuit of the purposes, the National Park Authority will pay due regard to its duty to seek to foster the economic and social wellbeing of the local communities within the National Park.'*

- SD20: Walking, Cycling and Equestrian Routes – *'Development proposals will be permitted provided they contribute to a network of attractive and functional non-motorised travel routes, with appropriate signage, throughout the National Park.'*

- SD42: Infrastructure – *'Development proposals for new, improved or supporting infrastructure will only be permitted where: a) It represents the least environmentally harmful option reasonably available, also having regard to the operational requirements and technical limitations of the proposed infrastructure; and b) The design minimises the impact on the natural beauty, wildlife and cultural heritage of the National Park and the general amenity of local communities.'*

[9] Worthing Borough Council (2011) Core Strategy 2011 [online] available at: https://www.adur-worthing.gov.uk/media/Media,98859,smxx.pdf (last accessed September 2022)
[10] South Downs National Park (2019) South Downs Local Plan [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2019/07/SD_LocalPlan_2019_17Wb.pdf (last accessed September 2022)

2 The Project

2.1 Need for the project

The A27 Worthing and Lancing Improvement scheme was initially part of Road Investment Strategy 1 (RIS1), with a RIS1 statement that described the scheme as follows: “Improvements to the capacity of the road and junctions along the stretch of single carriageway in Worthing and narrow lane dual carriageway in Lancing. The extent and scale of the improvements, including the option of full dualling, are to be agreed in consultation with West Sussex County Council and the public.”

A single, online option (Option 1) which sought to improve six junctions along the corridor, was taken to public consultation between July and September 2017 and was opposed by 76% of those who responded. Due to this lack of key local stakeholder and public support, the RIS1 project was paused in November 2018.

The second Road Investment Strategy (RIS2), published by the Department for Transport (DfT) in March 2020, re-included improvements to the A27 at Worthing and Lancing. The new iteration of the scheme featured a revised RIS statement and objectives. The scheme is defined within RIS2 as a “Package of enhancements between Worthing and Lancing to improve the capacity and flow of traffic.”

The project then returned to Project Control Framework (PCF) Stage 0 (Strategy, Shaping and Prioritisation) in September 2020.

The A27 through Worthing and Lancing is a route that has three important roles, firstly to serve longer distance strategic traffic, secondly to serve local traffic, and thirdly as an access route to residential properties. The route will serve a growing population, which is forecast to increase from 111,000 to 122,000 by 2041[11].

There are many longstanding issues on the stretch of the A27 through Worthing and Lancing. This includes congestion during peak hour travel, which leads to delays with consequential impacts upon journey time reliability. Demand exceeds capacity at a number of links and junctions on the A27 through Worthing and Lancing, and the key bottlenecks are identified as:

- The single carriageway section between Offington Corner and Sompting Road
- Offington Corner junction – a priority-controlled roundabout that exceeds capacity on both the A24 and A27 approaches, and has high circulating traffic flows resulting in reduced gaps to enter the circulatory carriageway

[11] Office for National Statistics (2020) Population projections for local authorities: Table 2. Available at: Population projections for local authorities: Table 2 - Office for National Statistics [Accessed: 1/10/21].

- Grove Lodge junction – a signal-controlled roundabout that operates at over capacity
- Sompting Road / Lyons Farm junctions – two signal-controlled crossroads that operate at over capacity. A short westbound merge between the two junctions results in conflict
- Busticle Lane junction – a signal-controlled crossroads that has high flows on the A27 mainline and high turning flows when it exceeds capacity

Without any action to address the congestion along the A27, and with traffic volumes forecast to grow by approximately 25% by 2041, all three functions of the corridor will continue to routinely under-deliver.

A negative consequence of congestion and delays on the corridor is that traffic diverts away from the A27 to alternative routes that are less suited to high volumes of traffic.

By improving the capacity and the flow of traffic along the A27 corridor, pressures on the local road network would be reduced and would also help meet National Highways' Strategic Vision for the RIS by:

- Providing safe, reliable, predictable and rapid journeys for both people and goods between the main centres of populations, major ports, airports and rail terminals, and regions within England
- Supporting a high quality and resilient transport network for all users

Addressing the fundamental issues presented along the A27 corridor through Worthing and Lancing are aligned with the requirements set out within the National Highways' Strategic Business Plan as follows:

- The creation of a safe, dependable and durable road network which is well-operated and maintained

2.2 Project objectives

The project objectives, along with supporting objectives, were defined during the PCF Stage 1 Value Management Workshop held in April 2021, which are aligned with the National Highways' Business Plan's performance goals. The Value Management Workshop used the PCF Stage 0 Client Scheme Requirements as the basis of the discussion to develop and agree the objectives. A Value Management Workshop report[12] was then produced to record this process. The agreed objectives are shown in Table 2-1.

[12] National Highways (2021). A27 Worthing and Lancing Stage 1 Value Management Workshop Report.

Table 2-1: Scheme objectives identified in the Value Management Workshop

Category	Agreed objective	Supporting objectives
Improving safety for all (health, safety, security and wellbeing)	Improve road safety for all on the A27 and alternative local road network in the Worthing and Lancing areas.	Reduction in the number of accidents.
Providing fast and reliable journeys (customers)	Reduce delays and improve journey times for the Worthing and Lancing areas.	Decrease journey times. Reduction of congestion, queuing and delays on A27.
		Reduction of rat-running through local roads.
Meeting the needs of all users (people and communities)	Not impede future enhancements to transport in the scheme area.	Incorporating local cycling and walking infrastructure plan (LCWIP).
	Provide for alternative travel modes along the A27 and crossing the A27 in the Worthing and Lancing areas.	Improve bus stop provision.
		Provision of walking and cycling crossing facilities where needed.
Being environmentally responsible (environment)	Ensure that the scheme does not result in any significant adverse environmental effects and seek opportunities for enhancements.	Minimise adverse impacts on air quality.
		Minimise adverse impacts on noise.
		Minimise adverse impacts on heritage assets.
		Minimise adverse impacts on designated sites *(including the South Downs National Park).*
		Minimise adverse impacts on water environment.
		Minimise carbon emissions.
		Opportunities for biodiversity net gain.

2.3 Project location

The A27 corridor runs along the northern edge of Worthing and Lancing and sits partially adjacent to the south of the South Downs National Park. Figure 2.1 shows the location of the scheme in respect of the series of junctions, with Figure 2.2 illustrating the nearby urban areas of Worthing, Lancing, Washington, Steyning, Shoreham-by-Sea and Brighton. Appendices A.1 to A.6, within Appendix A, set out the relevant environmental constraints in respect to each of the scheme options.

Figure 2.1 : Indicative scheme extent

Figure 2.2: Scheme location plan

There are no internationally recognised nature conservation sites, designated under Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the EC Habitats Directive) or under Council Directive 2009/147/EC on the conservation of wild birds (the EC Birds directive), identified within the scheme extents or within 2km of the scheme options. However, nationally and locally designated sites of historical, landscape and nature conservation interest are located within the footprint (or within close proximity) of the scheme options. They are as follows:

- Three Special Areas of Conservation (SAC), including The Mens SAC (located approximately 18.6km from the scheme), Ebernoe Common SAC (located approximately 24.1km from the scheme), and Singleton and Cocking Tunnels SAC (located approximately 26km from the scheme), are within 30km of the scheme.
- Two Sites of Special Scientific Interest (SSSI) (Cissbury Ring SSS and Adur Estuary SSSI) are located within 2km of the scheme.
- Nine local sites for nature conservation are located within 1km of the scheme (The Gallops and No Man's Land Local Wildlife Site (LWS), Tenants Hill and Reservoirs LWS, Offington Cemetery LWS, Worthing and Hill Barn Golf Courses (including Deep Bottom and Vineyard Hill LWSs), Cokeham Brooks LWS, The Sanctuary, High Salvington LWS, Clapham Wood LWS, and Lancing Ring Local Nature Reserve (LNR) and LWS)
- Thirty-two known designated historic environmental assets have been identified within 300m of the scheme (24 grade II listed buildings, three grade I listed buildings and five Conservation Areas)
- Five Noise Important Areas are located within 300m of the scheme (ID215, ID222, ID176, ID224 and ID13815)
- The scheme is partially located within the Worthing Air Quality Management Area (AQMA)

2.4 Project description

The extent of the scheme is approximately 9.5 kilometres long, from Offington roundabout (Worthing) to Busticle Lane junction (Lancing). The route passes through the northern parts of Worthing and Lancing and is bordered in part by the South Downs National Park.

The A27 is the only east to west trunk road south of the M25, linking key coastal communities between Portsmouth and Eastbourne and the rest of the strategic road network (SRN). It serves a population of over 750,000 people and a large number of businesses in the major towns and cities along the route. The A27 is subsequently used by both local traffic and through-traffic.

The series of junctions on the A27 through Worthing and Lancing cannot handle existing traffic flows during peak times which often results in long queues of traffic.

Due to traffic congestion on the A27, some longer distance traffic diverts to use less suitable routes to the north and south, some of which are through the South Downs National Park. These local roads are not suited to large volumes of traffic and as a result, the safety of these roads is compromised.

The purpose of this scheme is to improve the existing junctions to support current and future traffic by widening approaches to the existing roundabouts, such as Offington Corner and Grove Lodge, and widening circulatory carriageways where possible or providing additional lanes through junctions as proposed on the Sompting Road / Lyons Way junction. It would also improve safety on the A27 and alternative local roads in the scheme area by providing additional signalised crossings and installing the new traffic signals on the existing junctions and pedestrian crossings, as well as cutting rat-running on local roads by amending Upper Brighton Road to become a one-way road.

The options considered within this assessment are described below.

2.4.1 Option 1

This option consists of two interventions on the SRN. The interventions proposed as part of Option 1 are set out in Appendix B.1.

The SRN interventions comprise of upgrades to the following junctions and existing arrangements:

- Offington Corner Junction: As illustrated in sheet 1, Appendix B.1 (HE608509-MMD-HGN-OP01-DR-CH-0001-P03.1), access would be closed to and from Goodwood Road, and upgrades would be made to the Findon Road to Offington Lane movements by installing two new exit lanes from the roundabout to Offington Lane with traffic signals (three streams).
- Grove Lodge Junction: As illustrated in sheet 2, Appendix B.1 (HE608509-MMD-HGN-OP01-DR-CH-0002-P03.1), the roundabout layout would be modified which would improve the flow of traffic and increase capacity. New and upgraded crossings for pedestrians and cyclists would be installed to make it safer and easier to cross.

The interventions for Option 1 would require marginal land take from outside of the existing highway boundary. However, land take would be kept to a minimum, and would involve areas adjacent to the existing carriageway. Land take would be limited to the loss of vegetation only, consisting of scattered trees interspersed across the scheme, tall ruderal, scrub and amenity grassland only. Furthermore, all land take associated with Option 1 would be purchased from the Local Authority.

2.4.2 Option 2

Option 2 consists of four SRN interventions. The interventions proposed as part of Option 2 are set out in Appendix B.2.

The four SRN interventions are as follows:

- Offington Corner Junction: As illustrated in sheet 1, Appendix B.2 (HE608509-MMD-HGN-OP02-DR-CH-0001-P03.1), access would be closed to and from Goodwood Road, and upgrades would be made to the Findon Road to Offington Lane movements by installing two new exit lanes from the roundabout to Offington Lane with traffic signals (three streams). This intervention is also included as part of Option 1.
- Grove Lodge Junction: The existing roundabout would be converted to a part-time traffic signal-controlled roundabout. This is shown in sheet 2, Appendix B.2 (HE608509-MMD-HGN-OP02-DR-CH-0002-P03.1).
- Lyons Way Sompting Junction: As illustrated in sheet 3, Appendix B.2 (HE608509-MMD-HGN-OP02-DR-CH-0003-P03.1), this intervention would involve widening the existing junction, providing traffic signal controls and new and upgraded pedestrian and cycle crossings. Safety would be improved by signalising the left turn from Lyons Way onto the A27 eastbound. Hadley Avenue and Pines Avenue would both be 'left in/left out' access on and off the A27. Improvements would be made to existing facilities by upgrading all existing pedestrian crossings which can now accommodate cyclists.
- Upper Brighton Road: This would involve improvements to Upper Brighton Road between Lyon's Way and Church Lane, shown in sheet 3, Appendix B.2 (HE608509-MMD-HGN-OP02-DR-CH-0003-P03.1), by converting Upper Brighton Road to one-way from east to west.

The interventions for Option 2 would require marginal land take from outside of the existing highway boundary. However, land take would be kept to a minimum, and involve areas adjacent to the existing carriageway. Land take would be limited to the loss of vegetation only, consisting of scattered trees interspersed across the scheme, tall ruderal, scrub and amenity grassland only. One small parcel of land associated with Option 2 would be purchased from a business, which would not affect its operational function, whilst the remaining land take would be purchased from the Local Authority.

2.4.3 Option 3

Option 3 comprises four SRN interventions. The interventions proposed as part of Option 3 are set out in Appendix B3.

The four SRN interventions are as follows:

- Offington Corner Junction: As illustrated in sheet 1, Appendix B.3 (HE608509-MMD-HGN-OP03-DR-CH-0001-P03.1), access would be closed to and from Goodwood Road, and upgrades would be made to the Findon Road to Offington Lane movements by installing two new exit lanes from the roundabout to Offington Lane with traffic signals (three streams). This intervention is also included as part of Options 1 and 2.

- Grove Lodge Junction: This would require the existing roundabout to be converted to a part-time traffic signal-controlled roundabout. This is illustrated in sheet 2, Appendix B.3 (HE608509-MMD-HGN-OP03-DR-CH-0002-P03.1). This intervention is also included as part of Option 2.
- Upper Brighton Road: This would involve the conversion of Upper Brighton Road to one-way from east to west. This intervention is shown in sheet 3, Appendix B.3 (HE608509-MMD-HGN-OP03-DR-CH-0003-P03.1). This intervention is also included as part of Option 2.
- Busticle Lane Junction: This would involve a change in junction design from a staggered signal-controlled junction with two sets of lights to an enlarged signal controlled cross-road, similar to the existing configuration, as set out in sheet 4, Appendix B.3 (HE608509-MMD-HGN-OP03-DR-CH-0004-P03.1). To increase capacity at the junction, access from Hillbarn Parade to the A27 eastbound would be closed. New and upgraded pedestrian and cyclist crossings would also be provided as part of the improvements at this location.

The interventions for Option 3 would require marginal land take from outside of the existing highway boundary. However, land take would be kept to a minimum, and would involve areas adjacent to the existing carriageway. Land take would be limited to the loss of vegetation only, consisting of scattered trees interspersed across the scheme, tall ruderal, scrub and amenity grassland only. Furthermore, all land take associated with Option 3 would be purchased from the Local Authority.

2.5 Construction, operation and long-term management

The approach to construction, operation and long-term management described in this section is indicative and subject to change during preliminary and detailed design but is representative of the likely approach to be adopted.

2.5.1 Construction

The construction phase associated with the scheme is anticipated to be from March 2025 to September 2026 (PCF Stage 6). The exact construction duration remains unknown at present as the preferred route has not yet been selected. The programme currently estimates a construction period of approximately 18 months.

2.5.2 Operation

If the scheme progresses under the legislative and policy framework detailed in section 1.3, the scheme is expected to be open to traffic in 2026.

2.5.3 Maintenance

It is currently anticipated that short-term maintenance would be required approximately 12 years after the scheme becomes operational, whilst long-term maintenance is expected to be required after 40 years.

3 Assessment of Alternatives

3.1 Assessment methodology

During Project Control Framework (PCF) Stages 1 and 2, a range of alternative scheme interventions were considered and assessed using the National Highways' option sifting tool. The sifting tool aims to provide a rigorous overview of the interventions presented, level of evidence available, and a qualitative assessment of their impacts based on this evidence. As the assessment was qualitative, the scoring criteria at this stage had been subject to a sensitivity test during the initial sifting exercise to ensure that there had been sufficient differentiation between the interventions presented.

The options sifting tool was split into three distinct phases:

1. The overview of the sift.
2. Sift 1 to remove wholly unfeasible options.
3. Sift 2 to determine the best performing options to assess further.

The first section of the tool related to setting out the basis of the sift, listing out the objectives and the interventions to be sifted.

The objectives were aligned with the performance outcomes in National Highways' strategic business plan. Once the performance objectives had been agreed, a number of supporting objectives were generated during the scheme's Value Management Workshop. The outputs of the Value Management Workshop are explained in Section 2.1 whilst the objectives are set out in Section 2.2. Once the objectives and supporting objectives had been set, environmental sifting criteria was then generated, using the objectives as the basis, in order to sift each intervention in a consistent manner. The environmental sifting scoring criteria was consistent with the other performance factors for the scheme, using a range from large positive impact to large negative impact. Table 4.2 of the A27 Worthing and Lancing Sifting Methodology (HE608509-MMD-HGN-OP00-RP-CH-0001) provides further guidance on the sifting methodology undertaken for the option sifting process.

3.2 Reasonable alternatives studied

During PCF Stages 1 and 2, the current scheme options were sifted against various criteria that includes environmental considerations, as set out in section 3.1.

3.2.1 Sift 1

Sift 1 was undertaken in early September 2021 to remove the wholly infeasibly interventions. The process removed 27 strategic road network (SRN), with 24 in

total passing through to Sift 2. The outcome of Sift 1 is shown in Table B.1 of the scheme's Staged Overview of Assessment Report[13].

Sift 1 reduced the SRN longlist from 51 to 24. The most common reasons for rejection were: infeasible delivery within the scheme budget, lack of predicted benefit over the base case, significant land take, and the demolition of properties. Grade-separated interventions typically performed the best from a traffic modelling perspective but were all rejected during the sift due to high predicted costs, significant land-take and required property demolition.

3.2.2 Sift 2

Sift 2 was undertaken in mid-September 2021 to shortlist the interventions and identify those that should be developed and assessed further. It was decided that as several of the interventions were similar in nature, applying a scoring methodology and then selecting the top scoring options would very likely end up with several almost identical options chosen, which would not provide a robust assessment of the options available at the junctions. This is particularly acute at this stage in the design process where traffic modelling data is unavailable and detailed environmental assessment has not yet been undertaken, so a qualitative analysis is used instead. A view was instead taken to choose the best performing intervention or interventions from each type based on the available information. The outcome of the Sift 2 workshop is shown in Table B.1 and Table B.2 of the scheme's Staged Overview of Assessment Report[13].

Eight SRN interventions were selected for further development and assessment following Sift 2. The most common reasons for interventions not being selected were significant local impacts from construction, traffic management and land-take requirements, and other interventions at the same location being able to offer better cost and benefit values.

3.2.3 Options selected for further development

Following the sifting exercise, the selected interventions were combined to form three individual delivery packages (termed 'options'), guided by the scheme budget constraints, land constraints, and maximising benefit for all users. These options and their respective interventions are set out in Table 3-1, and described in detail within the preceding subsections.

Table 3-1: Summary of options

Option 1	Option 2	Option 3
A27 Offington Corner Roundabout A27 Grove Lodge Roundabout	A27 Offington Corner Roundabout A27 Grove Lodge Roundabout	A27 Offington Corner Roundabout A27 Grove Lodge Roundabout Upper Brighton Road

[13] National Highways (2022). A27 Worthing and Lancing Improvements Scheme: Staged Overview of Assessment Report.

Option 1	Option 2	Option 3
	A27 Lyons Way/Sompting Road Junction Upper Brighton Road	A27 Busticle Lane Junction

Please refer to Section 2.4 for further information relating to the three scheme options.

4 Environmental assessment methodology

4.1 Environmental scoping

An Environmental Scoping Report (ESR) (HE608509-MMD-ENG-OP00-RP-LE-0003) was prepared during National Highways' Project Control Framework (PCF) Stages 1 and 2 (Option Identification and Selection). The main aims of the ESR were as follows:

- To identify and report the baseline conditions of the existing environmental asset
- To determine which (if any) environmental topics are to be further examined in the course of the environmental assessment at PCF Stages 1 and 2
- To inform Project and Design Managers of all relevant environmental constraints present, therefore ensuring adverse effects can be minimised, and that the environmental assessment process is iterative
- To identify if there are any opportunities for environmental enhancement associated with the site of the proposed works that could simply be incorporated into the proposed design

The ESR was completed in accordance with the Design Manual for Roads and Bridges (DMRB) LA 104 Environmental assessment and monitoring[14]. It was also informed by the information gathered through desktop studies.

The outcomes of the PCF Stages 1 and 2 ESR confirmed the scope for further assessment of environmental topics, which is presented within this report. Table 4-1 provides a summary of the conclusions of the ESR which identified whether further environmental assessment was required on a topic-by-topic basis.

Table 4-1: Summary of the requirement for further assessment within this Environmental Assessment Report

Topic	Scoped in	Scoped out	Justification for scoping out where applicable
Air quality	Construction and Operation	n/a	n/a
Cultural heritage	n/a	Construction and Operation	Due to the limited nature of the archaeological baseline and the

[14] National Highways (2020) LA 104 – Environmental assessment and monitoring [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/0f6e0b6a-d08e-4673-8691-cab564d4a60a (last accessed January 2022).

Topic	Scoped in	Scoped out	Justification for scoping out where applicable
			minor impact of proposed works upon the significance of the identified heritage assets, it is recommended that cultural heritage is scoped out of the Environmental Assessment Report.
Landscape and visual	Construction and Operation	n/a	n/a
Biodiversity	Construction and Operation	n/a	n/a
Geology and soils	n/a	Construction and Operation	No designated geological features within 500m of the scheme. Soils within the scheme are overlain by existing hardstanding and/or form part of existing grass verges therefore not introducing any additional land take. The completed and operational scheme is not expected to result in any significant adverse effects on geology or soils. The impacts relating to controlled waters will be addressed in the road drainage and water environment assessment.
Material assets and waste	Construction	Operation	No significant effects relating to the operation of the scheme are anticipated on material assets as significant maintenance, repairs and replacements would be infrequent and unlikely to require large volumes of materials, therefore, it is proposed that this element if scoped out of further assessment. Waste produced during the operational phase of the scheme would be managed under existing/new contracts and unlikely to generate large volumes of waste requiring disposal or treatment.
Noise and vibration	Construction and Operational Noise	Operational vibration	DMRB LA 111 notes that “operational vibration is scoped out of the assessment methodology as a maintained road surface will be free of irregularities as part of project

Topic	Scoped in	Scoped out	Justification for scoping out where applicable
			design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effects". Operational vibration is therefore scoped out from further assessment.
Population and human health	Construction and Operation	n/a	n/a
Road drainage and the water environment	Construction and Operation	n/a	n/a
Climate	Construction and Operation	n/a	n/a
Major accidents and disasters	Construction and Operation	n/a	n/a
Heat and radiation	n/a	Construction and Operation	Due to the nature of the scheme as a road improvement scheme, it is considered unlikely that heat and radiation effects associated with the proposals are likely to arise.

4.2 Surveys and predictive techniques and method

Information gathered through desktop studies and site surveys, including a phase 1 habitat survey, have been collated to inform this report. The environmental constraints identified within this report have been mapped and are included in Appendix A.

It should be noted that several assessments, including air quality, noise, and climate, are reliant on traffic modelling information. Traffic modelling methods to be used for this scheme include the three models listed below.

4.2.1.1 Base traffic model

The traffic model for the scheme in PCF Stages 1 and 2 has been based on the modelling previously carried out for the PCF Stage 1 Arundel Bypass and Worthing and Lancing Improvement schemes, as well as an updated base model used for the PCF Stage 3 Arundel Bypass scheme. These models were further enhanced in the corridor anticipated to be affected by the scheme and updated to align with local traffic data for 2019. Additional network and zonal detail have been added to enhance the modelling response of the proposed improvements.

The base model time periods align with the models received and for each period represent an average one-hour peak period model. The AM model represents the

period of 7am-10am, the interpeak (IP) an average hour for the period of 10am-4pm, and the PM an average hour for the period of 4pm-7pm.

Due to the impact of the Covid-19 pandemic on traffic patterns, it was not appropriate to collect additional traffic data, therefore the enhanced traffic model for the scheme is validated to a 2019 base year making best use of existing data.

4.2.1.2 Forecast Do-Minimum model

Traffic forecasts have been prepared for the opening year for the scheme, 2027, the scheme design year, 2042, and a horizon year of 2051. The forecasts used the Department for Transport's (DfT) National Trip End Model (NTEM / TEMPRO v7.2) and Road Traffic Forecasts (RTF) 2015 forecasting data as well as accounting for local developments and committed schemes withing the model corridor, which has been assessed in an uncertainty log in accordance with WebTAG unit M4.

4.2.1.3 Forecast Do-Something model

These forecast models align with the 'Do-Minimum' models as well as incorporating the proposed corridor improvements.

Variable demand modelling has been used to consider the impact of the scheme with regards to time of travel, mode choice and distribution of travel patterns.

4.3 General assessment assumptions and limitations

4.3.1 Assumptions and limitations

Assumptions associated with the scheme design and construction methodology are described below. Topic-specific assumptions and limitations have been outlined in each of the individual environmental topic chapters (Chapters 5 to 12).

4.3.1.1 Scheme design

This report is based on the scheme design options selected at PCF Stages 1 and 2 (refer to the scheme description in Section 2.4) during the sifting process (refer to the sifting process in Section 3).

4.3.1.2 Construction information

The scheme is currently at PCF Stages 1 and 2 (Option Identification and Option Selection) and therefore specific information regarding construction methodology and site compound areas is not available as a contractor has not yet been selected at this stage. This information will become available at PCF Stage 3 (Preliminary Design) when buildability information will be available for the preferred option.

4.4 Significance criteria

The output of the environmental assessment is to report the likely significance of effects using established significance criteria, as presented within DMRB LA 104.

This requires an assessment of the receptor or resource's environmental value (or sensitivity) and the magnitude of project's impacts (change).

The DMRB states that the approach to assigning significance of effect relies on reasoned argument, professional judgement and taking on board the advice and views of appropriate organisations. For some factors, predicted effects may be compared with quantitative thresholds and scales in determining significance. Each environmental assessment chapter within the Environmental Assessment Report (EAR) will describe the specific thresholds / criteria used to determine value / magnitude / sensitivity (as set out within the assessment methodology section of chapters 5-13) and will align with the general methodology described within this section.

Assigning values to the relevant receptors for each discipline enables different environmental receptors to be placed upon the same scale and can assist with the process of assigning significance.

Table 4-2 below outlines the five value categories used to define the sensitivity of a receptor.

Table 4-2: Descriptions of environmental value (sensitivity)

Value (sensitivity) of receptor / resource	Typical description
Very High	Very high importance and rarity, international scale and very limited potential for substitution.
High	High importance and rarity, national scale, and limited potential for substitution.
Medium	Medium or high importance and rarity, regional scale, limited potential for substitution.
Low	Low or medium importance and rarity, local scale
Negligible	Very low importance and rarity, local scale.

Source: DMRB Volume 11, LA 104, Table 3.2N

The descriptions for defining the magnitude of impact on receptors are set out in Table 4-3.

Table 4-3: Magnitude of impact and typical descriptions

Magnitude of impact (change)		Typical description
Major	Adverse	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.
	Beneficial	Large scale or major improvement of resource quality; extensive restoration; major improvement of attribute quality.
Moderate	Adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements.

Magnitude of impact (change)		Typical description
	Beneficial	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Minor	Adverse	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
	Beneficial	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
Negligible	Adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements.
	Beneficial	Very minor benefit to or positive addition of one or more characteristics, features or elements.
No change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Source: DMRB Volume 11, LA 104, Table 3.4N

For the majority of environmental assessment chapters, the environmental value will be determined for each of the receptors that have been carried forward from the scoping exercise for further environmental assessment, along with the magnitude of change. Five significance categories can result from the assessment, as defined in Table 4-4. It is important to note that significance categories are required for positive (beneficial) as well as negative (adverse) effects. The greater the magnitude of impact, the more significant the effect. For example, the consequences of a highly valued environmental resource suffering a major detrimental impact would be a significant adverse effect. For the majority of environmental assessment chapters, effects that are Moderate Beneficial / Adverse or above will be considered significant.

Table 4-4: Significance categories

Environmental Value (Sensitivity)	Magnitude of potential impact (Degree of change)					
	No change	Negligible	Minor	Moderate	Major
Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

Source: DMRB Volume 11, LA 104, Table 3.8.1

Assigning each effect to one of the five significance categories enables different environmental issues to be placed upon the same scale, to assist the decision-

making process at whatever stage the project is at within that process. These five significance categories are set out in Table 4-5 below.

Table 4-5: Descriptions of the significance of effect categories

Significance category	Typical descriptors of effects
Very Large	Effects at this level are material in the decision-making process
Large	These beneficial or adverse effects are very important considerations and are likely to be material in the decision-making process.
Moderate	Effects at this level can be considered to be material decision-making factors.
Slight	Effects at this level are not material in the decision-making process.
Neutral	No effects or those that are beneath levels of perception, within normal bounds or variation or within the margin of forecasting error.

Source: DMRB Volume 11, LA 104, Table 3.7

There are a number of environmental topics which, for various reasons, do not follow this methodology exactly for defining significance. Where this is the case, the criteria used to determine the significance of effects is outlined in these individual chapters. This applies to the following chapters: Chapter 11 Material assets and waste, Chapter 12 Noise and vibration, and Chapter 15 Climate (effects on climate).

4.5 Major accidents and disasters

The EIA Regulations require an assessment of "the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents or disasters which are relevant to the project concerned." As per DMRB LA 104, the scope of the assessment will cover:

- Vulnerability of the scheme to risks of major accidents or disasters
- Any consequential changes in the predicted effects of that scheme on environmental topics as a result of major accidents and/or disasters

It is considered that there would not be any impacts associated with the scheme as a result of major accidents and disasters during the construction and operation phases for the following reasons:

- The scheme is not considered to have high vulnerability to major accidents or disasters. Although the legislation is not explicit, the language of the revised EIA Regulations is directed towards hazardous industries or operations (those with a high vulnerability to major accidents).
- The design, construction and operation of the scheme must comply with legal requirements, codes and standards, such as:

- Health and Safety at Work etc. Act 1974
- The Management of Health and Safety at Work Regulations (1999)
- The Workplan (Health, Safety and Welfare) Regulations 1992
- Design Manual for Roads and Bridges (DMRB)

- The term major accidents and disasters refers to events both within and external to the scheme that have the potential to cause significant harm to the environment (including but not limited to populations, biodiversity, land, soil, water, air, material assets, cultural heritage).

The impact of any unplanned events (accidents or disasters) should be considered against the current baseline conditions. The volume and type of traffic using the scheme would not change significantly from that using the current road alignment, and therefore it is reasonable to conclude that there is no general increase in risk.

Notwithstanding the following specific issues have been reviewed:

- The potential for construction-related accidents, causing harm to construction workers, are not within the scope of this environmental assessment, unless these could also cause harm to an environmental receptor including members of the public beyond the boundaries of the construction site. Existing legislation around safe working practices and Construction, Design and Management would ensure that such risks are mitigated appropriately without the need for further assessment.
- The potential for extreme weather events, combined with the presence of the scheme (for example, the scheme affecting flood patterns) would be adequately assessed within the road drainage and the water environment chapter and the climate chapter, without the need for further assessment.
- The potential for other external hazards to impact the scheme, such as earthquakes, landslides, mine collapse or sinkholes, will, where relevant, be covered within the design requirements of DMRB and will not require further assessment.
- Accidental spillage of contaminants such as hydrocarbons and their subsequent release into the drainage system will be considered in the road drainage and water environment chapter.
- There are no registered Control of Major Accident Hazards (COMAH) sites with three miles of the scheme and therefore no need to consider any associated risks.
- The safety of the scheme will be evaluated through a road safety audit, which will be undertaken during design, at the end of construction and post-construction, to identify road safety problems and to suggest measures to eliminate or mitigate any concerns.

In summary and as justified above, major accidents and disasters will be sufficiently addressed within the scheme design and relevant technical chapters where required.

4.6 Heat and radiation

The Environmental Impact Assessment (EIA) Regulations require consideration of the likely effects associated with heat and radiation. Due to the nature of the scheme as a road improvement scheme, it is considered unlikely that heat and radiation effects associated with the scheme are likely to arise. Further assessment as part of this report has therefore been scoped out.

4.7 Traffic and transport

Although the scheme is defined as a highways project, a traffic and transport assessment is not a requirement of an environmental assessment undertaken in accordance with the DMRB. However, to ensure traffic and transport impacts of the scheme during construction and operation are assessed, a traffic assessment will be carried out in accordance with National Highways PCF product matrix. The results of this assessment will then be presented within the scheme's Combined Modelling and Appraisals Report (ComMA) at the end of PCF Stages 1 and 2. The ComMA is an 'end of stage' report, which intends to comprehensively report all assessments relating to traffic, economics and environment undertaken throughout the PCF Stage.

5 Air quality

5.1 Legislative and policy framework

5.1.1 Legislation

The Air Quality Standards Regulations 2010[15], Air Quality Standards (amendment) Regulations 2016[16], Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019[17], and Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[18] implement Directive 2008/50/EC on ambient air quality[19].

These define limit values and times by which they are to be achieved for the purpose of protecting human health and the environment by avoiding, reducing, or preventing harmful concentrations of air pollutants.

The limit values apply everywhere, with the exception of:

- Any locations situated within areas where members of the public do not have access and there is no fixed habitation
- In accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply
- On the carriageway of roads
- On the central reservations of roads except where there is normally pedestrian access to the central reservation

The Department for Environment Food and Rural Affairs (Defra) assesses and reports on the compliance with the limit values for each of the 43 zones and agglomerations across the UK. Zones and/or agglomerations achieve compliance when everywhere within the zone and/or agglomeration (except locations provided in the Directive) does not exceed the relevant limit value.

Part IV of the Environment Act 1995[20] (as amended in Schedule 11 of the Environment Act 2021[21]) requires that every local authority shall periodically carry

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[15] Statutory Instrument. (2010), *The Air Quality Standards Regulations,* No. 1001.
[16] Statutory Instrument. (2016) *The Air Quality Standards (Amendment) Regulations*, No. 1184.
[17] Statutory Instrument. (2019) Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations
[18] Statutory Instrument. (2020) Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, No. 1313.
[19] European Union. (April 2008) *Directive on ambient air quality and cleaner Air for Europe, Directive 2008/50/EC* Official Journal, vol. 152, pp. 0001-0044
[20] Department for Environment Food and Rural Affairs. (2003) Part IV of the Environment Act 1995 Local Air Quality Management
[21] Statutory Instrument. (2021) Chapter 30, Schedule 11 Local Air Quality Management Framework of Environment Act 2021.

out a review of air quality within its area, including predictions of likely future air quality. The air quality objectives (AQO) specifically for use by local authorities in carrying out their air quality management duties are set out in the Air Quality (England) Regulations 2000[22] and the Air Quality (England) (Amendment) Regulations 2002[23]. In most cases, the air quality objectives are set at the same pollutant concentrations as the limit values specified in the air quality Directive although compliance dates differ.

As part of the review of air quality, the local authority must assess whether air quality objectives are being achieved, or are likely to be achieved within the relevant periods and identify the key sources of emissions responsible for the failure to achieve the objectives. Any parts of a local authority's area where the objectives are not being achieved or are not likely to be achieved within the relevant period must be identified and declared as an Air Quality Management Area (AQMA). Once such a declaration has been made, local authorities are under a duty to prepare an Action Plan which sets out measures to pursue the achievement of the air quality objectives within the AQMA.

The Environment Act requires the UK Government to produce a national Air Quality Strategy (AQS). The AQS establishes the UK framework for air quality improvements. The 2007 AQS[24] has now been superseded as of the 14 of January 2019 with the Clean Air Strategy 2019 (CAS)[25].

The CAS does not set legally binding objectives, the CAS instead has targets for reducing total UK emissions of nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$) from sectors such as road transport, domestic sources and construction plant (non-road mobile machinery or NRMM).

Air quality objectives and limit values relevant to the scheme are summarised in Table 5-1.

Table 5-1: Relevant Air Quality Objectives and Limit Values

Pollutant	Averaging Period	Concentration	Allowance	Attainment Date	
				Air Quality Objectives	Limit Values
Nitrogen dioxide (NO_2)	Annual	40 µg/m^3	-	31 December 2005[(a)]	1 January 2010[(c)]
	1 Hour	200 µg/m^3	18	31 December 2005[(a)]	1 January 2010[(c)]

[22] Statutory Instrument. (2000) Air Quality (England) Regulations, No. 928
[23] Statutory Instrument. (2002) Air Quality (England) (Amendment) Regulations, No. 3043.
[24] Department for Environment Food and Rural Affairs. (July 2007), 'The Air Quality Strategy for England, Scotland, Wales and Northern Ireland', Cm 7169, Department for Environment Food and Rural Affairs.
[25] Department for Environment Food and Rural Affairs. (January 2019), 'The Clean Air Strategy'

Pollutant	Averaging Period	Concentration	Allowance	Attainment Date	
				Air Quality Objectives	Limit Values
Particulates (PM_{10})	Annual	40 µg/m^3	-	31 December 2004[a]	1 January 2005[c]
	24 Hour	50 µg/m^3	35	31 December 2004[a]	1 January 2005[c]
Fine particulates ($PM_{2.5}$)[e]	Annual	20 µg/m^3	-	-	1 January 2020[c]
		25 µg/m^3	-	2020[b]	-
Oxides of nitrogen (NO_x)[d]	Annual	30 µg/m^3	-	31 December 2000[a]	19 July 2001[c]

Notes:
[a] Air Quality (England) Regulations 2000 as amended
[b] Air Quality Strategy 2007
[c] EU Directive 2008/50/EEC on ambient air quality and cleaner air for Europe, as transposed into UK Law
[d] Designated for the protection of vegetation and ecosystems and also referred to as the 'critical level' for NOx. The policy of the UK statutory nature conservation agencies is to apply the annual mean NOx criterion in internationally designated conservation sites and Site of Special Scientific Interest (SSSI) on a precautionary basis, as the limit value applies only to locations more than 20km from towns with more than 250,000 inhabitants or more than 5km from other built-up areas, industrial installations or motorways.
[e] As the Air Quality Strategy 2007 and EU Directive 2008/50/EC have a different numerical standard for $PM_{2.5}$, the more stringent standard of 20µg/m^3 has been adopted for this assessment.

Table 5-2 provides details of where the respective objectives should and should not apply and therefore the types of receptors that are relevant to the assessment of air quality.

Table 5-2:Locations where the Air Quality Objectives Apply

Averaging Period	Objectives should apply at:	Objectives should not apply at:
Annual	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes, etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24-Hour	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
1-Hour	All locations where the annual mean and 24-hour mean objectives apply.	Kerbside sites where the public would not be expected to have regular access.

Averaging Period	Objectives should apply at:	Objectives should not apply at:
	Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations, etc., which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	

Source: Defra Local Air Quality Management Technical Guidance (LAQM TG16)[26].

5.1.1.1 Statutory Nuisance

Section 79(1)(d) of the Environmental Protection Act 1990[27] defines one type of 'statutory nuisance' as *"any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance"*. Where a local authority is satisfied that a statutory nuisance exists, or is likely to occur or recur, it must serve an abatement notice. Failure to comply with an abatement notice is an offence. Best practicable means is a widely-used defence by operators, if employed to prevent or to counteract the effects of the nuisance.

5.1.2 Policy

5.1.2.1 National Planning Policy Framework

The revised National Planning Policy Framework[28] was published in July 2021 and sets out the Government's planning policies for England. With regard to air quality, it states that:

'Planning policies and decisions should contribute to and enhance the natural and local environment by: …preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air quality…'

And:

[26] Department for Environment, Food and Rural Affairs and Devolved Administrations (April 2021). Local Air Quality Management – Technical Guidance LAQM.TG16
[27] Parliament of the United Kingdom (1990) Environmental Protection Act 1990
[28] Ministry of Housing, Communities and Local Government (July 2021). National Planning Policy Framework

'Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas.'

Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible, these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications.

Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

5.1.2.2 National Planning Practice Guidance

On 6 March 2014, the Department for Communities and Local Government published a National Planning Practice Guidance web-based resource[29] which was updated on 1 November 2019.

The National Planning Practice Guidance includes a dedicated section on air quality. It notes that, for new planning applications, the local planning authority may require information on:

- 'The 'baseline' local air quality', including what would happen to air quality in the absence of the development'
- 'Whether the scheme could significantly change air quality during the construction and operational phases (and the consequences of this for public health and biodiversity)'
- 'Whether occupiers or users of the development could experience poor living conditions or health due to poor air quality'

It also states the following in relation to determining whether air quality is relevant to a planning decision:

"Whether air quality is relevant to a planning decision will depend on the scheme and its location. Concerns could arise if the development is likely to have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation

[29] National Planning Practice Guidance web-based resource. Accessible at: https://www.gov.uk/government/collections/planning-practice-guidance

of habitats and species). Air quality may also be a material consideration if the scheme would be particularly sensitive to poor air quality in its vicinity.")[30].

5.1.2.3 Local policy

The Local Plan for Arun District Council (ADC)[31] (adopted in July 2018) and the Local Plan for Adur and Worthing councils[32] (adopted in 2017) provide the planning frameworks which implement the Councils' aims and objectives affecting the use of land and buildings within the districts.

Policies relevant to air quality within the Arun District Local Plan includes Policy QE DM3: Air pollution:

"All major development proposals will be required to assess the likely impacts of the development on air quality and mitigate any negative impacts by:

a. Ensuring the development is located within easy reach of established public transport services;

b. Maximising provision for cycling and pedestrian facilities;

c. Encouraging the use of cleaner transport fuels on site, through the inclusion of electric car charging points; and

d. Contributing towards the improvement of the highway network where the development is predicted to result in increased congestion on the highway network.

Development proposed nearby any Air Quality Management Area (AQMA) declared within the District within the Plan period, will require an air quality assessment to identify likely impacts of development upon the designated area. Developers will be required to ensure delivery of the actions set out within any Air Quality Action Plan.

Industrial development which is regulated by environmental permits (that creates or results in dust, smell, fumes, smoke, heat, radiation, gases, steam or other forms of pollution) must be located in such a position which ensures that the health, safety and amenity of users of the site or surrounding land is not put at risk and the quality of the environment would not be damaged or put at risk.

Developments shall also be consistent with all other Local Plan policies."

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[30] National Planning Practice Guidance 'Air Quality Section'. Accessible at: https://www.gov.uk/guidance/air-quality--3 (published 6 March 2014 and updated July 2021)
[31] Arun District Council. 2018. Arun Local Plan 2011-2031.
[32] Adur and Worthing councils, 2017. Adur Local Plan 2017.

Policies relevant to air quality within the Adur and Worthing councils Local Plan includes Policy 34: Pollution and Contamination:

"Development should not result in pollution or hazards which prejudice the health and safety of the local community and the environment, including nature conservation interests and the water environment.

New development in Adur will be located in areas most suitable to the use of that development to avoid risks from noise, air, odour or light pollution.

Mitigation measures will need to be implemented for developments that could increase levels of pollution or have a negative impact on drinking water supplies in Adur. Where there are significant levels of increased pollution that cannot be mitigated, development will be refused.

Where appropriate, air quality assessments and/or noise assessments will be required in conjunction with development proposals. Investigations and assessments of all sites situated in or in close proximity to potentially contaminated land will be required in relation to relevant development proposals."

5.2 Assessment methodology

5.2.1 Consultation

Consultation has been undertaken with ADC to obtain the most recently available air quality monitoring data.

5.2.2 Construction phase

Potential construction dust effects have been assessed in accordance with Design Manual for Roads and Bridges (DMRB) LA 105[33], through determination of the sensitivity of the receiving environment. This is assessed by identifying construction dust risk potential of the scheme options and the distance of receptors from construction activities using distance buffers of 50m, 100m and 200m.

5.2.3 Operational phase

The air quality assessment has been completed in accordance with DMRB LA 105 and Defra's Local Air Quality Management Technical Guidance (LAQM TG16).

A simple assessment has been undertaken in accordance with the requirements set out within DMRB LA 105 for a PCF Stage 2 assessment. Significance of effect has been determined in accordance with DMRB LA 105.

[33] Highways England (2019) LA 105 – Air quality Revision 0[online] available at: 10191621-07df-44a3-892e-c1d5c7a28d90 (standardsforhighways.co.uk) (last accessed May 2022)

5.2.3.1 Screening Method

An operational air quality assessment has been undertaken using the National Highway's DMRB Screening Model version 9[34] which incorporates speed band emissions from the Emission Factor Toolkit v11. The Screening Model uses link traffic inputs, road width and the distance between the road and identified receptors to predict concentrations of NO_x and PM_{10}. In accordance with DMRB LA 105, PM_{10} has only been assessed in the base year to demonstrate that there is no risk of the PM_{10} air quality thresholds being exceeded as a result of the scheme options.

5.2.3.2 Assessment Scenarios

The following scenarios have been considered in the assessment of local air quality:

- 2019 base year
- 2027 opening year Do-Minimum (without scheme options)
- 2027 opening year Do-Something (with Option 1)
- 2027 opening year Do-Something (with Option 2)
- 2027 opening year Do-Something (with Option 3)

Pollutant concentrations predicted in the opening year Do-Minimum and Do-Something scenarios have been compared to determine the effect of the scheme options on local air quality. It should be noted that an assessment of opening year air quality effects is expected to provide a worst-case assessment, as pollutant concentrations are expected to decline in future years as a result of improvements in vehicle emissions and background air quality.

The local air quality assessment has considered emissions of NO_x and PM_{10}. $PM_{2.5}$ has not been considered further within the local air quality assessment. This is because:

- The results of the PM_{10} Base Year assessment presented in Section 5.8 show that predicted concentrations of PM_{10} are below the equivalent limit values set for $PM_{2.5}$ (annual mean concentration of 20µg/m^3) at all but one receptor location
- $PM_{2.5}$ is a constituent part of PM_{10} which means vehicles emission factors for $PM_{2.5}$ are lower than those for PM_{10}
- Projected background concentrations in the area (see paragraph 0 for more details) are well below $PM_{2.5}$ limit values

[34] Obtained from Highways England, January 2022

It can therefore be concluded that there would be no significant effects for $PM_{2.5}$.

5.2.3.3 Traffic Data

Outputs from the SATURN traffic model developed to assess the traffic impacts from the scheme options have been used for this assessment. Data on vehicle flow, speed and percentage Heavy Duty Vehicles (HDVs - the sum of Heavy Goods Vehicles and buses) are available for Annual Average Daily Traffic (AADT) flows for the base, Do-Minimum and Do-Something scenarios for each of the scheme options.

Speed data has also been derived from the SATURN traffic model. As the scheme is at the early stages of development (PCF Stage 1/2) full speed pivoting has not been undertaken. However, speed bands (high speed, free flow, light congestion and heavy congestion) have been assigned to each of the SATURN traffic links following the speed ranges presented in DMRB LA 105. The light congestion speed band has been applied to all SATURN traffic links within a 100m radius of a junction. Speed bands on traffic links at the Offington Roundabout, Grove Lodge Roundabout, Lyons Way and Busticle Lane junctions have been discussed and agreed with the scheme traffic consultant to ensure that this assessment takes account of the likely changes in congestion caused by the scheme options.

5.2.3.4 Background Pollutants

Total air pollutant concentrations comprise a background and local component. Background concentrations are determined by regional, national and international emissions, and often represent a significant proportion of the total pollutant concentration. The local component is determined by local pollutant sources such as roads, and in this case, has been determined using the DMRB Screening Model.

Background pollutant concentrations are spatially and temporally variable throughout the UK. Annual mean background concentrations of NO_x, nitrogen dioxide (NO_2) and PM_{10} were obtained from Defra's Air Information Resource (AIR) website[35]. The Defra maps provide yearly forecasts based on a grid at a resolution of $1km^2$ across the whole of the UK.

The background NO_x and NO_2 concentrations from the Defra maps were compared against the Defra operated urban background automatic measurements from Brighton Preston Park. This comparison is presented below in Table 5-3. The data indicates that the continuous monitor is monitoring concentrations that are slightly higher than the Defra background maps.

Considering the small difference between the background maps and the automatic monitoring location (the automatic monitoring location is approximately 10km away

[35] Defra 'Air Information Resource' Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?.

from the eastern most extent of the scheme options and the background concentrations are low), Defra background concentrations have been used within the assessment.

Table 5-3: Comparison of Monitored Background NO_2 Concentrations and Defra Background Pollutant Map Data

Data Source	2019		
	NO2 concentration (µg/m^3)	NOx concentration (µg/m^3)	Annual data capture (%)
Brighton Preston Park (Defra continuous monitoring site)[(a)]	15.2	22.3	96.6
Defra Background at Brighton Preston Park[(b)]	13.2	17.8	-

Notes: [(a)] Located at 530524, 106225.
[(b)] Grid square 530500,106500.

It is possible to adjust the Defra background maps to remove sources modelled explicitly, and so avoid double counting. No sources were removed from the Defra maps used in the assessment, as the air quality screening predictions presented here only include road sources within 200m of a receptor, and so do not consider the full contribution of these sources included in the Defra 1x1km background concentrations. Further details of the Defra backgrounds used within this assessment are presented in section 0.

5.2.3.5 NO_x to NO_2 Relationship

Emission rates used within the DMRB Screening Model use NO_x to represent all nitrogen-oxygen species emitted in vehicle exhaust gases. The proportion of NO_2 is needed for comparison with the AQOs presented in Table 5-1.

Research undertaken on behalf of Defra has provided a spreadsheet-based method which is available from Defra's AIR website for calculating annual mean NO_x to NO_2 conversions. Modelled road-traffic NO_x was converted to NO_2 using Version 8.1[36] of the calculator.

5.2.3.6 Future NO_x to NO_2 Projections

The Defra background pollution maps and vehicle emission factors assume that air quality improves in future years, as older vehicles are replaced with modern cleaner vehicles. Generally, UK monitored roadside NO_2 concentrations have not declined as would be expected in recent years. This trend is thought to be related to the increased use of modern diesel vehicles, which emit more NO_x than

[36] Defra (2020) NOx to NO2 Calculator, Version 8.1 [online] Available at: https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator (Accessed January 2022).

expected under urban driving conditions and have higher primary NO_2 emissions than petrol vehicles[37].

Defra updated the local air quality management toolkit in 2020 with new vehicle emission factors, background pollution maps, and NO_x/NO_2 converter. However, it is still considered that future NO_2 concentrations may be underestimated in some areas when using the updated tools.

ADC and Adur and Worthing Councils NO_2 annual mean monitoring for each year from 2016 to 2020 has been reviewed to determine if there has been a local reducing trend in NO_2 concentrations. The monitoring data suggests that, on average, between 2016 and 2017 there was little to no reduction in NO_2 annual mean concentrations across the districts. Between 2017 and 2020, however, there has been a sustained downward trend in NO_2 concentrations, independent of the effects of COVID-19 lockdowns in 2020. Given that improvements in NO_2 seem to have begun in 2017 and the increased uptake of Euro 6/VI occurred towards the latter half of the decade, the long-term trend (LTT_{E6}) gap analysis has therefore been carried out for NO_2 in accordance with DMRB LA 105.

5.2.3.7 Predicted 1 Hour NO_2 and Daily PM_{10}

Annual mean NO_2 concentrations have been presented for identified worst affected receptors. According to Defra guidance[26], the hourly NO_2 air quality objective of 200µg/m^3 (not to be exceeded more than 18 times per year) is unlikely to be exceeded at roadside locations where the annual mean concentration is less than 60µg/m^3. Exceedances of 60µg/m^3 as an annual mean are therefore used as an indicator of potential exceedances of the 1-hour mean NO_2 objective.

In accordance with TG16, the following formula has been used to determine daily mean PM_{10} concentrations:

- No. of 24-hour mean exceedances = -18.5 + 0.00145 x annual mean^3 + (206 / annual mean)

Based on this formula, an annual mean PM_{10} concentration of 32µg/m^3 equates to 35 days at or above 50µg/m^3.

5.2.3.8 Human Health Receptors

Pollutant concentrations have been predicted at sensitive receptors, defined according to Defra (Table 5-2) as:

[37] Defra (2016) Trends in NOx and NO_2 emissions and ambient measurements in the UK [online] Available at: https://uk-air.defra.gov.uk/assets/documents/reports/cat05/1108251149_110718_AQ0724_Final_report.pdf .

'Locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the relevant air quality objective.'

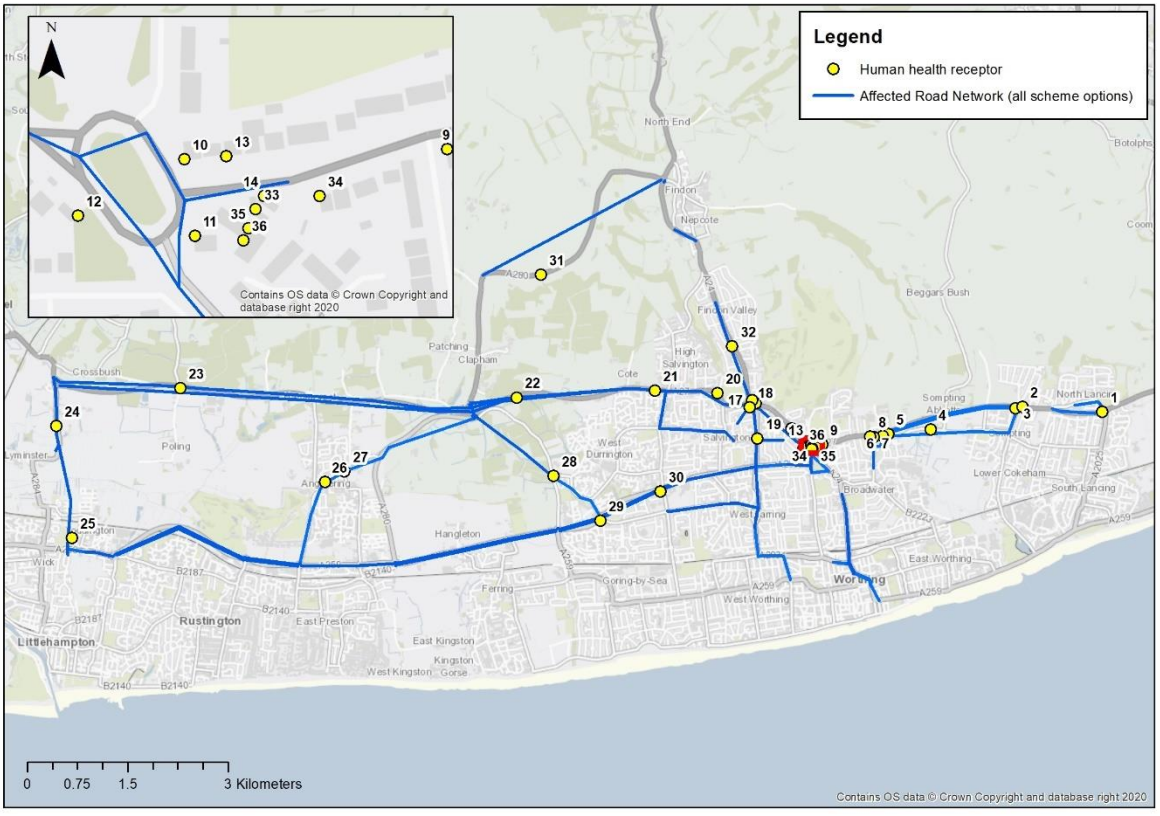
A total of 31 sensitive human receptors were identified within 200m of the affected roads in the study area for all scheme options, as shown in Table 5-4 and Figure 5.1 below. Receptors were selected using professional judgement to determine where the highest pollutant concentrations would be likely to arise, and where the greatest effects would be expected to occur due to the scheme options. In accordance with DMRB LA 105, additional receptors were included at the eastern arm of the Grove Lodge roundabout near an area where existing monitoring data indicated that there was a risk of an exceedance of the annual mean NO_2 AQO. This was undertaken to ensure that all receptors at risk of an exceedance were captured within the assessment.

Table 5-4: Human receptors modelled within the assessment

Receptor ID	Receptor	OS Grid Reference	
		X	Y
R1	Grinstead Lane Junction	518517	105476
R2	Busticle Lane Junction 1	517324	105551
R3	Busticle Lane Junction 2	517215	105525
R4	Upper Brighton Road 1	515949	105209
R5	Lyons Way Junction 1	515315	105143
R6	Lyons Way Junction 2	515238	105109
R7	Sompting Road 1	515095	105096
R8	Sompting Road 2	515048	105100
R9	Upper Brighton Road 2	514327	104984
R10	Grove Lodge RAB 1	514129	104976
R11	Grove Lodge RAB 2	514137	104918
R12	Grove Lodge RAB 3	514048	104934
R13	Grove Lodge RAB 4	514160	104979
R14	Grove Lodge RAB 5	514189	104948
R15	Warren Road	513865	105226
R16	Offington Corner RAB 1	513332	105604
R17	Offington Corner RAB 2	513276	105646
R18	Offington Corner RAB 3	513239	105539
R19	Offington Lane	513360	105072
R20	Cleveland Close	512757	105749
R21	Whylands Crescent	511826	105786

Receptor ID	Receptor	OS Grid Reference	
		X	Y
R22	Arundel Lodge	509754	105688
R23	Titmore Lane	510309	104516
R24	LIttlehampton Road 1	511012	103841
R25	Littlehampton Road 2	511890	104279
R26	Long Furlong	510120	107527
R27	Findon Road	512981	106450
R28	Grove Lodge RAB 6	514183	104939
R29	Grove Lodge RAB 7	514231	104948
R30	Grove Lodge RAB 8	514177	104924
R31	Grove Lodge RAB 9	514173	104915

Figure 5.1: Human Receptor Locations



5.2.3.9 Ecological Receptors

No National Site Network sites are located within 200m of the Affected Road Network (ARN) – the nearest site is the Arun Valley Ramsar site, approximately 7.4km north of the Crossbush Roundabout at the western extent of the ARN.

However, there are 17 ecological receptors with national/local designations within 200m of the ARN for the scheme options:

- Lancing Ring Local Nature Reserve (LNR)
- Batworth Park Plantation Ancient Woodland (AW)
- Stubbs Copse AW
- Wetlands Copse AW
- Poling Copse AW
- Charloe Copse AW
- Charlow Furse AW
- Pound Lane Coppice AW
- Groom's Copse AW
- Potlands Copse AW
- Titnore Wood AW
- Goring Wood AW
- Highdown Copse AW
- Wyatts Coppice AW
- Clapham Common AW
- The White House Coppice AW
- Longcroft Park AW

There are also 14 Local Wildlife Sites within 1km of the scheme options:

- Lancing Ring
- Shoreham Beach
- Widewater Lagoon
- Cokeham Brooks
- Applesham Farm Bank
- Long Furlong and Church Hill
- Clapham Wood
- The Gallops & No Man's Land
- The Sanctuary, High Salvington
- Titnore & Goring Woods Complex
- Ham Farm Wood

- Offington Cemetery
- Worthing & Hill Barn Golf Courses
- Tenants Hill & Reservoirs

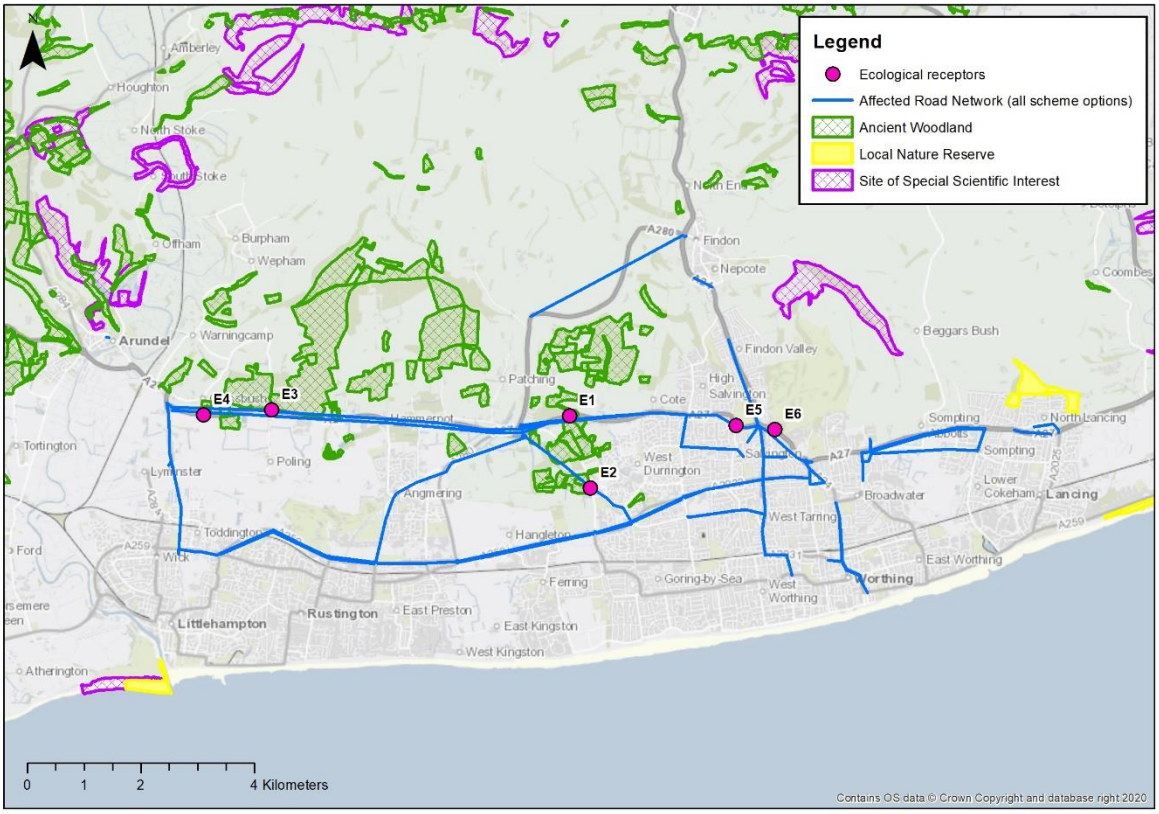
Annual mean nitrogen deposition rates have been predicted at six ecological receptor locations. These do not cover all the designated sites but are chosen based on the worst-case changes in traffic flows, speeds and road alignments as a result of the scheme options. These sites also contain the designated sites with the lowest minimum critical loads. This approach is considered proportionate and appropriate at PCF Stage 1/2.

Table 5-5 and Figure 5.1 below present the location of the nearest points of the ecological receptors to the ARNs.

Table 5-5: Ecological Receptors

Receptor ID	Receptor	OS Grid Reference		Habitat	Empirical CLO Range (kg N/ha/yr)
		X	Y		
E1	Ancient Woodland 1 (Clapham Common)	509928	105767	Broadleaved, mixed and yew woodland	10-20
E2	Ancient Woodland 2 (The White House Coppice)	510295	104495	Broadleaved, mixed and yew woodland	10-20
E3	Ancient Woodland 3 (Charloe Copse)	504680	105872	Broadleaved, mixed and yew woodland	10-20
E4	Ancient Woodland 4 (Stubbs Copse)	503479	105781	Broadleaved, mixed and yew woodland	10-20
E5	Offington Cemetery LWS	512858	105599	Calcareous grassland	15-25
E6	Worthing and Hill Barn Golf Courses LWS	513549	105524	Calcareous grassland	15-25

Figure 5.1: Ecological Receptor Locations



Nitrogen deposition rates at ecological receptors have been calculated by first converting modelled road NOx concentrations to road NO_2. The road NO_2 concentrations were then converted to dry nutrient nitrogen deposition rates using the conversion factors presented in DMRB LA 105. To assess a worst-case, the National Highways Ammonia Nitrogen Deposition Tool (v3) was also used so that the contribution from vehicle ammonia emissions could be considered.

5.2.3.10 Compliance Risk Assessment

An assessment of the scheme options' impact on the UK's reported ability to comply with the limit values has been undertaken. The Pollution Climate Mapping (PCM) model is used by Defra, in combination with monitoring data, to assess compliance with limit values. Compliance information is reported within 43 zones and urban agglomerations across the UK.

The assessment of compliance with limit values for a scheme should consider the annual mean NO_2 concentrations from roads identified in the PCM model which overlap with the schemes ARN. Roads where affected roads overlap with links

contained within the PCM model and are within 15m of a motorway running lane and within 25m of a major[38] junction are not included.

Existing concentrations from the PCM model have been presented in Section 5.5.5 for the worst links in the study area of the scheme options. This, along with the modelled impacts at the nearest qualifying features on the worst PCM links as a result of the scheme options, has been used to determine if the scheme options would delay the UK's reported compliance with the limit values.

5.2.3.11 Assessment of Significance

DMRB LA 105 provides advice for evaluating the significance of local air quality effects for public exposure, ecologically designated sites and compliance risk. Details for human health and ecologically designated sites are provided below whereas the outcome of compliance risk to inform significance is based on changes in the reported ability to meet the limit values.

Human health

The change in pollutant concentrations between the Do-Minimum and Do-Something scenarios is used to describe the magnitude of change in concentration in accordance with Table 5-6.

A conclusion of no likely significant air quality effect for human health is concluded where the:

- Outcomes of the air quality modelling for human health indicate that all concentrations at worst case receptors are less than the air quality standard; and / or
- Difference in concentrations is imperceptible, i.e. less than 1% of the relevant air quality standard

Where the above criteria are not met, the receptors in each magnitude band are then aggregated and compared to the guideline number of receptors constituting a significant effect as shown in Table 5-6. The guideline bands have been developed for each magnitude category and set the upper level of likely non-significance (e.g. 30 for small changes) and the lower level of likely significance (e.g. 60 for small changes). Between these two levels are the ranges where likely significance is more uncertain, and therefore professional judgment is required.

[38] For non-motorway junctions a "major junction" is defined as a junction, which interrupts the traffic flow on the road and includes, for example, traffic light controlled junctions.

Table 5-6: Guideline to number of properties constituting a significant effect

Magnitude of change in concentration	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2 to 4)	10 to 30	10 to 30
Small (>0.4 to 2)	30 to 60	30 to 60

Ecological designations

When nitrogen deposition rates are assessed for designated sites, and the total Do-Something nitrogen deposition rate is less than the applicable lower critical load (CLO) or the change in nitrogen deposition caused by the scheme is less than 1% of the lower CLO, significant effects are not anticipated.

It is important to note that where impacts are greater than 1%, effects are not necessarily considered 'significant'. Where changes greater than 1% of the lower CLO are predicted, Table 21 of Natural England's Commissioned Report NECR210[39] should be used to identify if the increase in nitrogen deposition caused by the scheme would reduce species richness by one. The lowest increase in nitrogen deposition presented in Table 21 of the NECR210 report which could result in the reduction of species richness is 0.4kg/ha/yr.

On this basis, where the predicted increase in nitrogen deposition is greater than 1% and less than 0.4kg/ha/yr, significant effects are not anticipated. Where nitrogen deposition is both greater than 1% and 0.4kg/ha/yr the scheme ecologist determines significance.

5.3 Assessment assumptions and limitations

Air quality modelling predictions have been based on the most reasonable, robust and representative methodologies in accordance with best practice guidance. However, there is an inherent level of uncertainty associated with the Screening Model predictions, including:

- Uncertainties with traffic forecasts
- Uncertainties with vehicle emission predictions
- Uncertainties with background air quality data

[39] Natural England (2016) 'Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance.'.

- Simplifications made within Screening Model calculations or post processing of the data that represent chemical reactions

The Screening Model has been verified in accordance with Defra guidance to manage the uncertainties referred to above. Modelled and monitored pollutant concentrations have been compared and, where necessary, the Screening Model output has been adjusted to account for systematic bias. However, it should be noted that predicted results following verification can still contain an element of residual uncertainty.

For this assessment, three separate verification factors were used to represent receptors located in different areas to verify the model and account for localised air quality impacts:

- Verification zone 1 – Receptors outside of verification Zones 2 or 3
- Verification zone 2 – Receptors within the vicinity of Grove Lodge Roundabout, except for receptors close to monitoring location N30A
- Verification zone 3 – Receptors located close to monitoring location N30A (south of the eastern arm of the Grove Lodge Roundabout)

Following the verification process for the scheme, an overall Root Mean Square Error value of less than 10% of the mean annual air quality objective is achieved, which is considered robust according to Defra guidance. On this basis, the modelled results are considered appropriate to allow a robust professional judgement of significance to be determined. Further details of the model verification for the scheme is presented in Appendix C.

5.4 Study area

The study area for the construction dust assessment is confined to within 200m of construction activities for each scheme option.

The study area for the air quality assessment covers human health receptors and designated habitats within 200m of roads that have the potential to be ‘affected’ by the scheme.

The DMRB LA 105 defines the ARN for the air quality assessment as all roads that trigger the traffic screening criteria and adjoining roads within 200m. The traffic screening criteria are:

- AADT will change by >= 1,000 or
- HDV AADT will change by >= 200 or
- a change in speed band or
- a change in carriageway alignment by >=5m

The criteria triggered for the scheme options includes changes in AADT, speed bands and alignment on the roads included within and surrounding the scheme options.

The scheme options will alter the alignments of junctions at:

- Offington Corner Roundabout
- Grove Lodge Roundabout
- Lyons Way/Upper Brighton Way
- Busticle Lane

All three options would introduce technological improvements to the above junctions, introduce signals and alter the road alignments at the Offington Corner Roundabout, and improve the signals at the Grove Lodge Roundabout. Option 1 would also introduce additional lanes, altering the road alignment at the Grove Lodge Roundabout. Options 2 and 3 would also improve the Lyons Way/Upper Brighton Way by altering the road alignments. Finally, Option 3 would also alter the road alignment at the Busticle Lane junction. A detailed description and drawings of the scheme alignment changes are presented in Appendix B.

As a result of all scheme options, changes in AADT, HDV, and speed bands are predicted to occur at all the above junctions, on the A27 and on the surrounding road network. In addition, as stated in Section 5.2.3.3, speed bands on roads within 100m of the junction, which have a modelled speed band of 'free flow' have been set to 'light congestion' in all scenarios for the purpose of generating emission factors.

The ARNs for the scheme options cover a section of the A27 (approximately 20km long) from the Crossbush Roundabout north of Littlehampton, west of the scheme, to the junction with the A2055, east of the scheme. The ARNs also include:

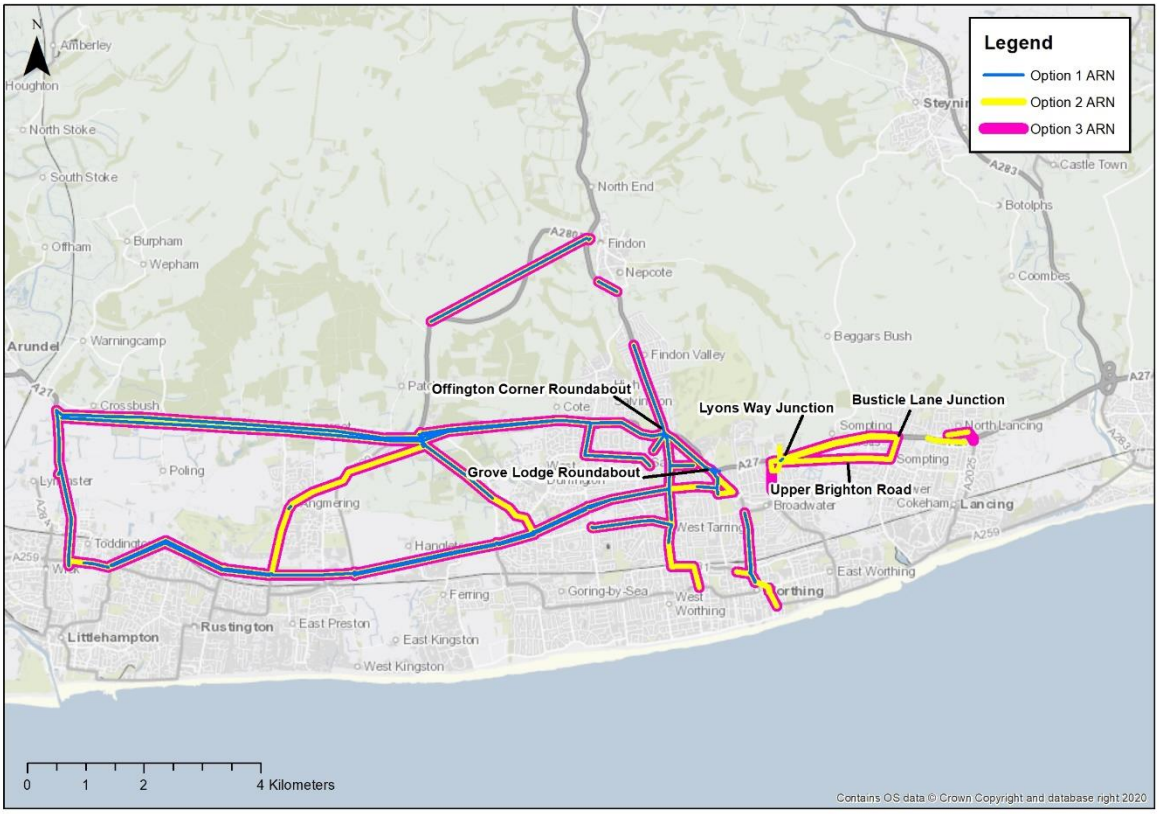
- The A284 (south of the Crossbush Roundabout)
- The A259 (between the A284 and A2032)
- The A2031 (between the A2032 and Offington Corner Roundabout)
- The A2032 (between the A259 and Grove Lodge Roundabout)
- The A280 (between the Findon and A259)
- The A24 (between the Offington Corner Roundabout and Findon)
- Station Road/Water Lane through Angmering
- A number of minor roads in the vicinity of the proposed interventions (which are currently used for rat-running).

The ARNs for all three options are similar, the most notable difference being that Options 2 and 3 include additional roads on the Upper Brighton Road (off the A27)

and other minor roads close to the Lyons Way junction. The ARNs for the three options are shown in Figure 5.2.

Across all ARNs, increases in AADT are predicted on the A27, A2031 Offington Lane and the roads through Angmering while reductions in AADT are predicted on the surrounding A roads and minor roads. These changes are associated with the junction improvements, which reduce travel times when driving on the section of the A27 through Worthing. Therefore, vehicles which currently 'rat-run' through Worthing are drawn back to the A27, increasing AADTs on the A27 and reducing AADTs on surrounding roads.

Figure 5.2: Study area – Options 1, 2 and 3



5.5 Baseline conditions

Information on air quality in the UK can be obtained from a variety of sources including local authorities, national network monitoring sites and other published sources. The baseline data most representative of the scheme options has been obtained from the ADC Air Quality Status Report 2021[40], Adur and Worthing

[40] Arun District Council. 2021. Air Quality Annual Status Report (ASR). Local Air Quality Management.

Council's Air Quality Status Report[41] and Defra[42]. The most recent full year of monitoring data available is for 2020.

The effects associated with the coronavirus (Covid-19) pandemic during 2020 when England was subject to a full lockdown for periods of the year may have an influence on the 2020 monitoring data and therefore it may not be representative of normal conditions at the monitoring sites. As such, this data has been included for information only. The 2019 data has been used to determine current baseline concentrations in place of 2020 as the most appropriate year to account for this.

5.5.1 Air Quality Management Areas

ADC currently has no AQMAs within its administrative area as there are no monitored exceedances of the relevant national objectives. Adur and Worthing Councils have declared three AQMAs within their administrative areas due to monitored exceedances of the annual mean NO_2 objective:

- Shoreham AQMA – located on the A259 High Street between Ropetackle Roundabout and Surry Street
- Southwick AQMA – located on the A270 Old Shoreham Road between Kingston Lane and Lower Drive
- Worthing Grove Lodge/Lyons Farm AQMA – located on Crockhurst Hill, Offington Corner Roundabout, Warren Road, Grove Lodge Roundabout, Upper Brighton Road up to and including the Downlands Retail Centre and Lyons Way.

The scheme boundary intersects the Worthing Grove Lodge/Lyons Farm AQMA and the ARN passes through this AQMA. Therefore, it is likely that the scheme options would impact air quality at this AQMA. The remaining AQMAs, the Shoreham and Southwick AQMAs, are located approximately 2.7km south-east and 5.2km east of the eastern most section of the scheme respectively. As none of the ARNs are predicted to pass through the A259 and A270 AQMAs, it is considered unlikely that any of the scheme options would impact air quality at either AQMA.

5.5.2 Local authority monitoring

ADC does not undertake monitoring at any automatic monitoring stations.

Adur and Worthing Councils have two automatic monitoring stations:

- AD1 High Street, Shoreham, located within the Shoreham AQMA and

[41] Adur and Worthing Councils. 2021. Air quality Annual Status Report (ASR). Local Air Quality Management.
[42] Defra (2021). Background mapping data for local authorities. Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018, accessed June 2022.

- WT2 Grove Lodge, located within the Worthing Grove Lodge/Lyons Farm AQMA.

The AD1 monitor is located approximately 2.7km south-east of the scheme option ARNs and monitors NO_2 and PM_{10}. WT2 is located within the scheme boundary adjacent to the Grove Lodge roundabout and monitors NO_2 and $PM_{2.5}$. The monitoring data for AD1 and WT2 are presented in Table 5-7 to Table 5-9. No exceedances of the long or short-term NO_2, PM_{10} or $PM_{2.5}$ objectives have been recorded at either location for the period from 2017 to 2020.

Table 5-7: Air Quality Monitoring Data for NO_2 (Automatic Monitor)

Site ID	Site name	Site classification	National grid reference		Annual mean concentration (µg/m^3)			
			X	Y	2017	2018	2019	2020
AD1[(a)] [(c)]	High Street	Kerbside	521399	105039	-	29.2	26.0	20.0
WT2[(b)]	Grove Lodge	Roadside	514184	104963	35.8	36.8	32.9	26.0

Source: Adur and Worthing Councils 2021
Note: [(a)] Data capture for 2019 was 93.6%.
[(a)] Data capture for 2019 was 97.4%.
[(b)] Monitoring at this location began in 2018
No exceedances of the short-term NO_2 objective have been recorded at either site.

Table 5-8: Air Quality Monitoring Data for PM_{10} (Automatic Monitor)

Site ID	Site name	Site classification	National grid reference		Annual mean concentration (µg/m^3)			
			X	Y	2017	2018	2019	2020
AD1[(a)]	High Street	Kerbside	521399	105039	-	23.0	24.3	22.0

Source: Adur and Worthing Councils 2021
Note: [(a)] Data capture for 2019 was 96.0%.
[(b)] Monitoring at this location began in 2018
No exceedances of the short-term PM_{10} objective have been recorded at this site.

Table 5-9: Air Quality Monitoring Data for $PM_{2.5}$ (Automatic Monitor)

Site ID	Site name	Site classification	National grid reference		Annual mean concentration (µg/m^3)			
			X	Y	2017	2018	2019	2020
WT2[(a)]	Grove Lodge	Roadside	514184	104963	-	10.6	9.9	8.0

Source: Adur and Worthing Councils 2021
Note: [(a)] Data capture for 2019 was 97.4%.

ADC monitors NO_2 using passive diffusion tubes at 22 locations and Adur and Worthing councils monitor NO_2 using passive diffusion tubes at 63 locations. Of these locations, 26 sites are within 1km of the scheme options, the monitoring data for which are presented in Table 5-10.

Exceedances of the annual mean NO_2 objective have been recorded at three of the diffusion tube locations between 2017 and 2020 at monitor locations S13, N30A and N44.

Diffusion tube S13, located adjacent to the A27 at the junction with Halewick Lane, monitored an exceedance of the objective in 2017, however has recorded concentrations below the objective between 2018 and 2020. Diffusion tubes N30A and N44 are both located within the Worthing Grove Lodge/Lyons Farm AQMA, however N44 only recorded an exceedance in 2017 while N30A has consistently monitored concentrations above the annual NO_2 AQO. N30A is a roadside site, approximately 2m from the kerbside of a heavily congested road on the eastern approach to the Grove Lodge Roundabout (which is representative of exposure at the nearby residential property at 19 Upper Brighton Road). Further details of the locations of these sites are presented in Figure 5.3.

Table 5-10: Local Authority Air Quality Monitoring Data for NO_2 (Diffusion Tubes)

Site ID	Site name	Site classification	National grid reference	Annual mean concentration (µg/m3)			
			X, Y	2017	2018	2019	2020
S11	Lancing Manor	Roadside	518820, 105584	36.3	35.1	32.5	26.3
S12	Boundstone Lane	Roadside	517731, 105505	31.4	30.2	25.8	20.2
S13	Upper Brighton Road	Roadside	517291, 105550	**40.3**	39.0	36.3	28.8
S14	West Street	Urban Background	516057, 105190	19.5	19.5	23.7	18.7
S25	Mash Barn Lane	Roadside	519117, 105710	28.9	30.4	26.2	21.0
S26	Loose Lane	Suburban	516536, 104783	14.3	16.5	13.4	11.5
S40	St Marys Close	Suburban	516466, 105171	-	17.8	16.1	-
S41	North Road	Roadside	518238, 104432	-	23.2	20.8	-
S44	Upper Brighton Road	Roadside	518494, 105464	-	-	38.4	30.7

Site ID	Site name	Site classification	National grid reference	Annual mean concentration (µg/m3)			
			X, Y	2017	2018	2019	2020
5N	Cleveland Road	Urban Background	512701, 105562	15.9	16.9	15.7	11.5
6N	Gainsborough Avenue	Roadside	515190, 105122	38.1	35.1	33.1	27.1
N5	First Avenue	Roadside	514495, 105020	31.0	25.6	28.3	24.0
N8	Littlehampton Road	Roadside	513236, 104651	30.7	29.6	28.6	22.3
N18	Kinnal Court	Suburban	515315, 105141	24.5	23.9	21.7	17.0
N21	Greenwood Cottage	Roadside	509777, 105696	17.2	13.5	10.8	8.5
N24	Upper Brighton Road	Roadside	515151, 105109	25.9	34.5	23.5	18.0
N25	Warren Court House	Suburban	513845, 105191	20.7	20.3	17.8	14.4
N29	Downlands Parade	Roadside	515014, 105099	32.4	23.6	29.9	25.0
N30a	Grove Lodge Cottages	Roadside	514183, 104948	**68.2**	**60.1**	**56.6**	**44.1**
N35	Upper Brighton Road House	Roadside	514266, 104961	28.5	26.2	24.4	20.6
N39	Grove Lodge roundabout	Roadside	514088, 104906	32.0	32.7	28.5	23.5
N43	23 Upper Brighton Road	Suburban	514199, 104982	23.1	22.3	19.9	17.2
N44	21 Upper Brighton Road	Roadside	514184, 104963	**40.5**	39.8	36.2	30.7
N45	11 Hill Barn Lane	Suburban	514126, 105063	17.2	16.2	15.4	-
N53	Offington Corner	Roadside	513278, 105623	34.9	33.9	30.7	24.8
N61	Broadwater Street West	Kerbside	514501, 104531	-	36.8	34.8	27.6

Source: Adur and Worthing Councils, 2021
Note: 2019 data capture for all sites was greater than 82%
The bias adjustment factor for 2019 was 0.87

5.5.3 National Highways monitoring

An air quality monitoring survey was undertaken by National Highways from January 2016 to July 2016. The results from monitoring were bias-adjusted and annualised in accordance with Defra's LAQM TG16[43] to represent an annual mean for 2016. The monitoring data for sites within 1km of the scheme are presented in Table 5-11. The locations of these monitoring sites in relation to the scheme is presented in Figure 5.4. Exceedances of the annual mean NO_2 objective have been recorded at 11 of the reported diffusion tube locations.

Table 5-11: National Highways Air Quality Monitoring Data for NO_2

Site ID	Site classification	National grid reference		Annual mean concentration (µg/m^3)
		X	Y	2016
HE_01	Roadside	510408	105674	39.8
HE_02	Roadside	511408	105839	34.2
HE_03	Roadside	511845	105781	22.7
HE_04	Roadside	513225	105551	29.3
HE_05	Roadside	513735	105344	**48.9**
HE_06	Roadside	514052	104948	**46.4**
HE_07(a)	Roadside	514141	104889	38.8
HE_08	Roadside	514409	105000	30.6
HE_09	Roadside	515205	105114	36.9
HE_10	Roadside	515389	105168	34.7
HE_11	Roadside	515782	105213	30.1
HE_12	Roadside	515610	105349	19.6
HE_13	Roadside	517290	105551	**43.9**
HE_14	Roadside	517227	105528	**49.4**
HE_15	Roadside	516170	105467	24.9
HE_16(b)	Roadside	517037	105510	25.9
HE_17(b)	Roadside	518448	105458	**44.1**
HE_18(b)	Roadside	518454	105441	**63.1**
HE_19	Roadside	518537	105494	**46.0**
HE_20	Roadside	518484	105575	26.8
HE_21	Roadside	517329	105522	31.6
HE_22(b)	Roadside	517996	105435	25.5

[43] Department for Environment, Food and Rural Affairs (2018), Local Air Quality Management – Technical Guidance (16).

HE_23	Roadside	520075	106077	**42.7**
HE_26	Roadside	521852	106550	25.9
HE_27(b)	Roadside	522605	106492	21.7
HE_28	Roadside	514184	104965	**52.5**
HE_29	Background	514184	104965	**54.7**
HE_30	Roadside	514184	104965	**51.9**
HE_31	Roadside	516732	105167	17.3

Source: National Highways, 2016
Note: [a] Data capture for site was 33%.
[b] Data capture for site was 42%.
Data capture for all other sites was 50%.
The National bias adjustment factor for 2016 was 1.04

Figure 5.3: Local authority monitoring locations

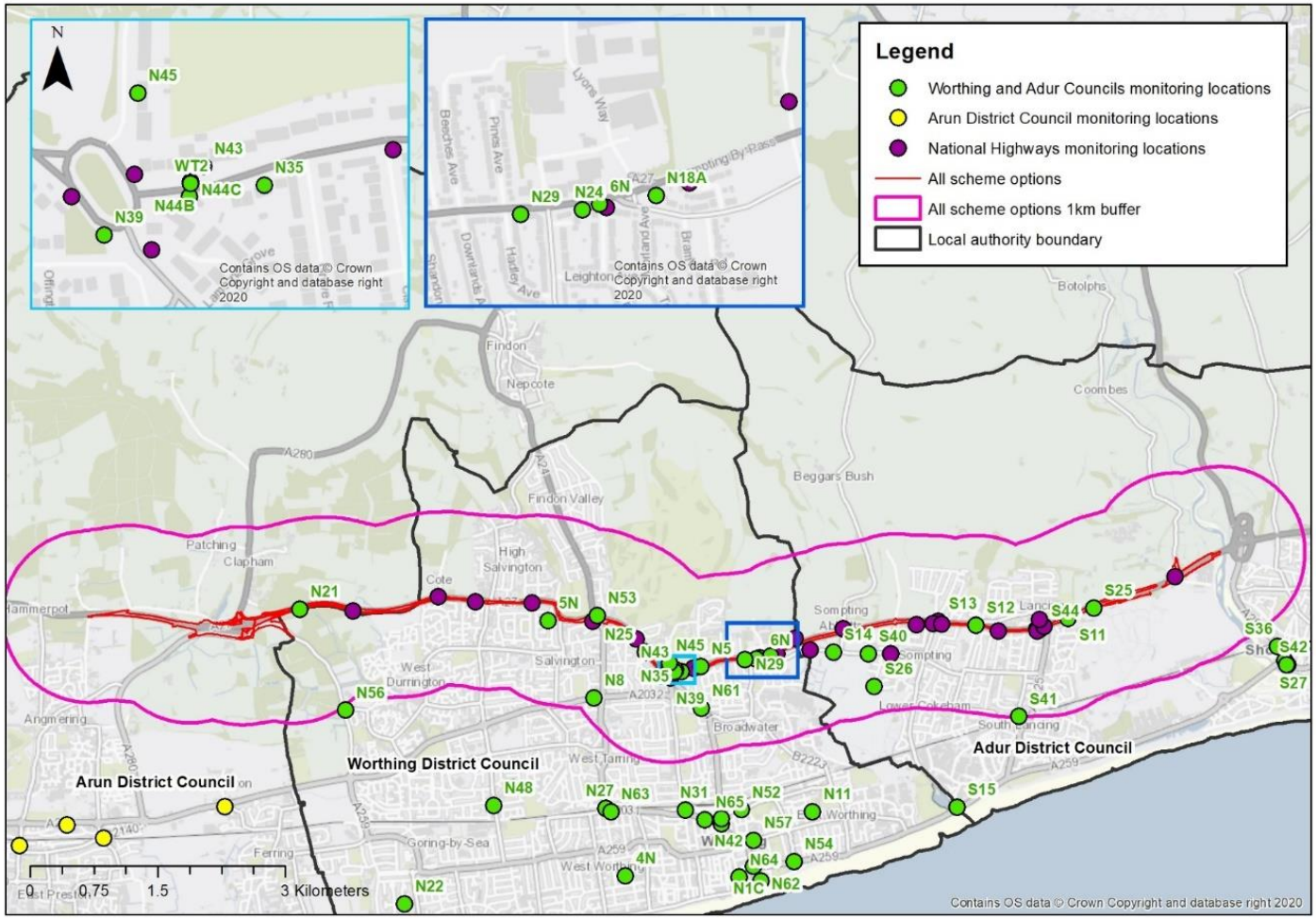
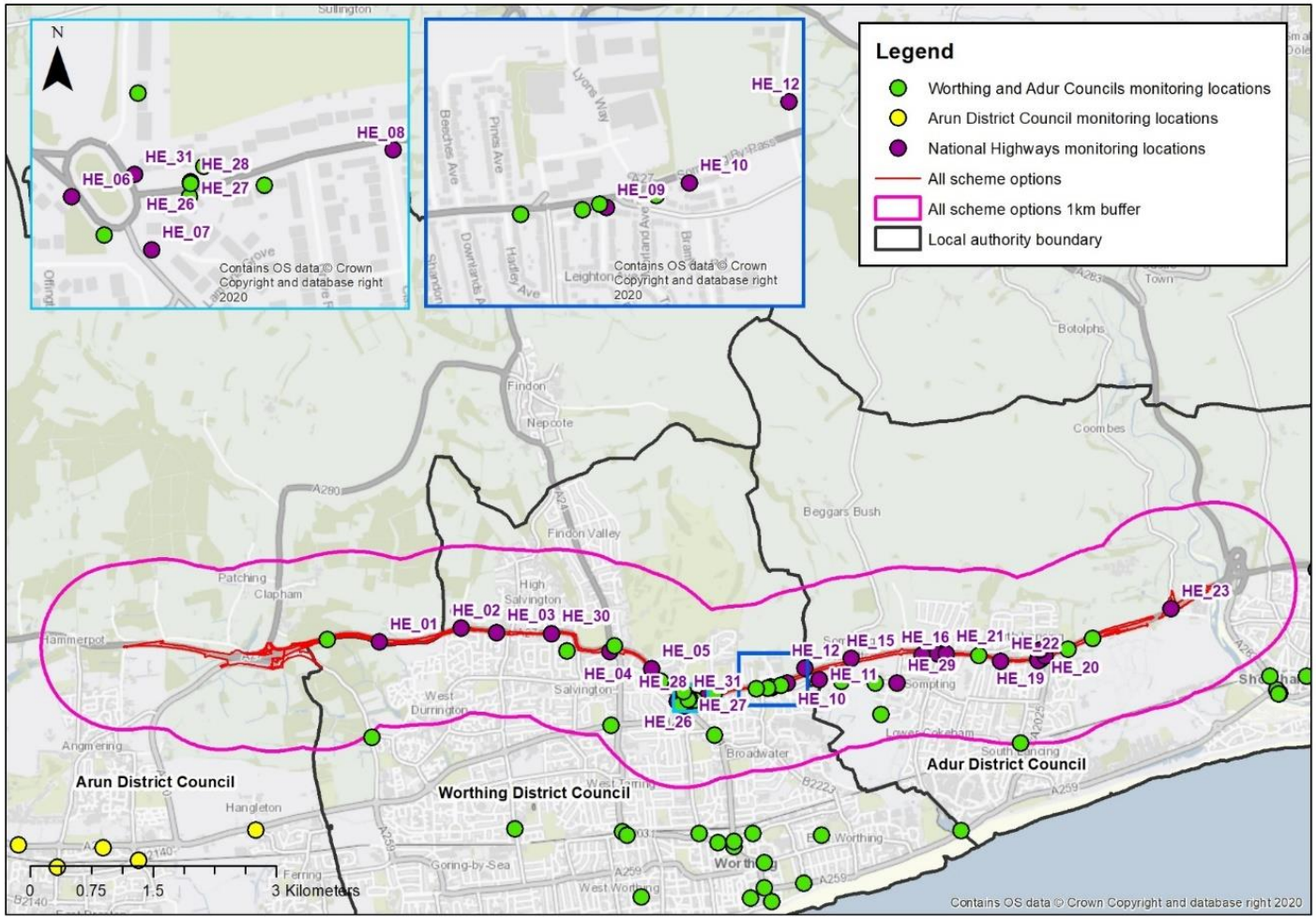


Figure 5.4: National Highways monitoring locations



5.5.4 Defra projected background concentrations

Defra provides mapped future year projections of background pollution concentrations for NO_X, NO_2, PM_{10} and $PM_{2.5}$ for each one-kilometre grid square across the UK for all years between 2018 to 2030[44].The maps include a breakdown of background concentrations by emission source, including road and industrial sources, which have been calibrated against UK monitoring data from 2018 (the baseline year).

Table 5-12 presents background concentrations for the 1km grid squares containing the receptors presented in Section 5.2.3 in the baseline year of 2019. The maximum background concentrations at the site are all within the relevant objectives for NOx, NO_2, PM_{10} and $PM_{2.5}$.

Table 5-12: Projected background concentrations (µg/m^3) of NO_x, NO_2, PM_{10} and $PM_{2.5}$ 2019

National grid reference	NOx	NO_2	PM_{10}	$PM_{2.5}$
507500,105500	13.4	10.3	14.1	9.3
508500,105500	14.3	10.8	14.4	9.4
509500,105500	14.2	10.8	13.9	9.3
510500,105500	12.7	9.7	14.1	9.3
511500,105500	14.2	10.7	14.8	10.1
512500,105500	15.0	11.3	15.1	10.6
513500,104500	15.8	11.8	15.2	10.8
513500,105500	15.6	11.8	14.8	10.3
514500,104500	17.3	12.9	15.4	10.9
514500,105500	14.2	10.8	14.1	9.8
515500,105500	14.8	11.1	15.0	9.9
516500,105500	14.9	11.2	14.6	10.0
517500,105500	15.8	11.8	15.3	10.7
518500,105500	17.6	13.1	15.3	10.7
519500,105500	18.8	13.8	14.8	9.8
519500,106500	13.2	10.0	13.9	9.2
520500,105500	16.5	12.2	13.7	9.4

Source: https://uk-air.defra.gov.uk/data/laqm-background-maps

[44] Defra Background maps (2018) available at: https://uk-air.defra.gov.uk/data/laqm-background-maps

5.5.5 Limit value compliance

PCM projections are available for all years from 2018 to 2030 from the base (reference) year of 2018. The most recent PCM model was published in 2020.

There are 11 PCM links which overlap with the scheme option ARNs, located on the following roads:

- A27 (census IDs 802078242, 802056246, 802026302)
- A259 (census IDs = 802056872, 802078244)
- A24 (census IDs = 802078241, 802016261)
- A2032 (census IDs = 802027603, 802007553)
- A2031 (census IDs = 802046284, 802026285)

The maximum roadside NO_2 concentration predicted in the opening year of 2027 is 19.7µg/m^3 (on 802056246 on the A27). This suggests that the study area is predicted to be compliant in the opening year.

The highest PCM link in the Brighton/Worthing/Littlehampton Zone or South East Zone is located on the A27 (census ID 802099631) in the Havant Borough Council administrative area, with a predicted NO_2 concentration of 30.5µg/m^3 in 2027. This link is currently non-compliant with the NO_2 limit value (the predicted 2022 concentration is 40.1µg/m^3) but is predicted to be compliant in 2023, which is well before the opening year of the scheme options.

5.5.6 Nitrogen deposition

Information on baseline levels of nitrogen deposition for designated sites is available from the Air Pollution Information System (APIS)[45]. The current nitrogen deposition rates and critical loads[46] from APIS for the most sensitive habitat to nitrogen deposition at modelled ecological receptors are shown in Table 5-13.

Table 5-13: Critical loads (CLO) range and background nitrogen deposition

Receptors ID	Habitat	CLO range (kg N/ha/yr)	Background nitrogen deposition (kg N/ha/yr)
E1	Broadleaved, mixed and yew woodland	10-20	18.9
E2	Broadleaved, mixed and yew woodland	10-20	16.4

[45] http://www.apis.ac.uk/

[46] A critical load is a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.

Receptors ID	Habitat	CLO range (kg N/ha/yr)	Background nitrogen deposition (kg N/ha/yr)
E3 and E4	Broadleaved, mixed and yew woodland	10-20	18.1
E5 and E6	Calcareous grassland	15-25	11.6

Source: www.apis.ac.uk

5.5.7 Summary

Local authority monitoring demonstrates that there are monitored exceedances of the annual mean NO_2 air quality objective within the study area at locations of relevant exposure. These areas where NO_2 concentrations are above the objectives are primarily at sites located on the A27.

5.6 Potential impacts

5.6.1 Construction

Information regarding the duration of the construction period for the scheme options is currently not available, however it is considered likely to be less than two years for any of the options. The main risks to sensitive receptors during the construction phase include on site dust emissions arising from construction activities, construction vehicle movements and traffic management.

Dust can be mechanically transported, either by wind or re-suspension by vehicles. It can also arise from wind erosion on material stockpiles and earth moving activities.

These impacts are expected to be restricted to within 200m of construction activities, as stated in DMRB LA 105, and would be controlled through appropriate mitigation measures to be included within the second iteration of the Environmental Management Plan (EMP) which would be prepared for the scheme.

The total number of construction vehicles likely to use the local road network is not known at this stage; based on previous experience in assessments of this nature, the maximum total annual average daily construction traffic flows are not expected to meet the DMRB LA 105 scoping criteria. Additionally, DMRB LA 105 states that a construction period of less than two years is unlikely to cause a significant effect. Potential effects from construction traffic and traffic management relating to the scheme are therefore considered to not be significant and have not been assessed further.

Combustion related emissions (such as NO_2, SO_2 and fine particulates) from on-site plant and vehicles would also occur during construction of the scheme options and could affect local air quality. However, given the local and temporary nature of site plant and potential effects of emissions on local air quality, the assessment of construction plant emissions has not been considered further. Mitigation measures

to reduce the effect of site plant on local air quality will nevertheless be included in the EMP.

5.6.2 Operation

The operational phase of the scheme options has the potential to affect air quality due to:

- Changes in emissions associated with changes in traffic flows and speed on the local road network
- Changes in road layout which may bring road traffic emission sources closer to, or further away from, sensitive receptors

5.7 Design, mitigation and enhancement measures

5.7.1 Construction

Appropriate mitigation measures to control dust generation will be included within the EMP for the scheme taking account of the level of construction dust risk identified within the assessment, which is considered to be 'High' as discussed in Section 5.8.1. Mitigation measures would include minimising the use of dust-generating activities, the use of water as a dust suppressant where appropriate and keeping stockpiles for the shortest time possible.

5.7.2 Operation

The results of the air quality assessment completed for the scheme options (presented in section 5.8.2) demonstrate that none of the scheme options would have a significant effect on air quality. Furthermore, no significant effects are predicted at ecologically designated sites and none of the scheme options affect the reported limit value compliance.

On this basis, no operational air quality mitigation is proposed.

5.8 Assessment of likely significant effects

Air quality effects have been predicted at a selection of worst-case receptor locations within 200m of the ARNs for the scheme options. This section presents results at receptors where the highest NO_2 concentrations and greatest effects are predicted. In line with DMRB LA 105, effects are only likely to be considered significant where AQOs are exceeded.

5.8.1 Construction

The construction phase has the potential to affect local air quality through construction dust, generated through construction activities and vehicle movements.

Detailed construction boundaries are not defined at this stage of the design. Therefore, only the construction boundaries associated with the new scheme options alignments in relation to sensitive receptors have been considered. Figure 5.5 presents the distance buffers and sensitive receptors identified for this assessment.

The dust risk potential of the scheme options is expected to be 'Small', for all scheme options due to the small scale of the junction improvements associated with the options.

Sensitive receptors have been identified within 50m of the construction works for all scheme options, therefore the likely dust risk potential is 'High'.

Figure 5.5: Construction dust buffers

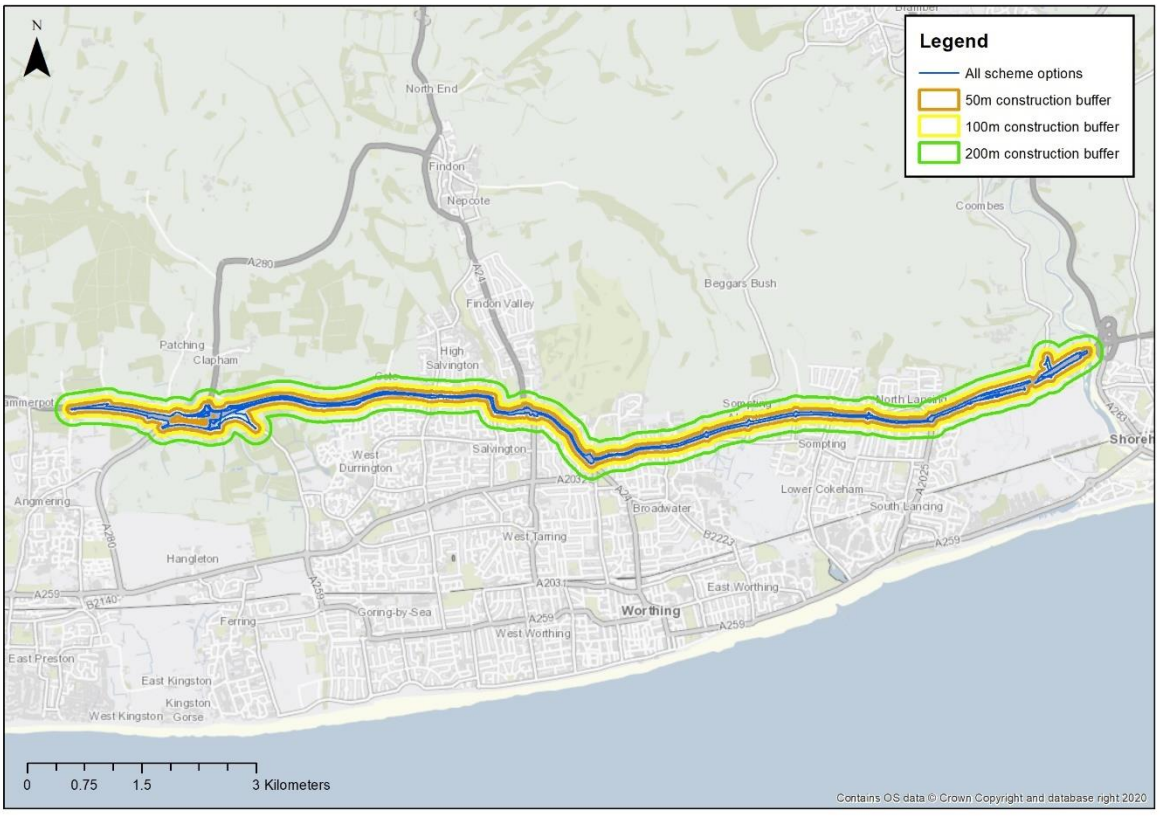


Table 5-14: Assessment of likely significant effects - construction

Receptor	Sensitivity/value	Impact magnitude	Mitigation	Significance of effect (with mitigation)
Sensitive receptors within 50m of scheme alignments	High	Small	Mitigation in accordance with best practicable means	Not significant

5.8.2 Operation

5.8.2.1 Human Health Effects

Predicted NO_2 concentrations at the worst-case human health receptors for Options 1, 2 and 3 are presented in the respective sections below. The modelled impacts at all receptors are presented in full in Appendix C.

The results indicate that there are some predicted increases and some predicted decreases in NO_2 concentrations between the Do-Minimum and Do-Something Opening Year scenarios for all scheme options. While there was a modelled exceedance of the annual mean NO_2 AQO in the base, Do-minimum and Do-something at one of the sensitive receptors, this receptor experiences an imperceptible or small change as a result of the scheme options. No other receptors, including additional receptors modelled in the vicinity of this receptor, experiences an exceedance of the AQOs. Therefore, in accordance with DMRB LA 105, there are no significant effects related to NO_2.

All predicted annual mean concentrations of NO_2 are below 60µg/m^3 and therefore no exceedances of the 1-hour NO_2 objective are predicted.

There are some predicted increases in NO_2 concentrations between the Base year scenario and Do-Minimum scenario, despite predicted improvements in vehicle emissions over time. This is attributed to the inclusion of another road scheme in close proximity to the ARN in both the Do-Minimum and Do-Something traffic data which is due to be operational by 2027 and would increase the amount of traffic on the A27.

Option 1

As presented in Table 5.15, The receptor with the highest total annual mean NO_2 concentration in Option 1 is receptor 14. This is predicted to have an increase of 0.7µg/m^3 from 48.0µg/m^3 in the Do-Minimum to µg48.7/m^3 in the Do-Something scenario. The increase at this receptor, which is located south of the eastern arm of the Grove Lodge Roundabout, is due an increase of approximately 1,000 AADT on the road adjacent to R14. Furthermore, there is a slight change in the alignment of the carriageway so the road moves marginally closer (0.5m) to the receptor in the Do-something.

There is also no improvement in speed bands predicted at the Grove Lodge Roundabout as a result of the scheme; the road adjacent to R14 has a heavy congestion speed band in both the Do-Minimum and Do-Something scenarios. This is because the Grove Lodge Roundabout is currently over-capacity and while the scheme is predicted to improve capacity at this roundabout, this is negated by the increase in vehicles rerouting from surrounding roads onto the A27 and at this receptor location levels of congestion do not change as a result of the scheme. This conclusion has been agreed with the scheme's traffic team.

The concentrations modelled at R14, which exceed the annual mean NO_2 AQO, are similar to those monitored in 2019 at local authority monitoring site N30A, which is adjacent to this receptor. As concentrations at R14 exceed the annual mean NO_2 AQO, additional receptors in the vicinity of R14 were considered (R28-R31) to determine if there were any other receptors likely to exceed the AQO. The same verification factor was assumed for these receptors as R14 as a worst case.

At R28-R31, concentrations are predicted to be below the annual mean NO_2 AQO. The receptor with the highest Do-Something concentration is R28 which is predicted to experience an increase of 0.3µg/m^3 from 30.1µg/m^3 in the Do-Minimum to 30.4µg/m^3 in the Do-Something scenario. Concentrations at these receptors are lower than at R14 as these receptors are set further back from the road; R14 is approximately 2.0m from the kerbside in the Do-Minimum while R28 is approximately 11.5m.

All other receptors modelled in the assessment predict Do-Something concentrations which are lower than 30µg/m^3.

The largest increase in annual mean NO_2 concentrations is predicted to be an increase of 1.9µg/m^3 from 17.6µg/m^3 to 19.5µg/m^3 at receptor R16 at Offington Corner roundabout. This increase is due to an increase in vehicles of approximately 4,300 AADT and a change in speed band from light congestion to heavy congestion, associated with the additional vehicles from rerouting as a result of the scheme option.

The largest decrease in annual mean NO_2 concentrations is predicted to be a decrease of 0.4µg/m^3 from 15.8µg/m^3 to 15.4µg/m^3 at receptor R25 on Littlehampton Road. This decrease is due to a reduction in vehicles of approximately 2,500 AADT on the roads adjacent to this receptor from rerouting as a result of the scheme option.

Table 5-15: Annual mean NO_2 concentrations at worst-case human health receptors - Option 1

Receptor	NO_2 annual mean concentration (µg/m^3)			Change in concentration (µg/m^3)
	Base year (2019)	Do-minimum (2027)	Do-something (2027)	
R14	55.6	48.0	48.7	0.7
R16	20.4	17.6	19.5	1.9
R25	17.7	15.8	15.4	-0.4

As presented in Table 5.16 below, only one receptor experiences a small worsening in air quality already above the objective. In accordance with DMRB LA 105, as this is less than the lower guideline band for the small magnitude of change category (as presented in Table 5.6), this scheme option is considered unlikely to trigger a significant air quality effect for human health.

Table 5-16: Summary of impacts at human health receptors - Option 1

Magnitude of change in concentration	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large	0	0
Medium	0	0
Small	1	0

Option 2

As presented in Table 5.17, the largest change in annual mean NO_2 concentrations in Option 2 is predicted to be an increase of 3.8µg/m^3 from 16.7µg/m^3 in the Do-Minimum to 20.5µg/m^3 in the Do-Something scenario at receptor R17. This increase, at the Offington Corner roundabout, is due to an increase of approximately 5,000 AADT on the A27 and 2,500 AADT on the A24, which are adjacent to this receptor.

The highest Do-Something concentration of 48.1µg/m^3 is predicted at receptor R14. This receptor is included as it is located within 200m of the Grove Lodge roundabout, however the change in AADT on the A27 adjacent to R14 is below the ARN criteria. The increase in NO_2 concentrations of 0.1µg/m^3 at this receptor, which is located south of the eastern arm of the Grove Lodge roundabout, is due an increase of approximately 100 AADT on the road adjacent to R14. As discussed above in Option 1, there would also be no improvement in speed bands on this section of road as a result of this scheme option.

The concentrations modelled at R14, which exceed the annual mean NO_2 AQO, are similar to those monitored in 2019 at local authority monitoring site N30A, which is adjacent to this receptor. As concentrations at R14 exceed the annual mean NO_2 AQO, additional receptors in the vicinity of R14 were considered (R28-R31) to determine if there were any other receptors likely to exceed the AQO. The same verification factor was assumed for these receptors as R14 as a worst case.

At R28-R31, concentrations are predicted to be below the annual mean NO_2 AQO. The receptor with the highest Do-Something concentration is R28 which is predicted to experience a negligible change of less than 0.1 µg/m^3 from the Do-Minimum to 30.1µg/m^3 in the Do-Something scenario. Concentrations at these receptors are lower than at R14 as these receptors are set further back from the road; R14 is approximately 2.5m from the kerbside in the Do-minimum while R28 is approximately 11.5m.

All other receptors modelled in the assessment predict Do-Something concentrations which are lower than 30µg/m^3.

The largest decrease in annual mean NO_2 concentrations is predicted to be a decrease of 1.7µg/m^3 from 14.3µg/m^3 to 12.6µg/m^3 at receptor R4 on Upper Brighton Road (off the A27, near the Lyons Way Junction). This decrease is due to a reduction of approximately 5,000 AADT on the roads adjacent to this receptor due to the closure of the road in the westbound direction and creation of a one-way road as a result of the scheme option.

Table 5-17: Annual mean NO_2 concentrations at worst-case human health receptors - Option 2

Receptor	NO_2 annual mean concentration (µg/m^3)			Change in concentration (µg/m^3)
	Base year (2019)	Do-minimum (2027)	Do-something (2027)	
R4	17.2	14.3	12.6	-1.7
R14	55.6	48.0	48.1	0.1
R17	19.7	16.7	20.5	3.8
R28	35.0	30.1	30.1	<0.1

As presented in Table 5.18 below, there are no receptors which experience a small, medium or large worsening in air quality which are already above the objective. In accordance with DMRB LA 105, this scheme option is considered unlikely to trigger a significant air quality effect for human health.

Table 5-18: Summary of impacts at human health receptors - Option 2

Magnitude of change in concentration	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large	0	0
Medium	0	0
Small	0	0

Option 3

As presented in Table 5.19, the largest change in annual mean NO_2 concentrations in Option 3 is predicted to be an increase of 3.8µg/m^3 from 16.7µg/m^3 in the Do-Minimum to 20.5µg/m^3 in the Do-Something scenario at receptor R17. This increase, at the Offington Corner roundabout, is due to an increase of approximately 5,000 AADT on the A27 and 2,500 AADT on the A24, which are adjacent to this receptor.

The highest Do-Something concentration of 48.0µg/m^3 is predicted at receptor R14. This receptor is included as it is located within 200m of the Grove Lodge roundabout, however the change in AADT on the A27 adjacent to R14 is below the ARN criteria. There is a change in NO_2 concentrations of less than 0.1µg/m^3 at this

receptor, which is located south of the eastern arm of the Grove Lodge roundabout, which is due to a minimal change in traffic on the road adjacent to R14. As discussed above in Option 1, there would also be no improvement in speed bands on this section of road as a result of this scheme option.

The concentrations modelled at R14, which exceed the annual mean NO_2 AQO, are similar to those monitored in 2019 at local authority monitoring site N30A, which is adjacent to this receptor. As concentrations at R14 exceed the annual mean NO_2 AQO, additional receptors in the vicinity of R14 were considered (R28-R31) to determine if there were any other receptors likely to exceed the AQO. The same verification factor was assumed for these receptors as R14 as a worst case.

At R28-R31, concentrations are predicted to be below the annual mean NO_2 AQO. The receptor with the highest Do-Something concentration is R28 which is predicted to experience a negligible change of less than 0.1µg/m^3 from the Do-Minimum to 30.1µg/m^3 in the Do-Something scenario. Concentrations at these receptors are lower than at R14 as these receptors are set further back from the road; R14 is approximately 2.5m from the kerbside in the Do-Minimum while R28 is approximately 11.5m.

All other receptors modelled in the assessment predict Do-Something concentrations which are lower than 30µg/m^3.

The largest decrease in annual mean NO_2 concentrations is predicted to be a decrease of 1.6µg/m^3 from 14.3µg/m^3 to 12.7µg/m^3 at receptor R4 on Upper Brighton Road (off the A27, near the Lyons Way Junction). This decrease is due to a reduction of approximately 5,000 AADT on the roads adjacent to this receptor due to the closure of the road in the westbound direction and creation of a one-way road as a result of the scheme option.

Table 5-19: Annual mean NO_2 concentrations at worst-case human health receptors - Option 3

Receptor	NO_2 annual mean concentration (µg/m^3)			Change in concentration (µg/m^3)
	Base year (2019)	Do-minimum (2027)	Do-something (2027)	
R4	17.2	14.3	12.7	-1.6
R14	55.6	48.0	48.0	<0.1
R17	19.7	16.7	20.5	3.8
R28	35.0	30.1	30.1	<0.1

As presented in Table 5.20 below, there are no receptors which experience a small, medium or large worsening in air quality which are already above the objective. In accordance with DMRB LA 105, this scheme option is considered unlikely to trigger a significant air quality effect for human health.

Table 5-20: Summary of impacts at human health receptors - Option 3

Magnitude of change in concentration	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large	0	0
Medium	0	0
Small	0	0

All Options - PM_{10} concentration

The annual mean PM_{10} concentrations predicted at key receptors for the base year demonstrates concentrations are well within the annual mean AQO. Considering the predicted changes for NO_2, and emissions for PM_{10} are a magnitude lower than for NO_2, it can be concluded that there would likely be no impact on achievement of the PM_{10} air quality thresholds as a result of any of the scheme options. In addition, all predicted annual mean concentrations of PM_{10} are well below 32µg/m^3 and therefore no exceedances of the 24-hour PM_{10} objective are predicted. Therefore, in accordance with DMRB LA 105 there are no significant effects related PM_{10}.

Table 5-21: Annual Mean PM_{10} Concentrations at Human Receptors

Receptor ID	Annual Mean PM_{10} Concentration (µg/m^3)
	2019 Base Year
R1	19.3
R2	18.1
R3	18.4
R4	16.5
R5	17.6
R6	17.2
R7	18.8
R8	18.9
R9	18.2
R10	18.3
R11	18.4
R12	17.8
R13	17.1
R14	24.3
R15	19.1
R16	16.8

Receptor ID	Annual Mean PM_{10} Concentration ($\mu g/m^3$)
	2019 Base Year
R17	16.6
R18	16.6
R19	16.8
R20	17.0
R21	17.4
R22	16.0
R23	17.8
R24	15.7
R25	14.2
R26	17.1
R27	16.7
R28	15.8
R29	16.8
R30	16.5
R31	17.0

5.8.2.2 Ecological Effects

A nitrogen deposition assessment has been undertaken for the designated sites in accordance with DMRB LA 105. The results of the nitrogen deposition assessment are presented in Table 14-14 to Table 14-16 in Appendix C.1.2.

The total nitrogen deposition rates at all designated sites modelled are higher than the lower critical load (10 kgN/ha/yr for E1-E4 kgN/ha/yr and 15 kgN/ha/yr for E5 and E6) at the point within each site closest to the A27 in both the Do-Minimum and Do-Something scenarios for all scheme options. Background nitrogen deposition rates are based on a 3-year average for 2017 to 2019. This has not been adjusted to account for the expected decline in pollutant concentrations in future years and therefore is likely to be a conservative assumption compared to actual deposition likely in the opening year of 2027.

For all scheme options, there are predicted changes in nitrogen deposition which are greater than one percent of the critical load. The greatest change is predicted in Option 2 at receptor E4 where a 3.8 kg/N/ha/yr change is predicted as a result of an increase of approximately 4,000 AADT on the section of the A27 which is approximately 1.5m from the receptor. Receptors E1, E3 and E5 also experience changes greater than 0.4kg/ha/yr as they are located adjacent to the A27. In accordance with DMRB LA 105, as these changes are greater than 0.4kg/ha/yr and the total nitrogen deposition rates are greater than the minimum applicable critical load, the likelihood of significant effects at these ecological sites has been discussed with the scheme ecologist.

While the total nitrogen deposition rates are greater than the critical loads and the change in nitrogen deposition rates as a result of the scheme options are greater than 0.4kg/ha/yr up to distances of:

- 20m at ecological site E1
- 20m at ecological site E3
- 70m at ecological site E4
- 40m at ecological site E5

The assessment has demonstrated that current nitrogen deposition rates greatly exceed (or are close to exceeding) the respective relevant minimum critical loads at these locations. This is due to the proximity of these ecological sites to the A27, which results in high existing nitrogen deposition rates. As the A27 has been at this location for a number of years, it is unlikely species sensitive to nitrogen deposition would be present within these designated site. Therefore, following discussions with a competent biodiversity expert, it is unlikely that the increase in nitrogen deposition rates predicted as a result of the changes in traffic associated with the scheme options would lead to the loss of one or more species within these habitats.

The effects of the scheme options on ecological receptors is therefore considered not significant. However, it is recommended that if any of these scheme options are progressed to PCF Stage 3, surveys are conducted within the habitats represented by receptors E1, E3, E4 and E5 (those closest to the A27) to confirm that there are no species sensitive to nitrogen deposition present which could be affected by the scheme options.

5.8.2.3 Compliance Risk Assessment

As discussed in Section 5.5.5, there are 11 PCM links which intersect with the ARN. For the purpose of this assessment, four PCM links have been considered (all three on the A27 and one on the A2031 at the Offington Corner roundabout) as these are the roads which are predicted to experience the greatest increases in AADT as a result of the scheme options.

For all the PCM links assessed, the qualifying features identified were public footpaths. Therefore, receptors were modelled at 1m from the kerbside in the Do-Minimum and Do-Something. As a worst case, these receptors were modelled on the PCM links at locations closest to the Offington Corner/Grove Lodge Roundabout. However, in accordance with DMRB LA 105, receptors were modelled more than 25m from junctions. Figure 5.6 presents the location of the qualifying features modelled.

A point 4m from the running lane at the same location as the qualifying features identified were also modelled to compare the results from the DMRB Screening Model against the national PCM modelled concentration. In accordance with DMRB LA 105, concentrations were modelled using the Defra methodology (not

using the LTT_{E6} Gap Analysis) so that the assessment is consistent with Defra's reporting on compliance with the limit values.

Table 5.22 presents a comparison of the results modelled at the locations 4m from the edge of the running lane in the DMRB Screening Model with the results from the PCM model in 2019. At all census IDs except 802056246, the difference in the modelled concentrations is more than 8% (with higher concentrations being modelled with the DMRB Screening Model). At census ID 802026302 there is also an exceedance of the limit value predicted in 2019. The large difference at ID 802026302 is the result of highly localised air quality impacts at this location, as demonstrated in the model verification presented in Appendix C. The concentration modelled in the DMRB Screening Model at this census ID is in line with the concentrations monitored at this location (monitored values are higher but the monitoring location is closer than 4m to the roadside) in 2019. Therefore, the DMRB model is considered more robust than the PCM model for use in the compliance risk assessment.

At the remaining PCM links (census IDs 802078242 and 802046284) while the difference between the PCM model and local model is more than 8%, neither model identifies an exceedance of the limit value of 40µg/m^3 in 2019. Therefore, based on the magnitude of changes in concentrations modelled in the main assessment, concentrations in the future year are expected to remain below the limit value and therefore do not present a compliance risk so have not been considered further.

Table 5-22: Comparison of concentrations modelled 4m from the edge of the road in the PCM model and the local model

Census ID	2019 PCM model concentration (µg/m^3)	2019 local modelled concentration (µg/m^3)	Difference between modelled concentrations (µg/m^3)	Difference between modelled concentrations (µg/m^3)
802026302	30.4	50.4	20.0	65.8%
802056246	31.7	29.3	-2.4	-7.8%
802078242	28.1	30.5	2.4	8.5%
802046284	18.3	22.5	4.2	23.0%

Table 5.23 presents the results from the compliance risk assessment for the qualifying features at census ID 802026302 for all three scheme options. This is the PCM link with the highest concentrations within the study area. All three scheme options are predicted to result in a similar change in concentrations as the changes in traffic are broadly similar but Option 1 has slightly larger changes than Options 2 and 3. While Option 1 experiences greater increases in AADT, the change in the road alignment as a result of this scheme option result in the eastbound carriageway of the A27 moving further away from the qualifying feature

whilst the qualifying feature is modelled at 1m from the westbound carriageway in both the Do-Minimum and Do-Something and this is why an improvement is predicted,

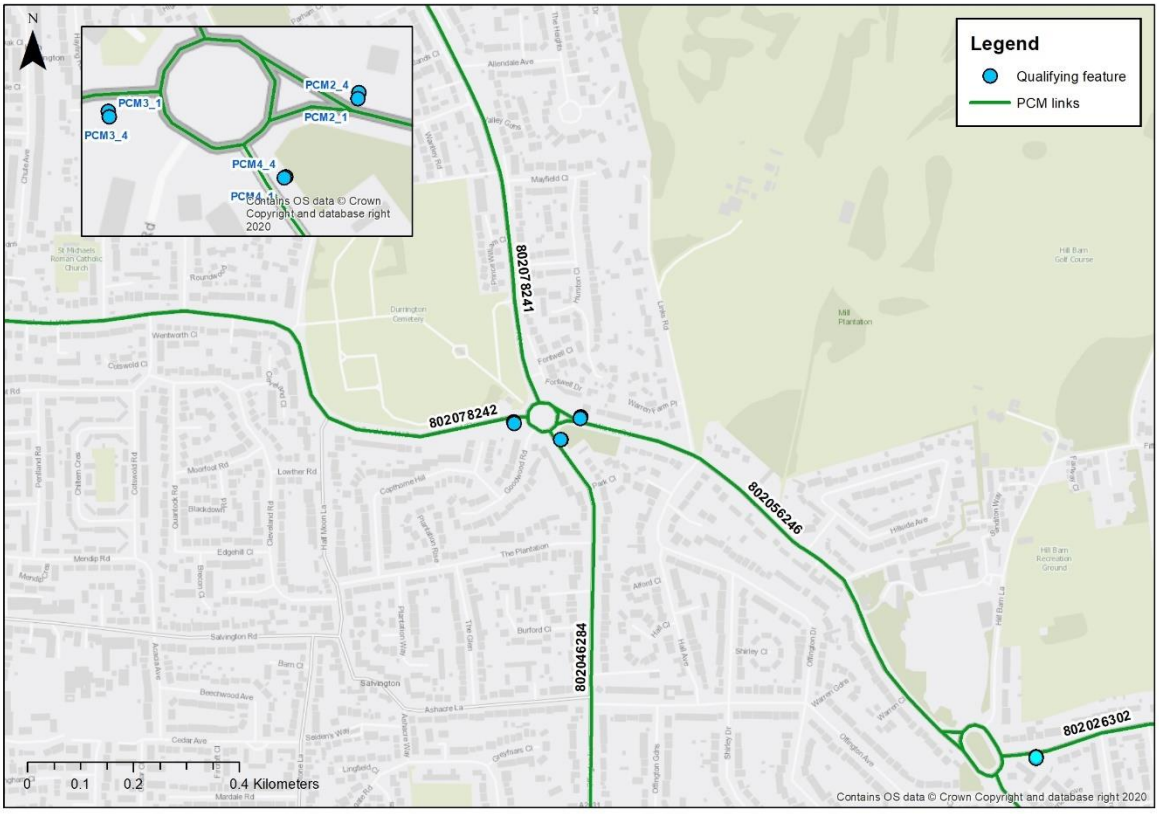
There are no predicted increases of more than 0.4µg/m^3 at the qualifying feature on this link for all scheme options when applying the Defra methodology and concentrations remain below the limit value in the opening year. Concentrations also remain below the limit value in the opening year at the remaining PCM links within the study area. Therefore, in accordance with DMRB LA 105, there is no risk to the UK's reported date of compliance, and therefore there is no requirement for further assessment.

However, it should be noted that predicted concentrations are close to the limit value. Therefore, the risk of non-compliance with the limit value requires careful consideration at future PCF stages of the scheme development.

Table 5-23: Concentrations modelled 1m from the edge of PCM link census ID 802026302

Scheme Option	NO_2 annual mean concentration (µg/m^3)		Change in concentration (µg/m^3)
	Do-minimum (2027)	Do-something (2027)	
Option 1	32.4	32.2	-0.2
Option 2	32.4	32.4	-0.1
Option 3	32.4	32.4	<0.1

Figure 5.6: PCM road network and qualifying features



5.8.3 Conclusions

One exceedance of the annual mean NO_2 AQO is predicted at a human health receptor in the 2027 opening year in both the Do-Minimum and Do-Something scenarios for all scheme options. This receptor, which currently exceeds the AQO, is also expected to experience a change greater than 0.4µg/m^3. For Option 1, this receptor experiences a small change in concentrations while in Options 2 and 3, there is an imperceptible change. Additional receptors in the vicinity of this receptor were therefore modelled but no other receptor was predicted to experience an annual mean NO_2 concentration above the AQO. Therefore, all three options are below the lower threshold for significance in accordance with DMRB LA 105, and therefore the effect of the scheme options on human health receptors is not significant.

The predicted changes in nitrogen deposition at the ecological receptors as a result of the scheme options are also not predicted to be significant in accordance with DMRB LA 105. However, this should be confirmed by undertaking ecological surveys at PCF Stage 3 to determine whether species sensitive to nitrogen deposition are present at these designated sites which could be affected by the scheme options.

Finally, the outputs from the compliance risk assessment demonstrate that there are no exceedances of the limit value or no risk to the UK's reported date of compliance due to all scheme options. However, predicted concentrations are close to the limit value so the risk of non-compliance with the limit value requires careful consideration at future PCF stages of the scheme development.

On the basis of the above, the effect of the scheme options on air quality at human health receptors, ecological receptors or limit value compliance is considered not significant in accordance with DMRB LA 105. At future PCF stages, further assessment will be undertaken. It is proposed that a detailed assessment will be undertaken at PCF Stage 3. Due to the suitable availability of local authority monitoring it is not proposed to undertake any scheme specific monitoring at PCF Stage 3.

6 Landscape and visual effects

6.1 Legislative and policy framework

6.1.1 National Policy

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England with Section 15, Paragraphs 174-188 of the NPPF setting out the framework with respect to conserving and enhancing the natural environment. Paragraph 176 states that *"Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks, the Broads and Areas of Outstanding Natural Beauty which have the highest status of protection in relation to these issues."*

6.1.2 South Downs National Park policy

The South Downs Local Plan states that the purposes of the South Downs National Park (SDNP) are:

"To conserve and enhance the natural beauty, wildlife and cultural heritage of the area.

To promote opportunities for the understanding and enjoyment of the special qualities of the National Park by the public."

It goes on to state:

"The National Park Authority also has a duty when carrying out the purposes: To seek to foster the economic and social well-being of the local communities within the National Park.

In addition, Section 62 of the Environment Act 1995 also requires all relevant authorities, including statutory undertakers and other public bodies, to have regard to these purposes. Where there is an irreconcilable conflict between the statutory purposes, statute requires The Sandford Principle to be applied and the first purpose of the National Park will be given priority."

Several policies of the plan are relevant to the scheme and assessment of landscape and visual effects, as follows:

- Strategic Policy SD4: Landscape Character, which includes: *"1. Development proposals will only be permitted where they conserve and enhance landscape character…".*
- Strategic Policy SD5: Design, which includes: *"1. Development proposals will only be permitted where they adopt a landscape led approach and respect the local character, through sensitive and high quality design that makes a positive contribution to the overall character and appearance of the area."*

- Strategic Policy SD6: Safeguarding Views, which includes: *"1. Development proposals will only be permitted where they preserve the visual integrity, identity and scenic quality of the National Park, in particular by conserving and enhancing key views and views of key landmarks within the National Park."*
- Strategic Policy SD7: Relative Tranquillity, which includes: *"1. Development proposals will only be permitted where they conserve and enhance relative tranquillity…".*
- Strategic Policy SD8: Dark Night Skies, which includes: "*1. Development proposals will be permitted where they conserve and enhance the intrinsic quality of dark night skies…".*
- Strategic Policy SD9: Biodiversity and Geodiversity, which includes: *"1. Development proposals will be permitted where they conserve and enhance biodiversity and geodiversity…".*
- Development Management Policy SD11: Trees, Woodland and Hedgerows, which includes: *"1. Development proposals will be permitted where they conserve and enhance trees, hedgerows and woodlands."*

6.1.3 Other guidance from SDNP

6.1.3.1 View Characterisation and Analysis

The SDNP View Characterisation and Analysis, maps and analyses views to, from and within the area. The aims and purpose of the study is to provide evidence on view types within the National Park and its setting to support development management, including being used for evidence on landscape and visual matters. It includes a selection of views representative of those found across the park, focusing on revealing special qualities, observation points to appreciate the downs, and places with facilities to enjoy landscape and views. None are located within the 1km study area, however, there are three representative views near or just beyond 2km from the scheme extents, which may need to be taken into consideration once further detail of the scheme design and construction strategy are known. These are:

- View 72: A280 at Long Furlong, to the north-west, which provides views of the transition from the Arun to Adur Open Downs (LCA A3) to the wooded landscape of the Angmering and Clapham Woods (LCA B4).
- View 21: View to Cissbury Ring, to the north. A landmark feature with views from the Monarch's Way north of it.
- View 30: Lancing College, to the east, identifying views from the Downs Link long distance footpath looking across the River Adur towards the college chapel. The college is also seen from Monarch's Way.

The South Downs Local Plan strategic policy SD6: Safeguarding Views includes provisions for *"conserving and enhancing key views and views of key landmarks within the National Park"* in relation to development proposals.

6.1.3.2 Dark skies

In May 2016, the SDNP became an International Dark Sky Reserve (IDSR). The SDNP Dark Skies Technical Advice Note, Figure 2, shows that the study area falls primarily within Dark Night Sky Zone E1b Transition Zones. An area to the north-west of Worthing is shown to fall within Dark Night Sky Zone E1a Intrinsic Rural Darkness which, according to the South Downs Local Plan Strategic Policy SD8: Dark Night Skies, falls into the same category as Zone E1a 2km Buffer Zone. The majority of the area within Zone E1a falls beyond 1km of the scheme extents, although small parts lie within 1km and 500m of the western end of the scheme extents.

The accompanying text to strategic policy SD8s states that "*Zone E1 (a) 2km Buffer Zone and (b) Transition Zone"* are *"areas that lie between the larger urban settlements and the surrounding darker skies notably vulnerable to light pollution. These areas are generally in the buffer zones and rural transition areas. Generally this will be where the sky quality changes from poor to the edge of an intrinsic dark sky zone".* The policy states that Zone E1a Intrinsic Rural Darkness are areas outside of the 2km buffer zone and the Zone E0 Dark Sky Core, which are of intrinsic rural darkness with a Sky Quality Meter (SQM) range of 20 to 20.5. Section 2 of Policy SD8 includes: *"Development proposals must demonstrate that all opportunities to reduce light pollution have been taken"*.

6.1.3.3 Tranquillity

The SDNP Tranquillity Study states that *"Tranquillity is considered to be a state of calm, quietude and is associated with a feeling of peace. It relates to quality of life, and …it also helps to promote health and well-being. It is a perceptual quality of the landscape, and is influenced by things that people can both see and hear in the landscape around them."* It goes on to state, *"'Tranquil and unspoilt places' are one of seven special qualities of the National Park."*

The associated mapping includes three broad categories of 'highest tranquillity' coloured dark green, 'intermediate tranquillity' coloured yellow and 'lowest tranquillity' coloured orange and red. The scheme extents are coloured primarily red with areas of orange around Sompting Abbots indicating low tranquillity. Neighbouring urban and rural areas within 1km of the scheme fall mainly within the low to intermediate tranquillity categories. However, there are areas coloured light to dark green in the South Downs located approximately 500m or more from the scheme. These include areas to the north-west, around Clapham Wood; to the north, around Worthing Golf Course and around The Mountain woodland north of Sompting, and to the north-east, around Lancing Hill.

6.1.4 Local policy

6.1.4.1 Worthing Local Plan

The existing Worthing Core Strategy was adopted in 2011 and intended to run to 2026. However, the Council has recently been preparing a new Plan. The

Submission Draft Worthing Local Plan (SDWLP) was submitted to the Secretary of State for examination on 11 June 2021. Therefore, the policy framework of this version of the Plan is considered in this chapter. However, it is noted that following the Inspectors' Post Hearing Advice Letter, the Council had, at the time of writing not yet published the Schedule of Modifications for consultation. Therefore, the policies set out below may be subject to further change.

Policies relevant to the scheme and assessment of landscape and visual effects, include:

- DM18 – Biodiversity, which includes:

  "b) All development should ensure the protection, conservation, and enhancement of biodiversity."; and

  "*h) New developments (excluding change of use and householder) should provide a minimum of 10% net gain for biodiversity - where possible this should be onsite."*

- DM19 – Green infrastructure, which includes:

  "b) All developments (excluding householder) will need to demonstrate how they will contribute to the implementation of the Green Infrastructure Strategy both at site level and with regard to the wider green infrastructure network."; and

  "c) In all new developments there should be no net loss of trees and any trees removed should usually be replaced on a 1:1 basis to maintain current levels of canopy cover. Additional tree planting is encouraged where appropriate to improve the quality of the local environment and increase appropriate species canopy cover."

6.1.4.2 Adur Local Plan

The Adur Local Plan was adopted on 14 December 2017 and runs to 2032. Policies relevant to the scheme and assessment of landscape and visual effects, include:

- Policy 30: Green Infrastructure, which states:

  "Green infrastructure will be protected and enhanced and access to it improved where necessary and appropriate. When considering green infrastructure provision, the ecological characteristics of the area will be taken into account in order to maximise the biodiversity benefits.

  Developments will be required to incorporate elements of green infrastructure into their overall design, and/or enhance the quality of existing Green Infrastructure as appropriate.

  The planting of trees will be supported and encouraged."

- Policy 31: Biodiversity, which includes:

  "All development should ensure the protection, conservation, and where possible, enhancement of biodiversity."

6.2 Assessment methodology

Landscape encompasses many more elements than the common association which focuses merely upon the view or appearance of the land. The notion of landscape can be applied to both rural and urban environments with the term 'townscape' frequently adopted within the urban context. The term 'landscape' applies to capture the appraisal of environmental factors such as topography, drainage, land use and management, vegetation and ecology, as well as historical and cultural associations.

The assessment uses structured, informed and reasoned professional judgement, taking into account a combination of quantitative and qualitative data derived from desk study. Future desk study and future walkover survey in Project Control Framework (PCF) Stage 3 will clarify both the study area and Zone of Theoretical Visibility (ZTV) and allow the project Landscape Architect to undertake a local character assessment to understand the landscape value and associated sensitivity to change of each character area.

6.2.1 Policy requirements, guidance and advice

The landscape assessment follows the recommendations set out in National Highways' Design Manual for Roads and Bridges (DMRB) document LA 107 Landscape and visual effects, 2020 which aligns with the Guidelines for Landscape and Visual Impact Assessment 3 produced by the Landscape Institute and Institute of Environmental Management and Assessment (IEMA), third edition, 2013.

The policy requirements and other guidance are set out in Section 6.1.

6.2.2 Data sources

Information to assist with defining the existing baseline conditions has been obtained from the following sources:

- Magic interactive geographic information about the natural environment[47]
- Google Maps[48]
- Bing Maps[49]

[47] Defra, Magic [online] available at: MAGIC (defra.gov.uk) (last accessed March 2022).
[48] Google Maps [online] available at: Great Yarmouth - Google Maps (last accessed March 2022).
[49] Bing Maps [online] available at: Bing Maps - Directions, trip planning, traffic cameras & more (last accessed March 2022).

- South Downs Local Plan[50]
- Submission Draft Worthing Local Plan[51]
- Adur Local Plan[52]
- Natural England's database of National Character Areas[53] [54]
- South Downs Landscape Character Assessment[55] and map[56]
- South Downs National Park: View Characterisation and Analysis[57] map[58]
- South Downs National Park Dark Skies Technical Advice Note[59] and map[60]
- South Downs National Park Tranquillity Study[61] and map[62]

[50] South Downs Local Plan (Adopted 2 July 2019 (2014-33) [online] available at: South Downs Local Plan - South Downs National Park Authority (last accessed March 2022).
[51] Worthing Borough Council (Jan 2021) Submission Draft Worthing Local Plan (SDWLP) [online] available at: Worthing Local Plan Submission & Examination - Adur & Worthing Councils (adur-worthing.gov.uk) (last accessed February 2022).
[52] Adur District Council (2017) Adur Local Plan 2017 [online] available at: Adur Local Plan 2017 - Adur & Worthing Councils (adur-worthing.gov.uk) (last accessed February 2022).
[53] Natural England (2015) National Character Area Profile:125:South Downs (NE432) [online] available at: NCA Profile:125:South Downs - NE432 (naturalengland.org.uk) (last accessed March 2022).
[54] Natural England (2014) National Character Area Profile:126:South Coast Plain (NE525) ([online] available at: NCA Profile:126 South Coast Plain - NE525 (naturalengland.org.uk) (last accessed March 2022).
[55] South Downs Landscape Character Assessment Report prepared by LUC (August 2020) [online] available at: South Downs Landscape Character Assessment (LCA) 2020 - South Downs National Park Authority (last accessed March 2022).
[56] South Downs Landscape Character Assessment interactive map [online] available at: South Downs National Park Landscape Character Assessment (arcgis.com) (last accessed March 2022).
[57] South Downs National Park: View Characterisation and Analysis Final Report Prepared by LUC on behalf of the South Downs National Park Authority (November 2015) [online] available at: South Downs National Park: View Characterisation and Analysis (last accessed March 2022).
[58] South Downs National Park: View Characterisation and Analysis map (2015) [online] available at: SDNP-Viewshed-Viewpoints.pdf (southdowns.gov.uk) (last accessed March 2022).
[59] South Downs National Park (April 2018) Dark Skies Technical Advice Note [online] available at: Dark Skies Technical Advice Note (TAN) - South Downs National Park Authority (last accessed March 2022).
[60] South Downs National Park Authority (2018) South Downs Dark Night Sky Zones map [online] available at: South Downs Landscape Qualities (arcgis.com) (last accessed February 2022).
[61] South Downs National Park Authority (2017) Tranquillity Study [online] available at: 13-04-17-South-Downs-National-Park-Tranquillity-Study.pdf (southdowns.gov.uk) (last accessed February 2022).
[62] South Downs National Park Authority Tranquillity Study map [online] available at: South Downs Landscape Qualities (arcgis.com) (last accessed February 2022).

- Landscape Character Assessment of West Sussex[63], including A Strategy for the West Sussex Landscape[64]

6.2.3 Significance criteria

The significance of effect upon landscape character considers a combination of the magnitude of change (or impact) against the quality and sensitivity to change of the affected landscape.

The significance of visual effects is determined by combining the sensitivity of the visual receptor to the proposed change in conjunction with the magnitude of change.

6.2.3.1 Sensitivity (susceptibility and value) of resource

Landscape sensitivity considers the robustness of the landscape to accommodate change. The evaluation of the sensitivity of the landscape resource is based on factors and attributes which affect the value of the landscape and its susceptibility to change. Table 6-1 outlines levels of sensitivity and associated typical descriptors for landscape character.

Table 6-1: Landscape sensitivity (susceptibility and value) and typical descriptions

Sensitivity	Typical descriptors and examples
Very High	Landscapes of very high international / national importance and rarity or value with no or very limited ability to accommodate change without substantial loss / gain (i.e. national parks, internationally acclaimed landscapes - UNESCO World Heritage Sites).
High	Landscapes of high national importance containing distinctive features / elements with limited ability to accommodate change without incurring substantial loss / gain (i.e. designated areas, areas of strong sense of place - registered parks and gardens, country parks).
Medium	Landscapes of local or regional recognition of importance, able to accommodate some change (i.e. features worthy of conservation, some sense of place or value through use / perception).
Low	Local landscape areas or receptors of low to medium importance with ability to accommodate change (i.e. non-designated or designated areas of local recognition or areas of little sense of place).
Negligible	Landscapes of very low importance and rarity able to accommodate change.

[63] West Sussex County Council (2003) Landscape Character Assessment of West Sussex [online] available at: Landscape character assessment of West Sussex - West Sussex County Council (last accessed March 2022).
[64] West Sussex County Council (October 2005) A Strategy for the West Sussex Landscape [online] available at: A Strategy for the West Sussex Landscape, October 2005 (last accessed March 2022).

Source: LA 107, DMRB, 2020 (Table 3.22)

The sensitivity of the visual receptor varies with the type of receptor assessed. For example, residential receptors are likely to have a higher sensitivity to change, as with Public Rights of Way (PRoW), where walkers will be focusing on the views within the local landscape. Places of work, passengers on major transport routes and recreational receptors, where the focus is on the task in hand rather than the surrounding view, are considered to have a low sensitivity to change. Table 6-2 outlines levels of sensitivity and associated typical descriptors for visual receptors addressed within the assessment.

Table 6-2: Visual sensitivity (susceptibility and value) typical descriptions

Sensitivity	Typical descriptors and examples
Very High	• Static views from and of major tourist attractions. • Views from and of very important national / international landscapes, cultural / historical sites (for example National Parks, UNESCO World Heritage sites). • Receptors engaged in specific activities for enjoyment of dark skies.
High	• Views by users of nationally important PRoW / recreational trails (for example national trails, long distance footpaths). • Views by users of public open spaces for enjoyment of the countryside (for example country parks). • Static views from dense residential areas, longer transient views from designated public open space, recreational areas. • Views from and of rare designated landscapes of national importance.
Moderate	• Static views from less populated residential areas, schools and other institutional buildings and their outdoor areas. • Views by outdoor workers. • Transient views from local / regional areas such as public open space, scenic roads, railways or waterways, users of local / regional designated tourist routes of moderate importance. • Views from and of landscapes of regional importance.
Low	• Views by users of main roads or passengers in public transport on main arterial routes. • Views by indoor workers. • Views by users of recreational / formal sports facilities where the landscape is secondary to enjoyment of the sport. • Views by users of local public open spaces of limited importance with limited variety or distinctiveness.
Negligible	• Quick transient views such as from fast moving vehicles. • Views from industrial area, land awaiting re-development. • Views from landscapes of no importance with no variety or distinctiveness.

Source: LA 107, DMRB, 2020 (Table 3.41)

6.2.3.2 Magnitude of impact

In determining the magnitude of landscape impacts, the scale, geographic extent of influence and the duration and reversibility of the scheme shall be considered. Table 6-3 presents the magnitude of impact and associated typical descriptors for landscape character.

Table 6-3: Magnitude and nature of the impact on the landscape and typical descriptions

Magnitude of impact		Typical descriptions
Major	Adverse	Total loss or large-scale damage to existing landscape character or distinctive features or elements; and/or addition of new uncharacteristic, conspicuous features or elements (i.e. road infrastructure).
	Beneficial	Large scale improvement of landscape character to features and elements; and/or addition of new distinctive features or elements, or removal of conspicuous road infrastructure elements.
Moderate	Adverse	Partial loss or noticeable damage to existing character or distinctive features and elements, and/or the addition of new but uncharacteristic noticeable features and elements (i.e. road infrastructure).
	Beneficial	Partial or noticeable improvement of landscape character by restoration of existing features or elements; or addition of new characteristic features or elements or removal of noticeable features or elements.
Minor	Adverse	Slight loss or damage to existing landscape character of one (maybe more) key features and elements; and/or addition of new uncharacteristic features and elements.
	Beneficial	Slight improvement of landscape character by the restoration of one (maybe more) key existing features and elements; and/or the addition of new characteristic features.
Negligible	Adverse	Very minor loss, damage or alteration to existing landscape character of one or more features and elements.
	Beneficial	Very minor, but noticeable improvement of character by the restoration of one or more existing features and elements.
No Change		No noticeable alteration or improvement, temporary or permanent, of landscape character of existing features and elements.

Source: LA 107, DMRB, 2020 (Table 3.24)

The establishment of the magnitude of visual impacts has been informed by a number of criteria including, but not limited to the scale, nature and duration of change; distance; direction and focus of the view and whether screening is present. Table 6-4 presents the magnitude of visual impact and associated typical descriptors.

Table 6-4: Magnitude of visual impact (change) and typical descriptions

Magnitude of impact	Typical descriptors and examples
Major	The project, or a part of it, would become the dominant feature or focal point of the view.
Moderate	The project, or a part of it, would form a noticeable feature or element of the view which is readily apparent to the receptor.
Minor	The project, or a part of it, would be perceptible but not alter the overall balance of features and elements that comprise the existing view.
Negligible	Only a very small part of the project work or activity would be discernible or being at such a distance it would form a barely noticeable feature or element of the view.
No Change	No part of the project work or activity would be discernible.

Source: LA 107, DMRB, 2020 (Table 3.43)

6.2.3.3 Assessment of significance

The assessment of the significance of effect is undertaken by combining the sensitivity to change of an asset with an assessment of the magnitude of change put upon it. These effects can be beneficial or adverse, and temporary or permanent, depending on the nature of the development and the mitigation and any enhancement measures proposed. The output of this function is detailed within Table 4-3.

6.3 Assessment assumptions and limitations

In this assessment, landscape is a term used to cover rural and urban environments. The term townscape is also applied to fully urban contexts.

Full details of the construction methods, timescales and spatial requirements, including that needed for haul routes and construction compounds have yet to be determined, and therefore the full extent of the study area and associated receptors is yet to be confirmed. In addition, at this stage of assessment, the exact extent and type of embedded mitigation, including planting is not known.

The assessment of likely significant effects is therefore currently predicated on limited information, and simple horizontal alignments only at this time. As such only an indication can be made as to whether significant effects are likely to be afforded or experienced during construction and operation of any of the three scheme options.

The assessment of potential impacts during operation does not take into account mitigation planting being integrated into the scheme.

The assessment of likely significant effects during operation takes into consideration an assumed level of mitigation planting integrated in the scheme. A

single judgement of significance of effects is made, based on year 15 after the scheme is implemented and planting is reaching maturity.

At this stage, the assessment takes into consideration broad groups of receptors. Further, more detailed assessment at later stages of the scheme would consider potential impacts and significance of effects on individual or smaller groups of receptors.

6.4 Study area

The scheme extents and associated Landscape and Visual Impact Assessment (LVIA) study area are located within the existing urban areas of Worthing and Lancing. The SDNP lies to the north. The existing highway network includes the A27, which provides a through route from west to east, while the A24 runs north to south passing into the downs and crossing the A27 at Offington Corner Roundabout. Further networks of local roads serve the built up and urban-fringe areas. Extensive development alongside these roads constrains views in many locations, however sections of the existing A27 also adjoin undeveloped areas with potential for longer views. Parts of this undeveloped landscape fall within the SDNP. Taking these factors and the guidance from LA 107 into consideration, a preliminary study area of landscape and visual effects has been established that extends 1km from the existing A27, narrowing to 500m within the urban areas.

Refinement of the study area may be undertaken in further stages of the assessment, taking into consideration the findings of field studies and any inputs from the competent authority or key stakeholders. The emphasis would be on a proportionate approach to the assessment at each stage of the scheme.

6.5 Baseline conditions

The SDNP, designated in 2010, lies to the north of the scheme options, abutting the urban area and several sections of the A27.

Several conservation areas are present within 500m of the scheme, including Sompting Conservation Area which crosses the A27 at Sompting and North Lancing Conservation Area to the north-west of Grinstead Lane Junction. Two conservation areas are located to the west of Offington Corner Junction. These are Salvington Conservation Area to the south of the A27 at the junction with Half Moon Lane, and Durrington Conservation Area within the urban area further west. A further three conservation areas are located to the west, one being at the western end of the scheme extents and the other two between 1km and 2km distance away.

A number of listed buildings are present both within and beyond the conservation areas, with several located within close proximity to the A27. These include the grade II listed Sompting Peverel within 50m north of the A27 at Sompting, and the Coach and Horses Public House and Stanhope Lodge Stanhope Store, both grade

II listed and respectively within 65m and 80m south of the A27 in Worthing to the west.

Lancing Ring Local Nature Reserve (LNR) lies to the immediate north of North Lancing in the eastern section of the scheme extents. Part of the LNR is designated as Open Access Land (Countryside and Rights of Way Act 2000) that is located between 500m and 1km distance of the A27.

A number of PRoW provide connections through the urban areas within 500m and 1km north and south of the A27. Some of these PRoW also continue into the rural areas between and adjacent to settlements.

The SDNP is well served with PRoW, a number of which extend from the urban area. Beyond the study area, the South Downs Way National Trail, where it passes Steyning Bowl, lies over 3km to the north of the A27 at Sompting. The Monarch's Way long-distance footpath runs north-east from Findon, passing north of Cissbury Ring Site of Special Scientific Interest (SSSI) around 3.8km north of A27 Grove Lodge Roundabout. The Monarch’s Way crosses the South Downs Way near Steyning Bowl.

There are several areas of ancient woodland to the north-west of Worthing, parts of which fall between 500m and 1km distance of the A27. These include Clapham Wood north of the A27 and Titnore Wood and Goring Wood to the south of it.

6.5.1 Landscape and townscape context

The desk study has identified that the urban areas of Worthing and Lancing, within the study area, are flat to gently sloping and lie less than 20m Above Ordnance Datum (AOD). The A27 marks a transition to the undulating downland north of the road. Slope gradients there vary, with both gentle and steeply sloping ground, up to 100m AOD elevation at the periphery of the urban areas.

Worthing and Lancing comprise extensive sub-urban residential development, with many areas directly fronting onto the A27. There are also a number of other land uses including business, retail, education, recreation and leisure alongside and set back from the A27. Within the urban areas, trees and other vegetation form boundaries to open land uses such as Durrington Cemetery and the grounds of Worthing College. Private gardens include mature vegetation, particularly in the western area of the scheme extents, while there are also trees in grassed verges along part of the A27 in Worthing. The buildings, combined with the low-lying ground and vegetation cover, tend to limit long views.

The belt of farmland between Worthing and Lancing is largely open, but also includes trees and low hedges along boundaries. There is intervisibility with the surrounding built areas and views to the southern extents of the downland and lighting columns along the A27. Farmland also lies immediately north of the A27 at Lancing and Worthing. The majority falls within the southern extents of the SDNP, although this context is typically highly urbanised and of mixed quality. Whilst the

wider downland is broadly open in nature, vegetation is also present around leisure and education land uses, within the National Park and along field boundaries including those bounding the A27 within the designated area.

The section of the A27 at the Lyons Way / Sompting Road Junction is distinctly more urban. Here, residential and commercial built form is set close the road and there is a lower proportion of vegetation and grassland in private properties and alongside the road. From the Busticle Lane Junction and eastward to the Grinstead Lane Junction, the A27 is also distinctly urban. The built areas are predominantly residential, although there are also a limited number of commercial and community properties. Dwelling sizes are typically much smaller than to the west of the Lyons Way / Sompting Road Junction. In tandem, garden sizes are smaller, the proportion of garden planting is lower and where plants are present, they tend to be smaller in scale. There are a few exceptions, such as the taller trees alongside the academy school. Most buildings are set relatively close to the A27, and there are sections of footway with no associated grass verge. Immediately east of the Grinstead Lane Roundabout, the A27 retains a strongly urban character. However, this area also includes a grassed central reserve and verges, and trees within and adjacent to the Lancing Manor Leisure Centre grounds.

There are street lighting columns along the entire length of the A27 within the scheme extents. In some places, such as west of Offington Corner Roundabout, lighting columns are only to one side of the road. There is also a varying level of other road-related infrastructure such as cameras, signs and bollards, traffic signals and inspection cabinets. Other elements present include occasional seats, litter bins, bus shelters and a ramped footbridge. Galvanised pedestrian guardrails are also present in a number of locations.

Given that the scheme options fall principally within urban areas, for the purposes of this assessment, two broad townscape areas have been defined, with judgements made about sensitivity (susceptibility and value).

Townscape area 1 - immediate area of the A27, from the area of Offington Corner roundabout to A27 junction with Hadley Avenue. The area has a leafy, enclosed character with larger scale buildings, predominantly dwellings, set well back from the road. The area would be susceptible to change that could result in the loss of mature planting, or the introduction of elements that could increase the urbanising effect of the highway on character. Sensitivity (susceptibility and value) is judged to be medium.

Townscape area 2 - immediate area of the A27, from A27 junction with Hadley Avenue to A27 junction with Lyons Way. The area is strongly urban, with residential and commercial buildings set close to the road. There is limited planting, and the highway dominates the character of the area. The area would be susceptible to change that could introduce additional detracting features. Sensitivity (susceptibility and value) is judged to be low.

6.5.2 Landscape character

The national character areas, SDNP character types and areas, and West Sussex character areas pertaining to the 1km study area are set out below. Details of the described characteristics of each area, and relevant management guidelines are included in Appendix D.

6.5.2.1 National landscape character

The A27 at Worthing and Lancing straddles the boundary between National Character Area (NCA) 125 South Downs (NE432) to the north, and NCA 126 South Coast Plain (NE525) to the south. The NCAs can be viewed in Appendix D.1.1.

Referring to Table 6-1, sensitivity (susceptibility and value) judgements have been made in relation to the NCAs within the 1km study area. The importance / value of NCA 125 South Downs, which includes the National Park is judged to be very high. The importance / value of NCA 126 South Coast Plain is judged to be medium.

6.5.2.2 SDNP landscape character

The South Downs Landscape Character Assessment shows that the majority of the northern part of the study area and land beyond this, falls within landscape character type (LCT) A: Open Downland and landscape character area (LCA) A3: Arun to Adur Open Downs. The SDNP LCAs can be viewed in Appendix D.1.2 and Appendix D.2.

The South Downs Landscape Character Assessment shows that a small part of the study area to the north-west of Worthing, falls within LCT B: Wooded Estate Downland and LCA B4: Angmering and Clapham Wooded Estate Downland.

The assessment also shows that a very small part of the 1km study area to the east of Lancing falls within LCT G: Major Chalk Valley Sides and LCA G3: Adur Valley Sides.

Given the location within the National Park, the sensitivity (susceptibility and value) of LCA A3 Arun to Adur Open Downs, LCA B4 Angmering and Clapham Wooded Estate Downland, and LCA G3: Adur Valley Sides are all judged to be very high. However, no elements of the proposed interventions lie in close proximity to SDNP LCA B4 or LCA G3, nor would the character of these areas be indirectly affected by the options. Therefore, these LCAs are not considered further in this assessment.

6.5.2.3 Landscape Character Assessment of West Sussex

The designation of the National Park in 2010 and updating of the South Downs Landscape Character Assessment in 2020, has resulted in some overlap with the West Sussex Landscape Character Assessment. The West Sussex assessment includes Land Management Guidelines with key characteristics sheets for each character area, derived from the 2003 assessment. The West Sussex LCAs can be viewed in Appendix D.1.3 and Appendix D.3.

The settlements are shown as built-up areas although these have no accompanying description of characteristics. South of the A27, several areas of undeveloped land within the 1km study area fall within LCA SC11/SC13 Littlehampton and Worthing Fringes / Worthing and Adur Fringes. These include land to the east of Lancing, between Worthing and Lancing and to the west of Worthing around the A2032.

Land to the west of Worthing on both sides of the A27, falls within LCA SC12 Angmering Upper Coastal Plain and covers a small part of the 1km study area. Given the overlap with the National Park designation, the sensitivity (susceptibility and value) of LCA SC12 Angmering Upper Coastal Plain is judged to be high. However, no elements of the proposed interventions lie in close proximity to LCA West Sussex SC12, nor would the character of these areas be indirectly affected by the options. Therefore, SC12 is not considered further in this assessment.

The remaining part of the 1km study area falls within West Sussex LCA SD3 Central Downs. This area lies predominantly to the north of the A27, except for a small area of open land at Sompting, south of the road. LCA SD3 is broadly consistent with SDNP LCA A3 Arun to Adur Open Downs, and the sensitivity (susceptibility and value) is judged to be very high.

Referring to Table 6-1, the sensitivity (susceptibility and value) of LCA SC11/SC13 Littlehampton and Worthing Fringes / Worthing and Adur Fringes is judged to be medium. However, no elements of the proposed interventions lie in close proximity to West Sussex LCA SC11, nor would the character of these areas be indirectly affected by the options. Therefore, SC11 is not considered further in this assessment.

A summary of the landscape character areas considered in this assessment, and sensitivity (susceptibility and value) judgements is shown in Table 6-5.

Table 6-5: Landscape and townscape receptors and sensitivity (susceptibility and value)

Landscape/townscape Receptor	Sensitivity (susceptibility and value)
NCA 125 South Downs	Very high
NCA 126 South Coast Plain	Medium
SDNP LCA A3: Arun to Adur Open Downs	Very high
West Sussex LCA SD3	Very high
West Sussex LCA SC13 Worthing and Adur Fringes	Medium
Townscape area 1	Medium
Townscape area 2	Low

6.5.3 Visual baseline

There are expected to be a range of potential visual receptors for the scheme options. Receptors would include the users of the A27 itself, users of the nearby local road and footway network, occupants of residential properties, users of community facilities and workplaces, and users of publicly accessible land and paths including the PRoW network.

The potential visual receptors have been identified through desktop study. These include residents, users of businesses and users of the local road network, such as drivers, pedestrians and cyclists. The visual receptors also include users of community facilities and public paths. The number of the visual receptors may be reviewed in further assessment, taking into consideration the findings of field studies and any inputs from the competent authority or key stakeholders.

The potential visual receptors for the scheme options have been set out in Table 6-6 below. Referring to Table 6-2, judgements about the sensitivity (susceptibility and value) of receptors by type are also given.

Table 6-6: Visual receptors, distance and sensitivity (susceptibility and value)

Visual Receptor	Approximate nearest distance to Option 1	Approximate nearest distance to Option 2	Approximate nearest distance to Option 3	Sensitivity (susceptibility and value)
Offington Corner Roundabout - Residential receptors	Adjacent	Adjacent	Adjacent	High
Dwellings on the east side of the A24 Findon Road are one and two stories in height. At the south end of Fontwell Drive, which runs parallel with the A24, a small number of dwellings are set back from the roundabout. Mature vegetation at the end of the rear gardens obscures views to the roundabout in summer months. On the northern section of Fontwell Close, the bungalows have open views to the A24 due to few elements such as fences or vegetation to provide screening. Beyond these, two storey dwellings close to the A24 have open views to the road, or views partly screened by boundary hedges to front gardens. Along the A27 Warren Road, large dwellings are set back from the road behind mature hedges and trees that partly screen views. Along the A2031 Offington Lane and Goodwood Road, most of the two storey dwellings overlook these roads, due to limited or no garden vegetation. However, views to the roundabout are oblique and in part screened by mature vegetation close to the roundabout.				
Offington Corner Roundabout - Users of Durrington Cemetery	Adjacent	Adjacent	Adjacent	Moderate
Views to the roundabout from Durrington Cemetery are limited by mature planting at the boundaries. However, there are more open views beyond metal fences to the A24 Findon Road.				
Offington Corner Roundabout - Road users, including pedestrians and cyclists	Within the footprint	Within the footprint	Within the footprint	Low
Road users have open views to the highway network. Some footways are set back from the road behind grass verges with occasional trees. Buildings and vegetation along the road enclose views.				
Grove Lodge Roundabout - Residential receptors	Adjacent	Adjacent	Adjacent	High
Large dwellings on the west side of the A27 Warren Road and the roundabout are set back, with garden trees and shrubs providing partial screening views of the road. To the south-west, views to the junction from large dwellings along Offington Avenue are well screened in summer by intervening vegetation. To the south-east of the roundabout, a three storey block of flats lies behind a boundary wall and vegetation, but there are partial views to the junction. Along the A27 Upper Brighton Road, large dwellings are set back in large grounds. However, many have open views to the road. Views to the roundabout are limited except for a small number of properties in close proximity				

Visual Receptor	Approximate nearest distance to Option 1	Approximate nearest distance to Option 2	Approximate nearest distance to Option 3	Sensitivity (susceptibility and value)
to it. However, garden planting provides partial screening. Two storey dwellings on the lower section of Hill Barn Lane have oblique views toward the roundabout, with some screening of ground floor views by hedgerows.				
Grove Lodge Roundabout - Users of Worthing College	Adjacent	Adjacent	Adjacent	Moderate
The college grounds abut the roundabout, and a break in the boundary vegetation allows a framed view toward the roundabout. The college building is set back over 300m north of the roundabout, beyond sports pitches and amenity grassland. Views from the grounds and college building to the A27 Warren Road are partly screened by a belt of trees and other vegetation at the west side of the college.				
Grove Lodge Roundabout - Users of business	Adjacent	Adjacent	Adjacent	Low
Grove Lodge Vets is set back from the A27 Upper Brighton Road. Oblique views are available across the car park to this road. Views to the roundabout are partly obscured by the boundary wall, a block of flats and mature vegetation, including conifers, which are sited within the vet's and a neighbouring property.				
Grove Lodge Roundabout - Road users, including pedestrians and cyclists	Within the footprint	Within the footprint	Within the footprint	Low
Road users have open views to the highway network. Some footways are set back from the road behind grass verges with occasional trees. Buildings and vegetation along the road enclose views.				
Lyons Way / Sompting Road Junction - Residential receptors	N/A	Adjacent	N/A	Low
In the western section, large properties in large grounds have foreground views to the A27 with partial screening in places, by garden trees and hedges. In the eastern section, a small number of residents of dwellings and flats have open views to the road, with limited screening by garden planting. Further residents of two storey dwellings on side roads joining the A27 have oblique views, with in places, partial screening by garden planting.				
Lyons Way / Sompting Road Junction - Users of businesses	N/A	Adjacent	N/A	Low

Visual Receptor	Approximate nearest distance to Option 1	Approximate nearest distance to Option 2	Approximate nearest distance to Option 3	Sensitivity (susceptibility and value)
Users of the large retail park have partial views to the junction, although the buildings and vegetation close to the road obscure many views. Users of businesses at the A27 / Sompting Road junction have close range, open views to the road.				
Lyons Way / Sompting Road Junction - Road users, including pedestrians and cyclists, and users of 1 PRoW emerging onto the A27 via Lyons Retail park	N/A	Adjacent	N/A	Low
Road users have open views to the highway network. Some footways to the west are set back from the road behind grass verges with occasional trees. Buildings and vegetation along the road limit views outward.				
Busticle Lane Junction - Residential receptors	N/A	N/A	Adjacent	Low
Residents along the A27 Upper Brighton Road have close range, open views to the A27 with little screening by fences or garden planting. Further west, views from dwellings backing onto the road benefit from screening by mature vegetation. Views to the junction from properties on Busticle Lane, Halewick Lane and Steepdown Road are oblique and partly obscured by intervening vegetation, particularly to the north. Views to the A27 from Steepdown Road are limited by garden planting, roadside trees and the hedge bounding the field to the west.				
Busticle Lane Junction - Users of businesses	N/A	N/A	Adjacent	Low
Users of the terrace of businesses have close range views of the junction, with little screening by intervening vegetation. Views from the retail unit in the south-east quadrant of the junction are limited due to there being few windows. The public house has direct views to the junction, although the building is set back around 120m north of the A27 and overlooks a car park at the frontage.				
Busticle Lane Junction - Road users	N/A	N/A	Adjacent	Low
Road users have open views to the highway network and surrounding buildings and vegetation. Views also look across farmland which abuts the settlement, and which lies within the southern part of the SDNP. Some footways are set back from the road behind grass verges.				
Upper Brighton Road - Residential receptors	N/A	Adjacent	Adjacent	High

Visual Receptor	Approximate nearest distance to Option 1	Approximate nearest distance to Option 2	Approximate nearest distance to Option 3	Sensitivity (susceptibility and value)
The majority of residents have foreground views to the road with limited or no screening by garden planting. Views are limited by the buildings opposite.				
Upper Brighton Road - Road users including pedestrians and cyclists	N/A	Adjacent	Adjacent	Low
Road users have open views to the highway network. Buildings and vegetation along the road limit views outward except for some passing glimpses of farmland alongside the road where there are low walls. There are no footways along the road beyond the village. In parts, the footway only follows one side of the road and is typically very narrow.				

6.6 Potential impacts

Construction impacts may be short-term, long-term, temporary or permanent in nature. The sources of potential impacts considered in relation to landscape and visual amenity during construction include:

- Presence and movement of construction traffic, plant and equipment
- Construction compounds and haul routes, particularly if sited within areas of farmland
- Temporary fencing and hoardings
- Demolition and site clearance, including vegetation clearance
- Introduction of temporary structures and signage
- Earthworks and changes in the landform of the site
- Storage of earth and other materials
- Presence and views of lighting for works during low daylight levels or for night work
- The progressive construction of the permanent built elements

Operational impacts may be short-term, long term, temporary or permanent in nature. Sources of potential impacts considered in relation to landscape character and visual amenity during operation include:

- Additional road infrastructure, notably paved surfacing, increasing the overall scale and perception of the highway network
- Potential increase in the number or scale of related infrastructure such as signs, traffic signals, CCTV, technology elements, servicing or power units; also, any maintenance access platforms / routes and associated hard surfacing and guardrails
- Permanent loss of vegetation, limited to scattered trees interspersed across the scheme, tall ruderal, scrub and amenity grassland, within and outside the existing highway boundary, which in turn may reduce physical containment and open up views
- New or modified earthworks

6.6.1 Construction

6.6.1.1 Landscape

Potential landscape character impacts for each of the three scheme options during construction, are presented below. The exact areas required to construct the scheme, hours of working and extent of vegetation clearance have yet to be determined, however these would be important aspects of further assessment.

6.6.1.1.1 Option 1

The presence of construction activity, machinery, storage, compounds and associated infrastructure would introduce detracting features into the local urban context around the junctions. However, these detracting elements are expected to be located in close proximity to the road infrastructure.

The SRN interventions at Offington Corner Junction (C10) and Grove Lodge Junction (E1) are expected to impact on existing grass verges alongside and between existing roads and adjacent footways and shared paths. There would also be potential for impacts on neighbouring vegetation within the highway boundary. This is predicted to include impacts on an area of mature trees between the A2031 Offington Lane and A24 Warren Road in Offington Corner Junction (C10), due to widening. It would also include impacts on grassland and mature vegetation within the existing roundabout at the E1 Grove Lodge Junction where lane widening is proposed.

The direct impacts are expected to be contained principally within the highway boundary, with the exception that neighbouring boundary vegetation may be affected, for example, by requiring pruning or excavation around rooting zones in order to install new infrastructure assets and associated cable ducts. Further detail of the requirements for each asset would be needed to determine the exact level of impact.

Existing vegetation cover and surrounding built form would limit the extent to which the construction works would impact upon the wider landscape character around the proposed works for the SRN contained within the existing built areas.

Whilst the permitted hours of construction works are not currently known, it is not predicted that the construction of Offington Corner Junction (C10) and Grove Lodge Junction (E1) would adversely impact on the areas of SDNP Dark Night Sky Zone E1b - Transition Zone, as illustrated in Appendix D.4. This is due to the separation from the park by surrounding urban development, and in places, mature vegetation. In addition, as stated in SDNP Local Plan Policy SD8, Zone E1b areas are already vulnerably to light pollution given the location between larger urban settlements.

The construction works for Offington Corner Junction (C10) and Grove Lodge Junction (E1) are expected to generate a level of additional noise above that already arising from vehicles using roads and surrounding urban activities. However, all of the works would fall within and adjacent to areas which the SDNP mapped as having lower existing tranquillity scores, as illustrated in Appendix D.5. Further detail on noise impacts are set out in Chapter 9 Noise and vibration.

6.6.1.1.2 Option 2

The general potential landscape impacts described for Option 1 would also apply to the Option 2 interventions.

As with Option 1, all of the SRN interventions are expected to impact on existing grass verges, with potential for some impacts on neighbouring vegetation within and adjacent to the highway boundary.

Impacts relating to the Offington Corner Junction (C10) would be similar to that described in Option 1. There is also potential for some impacts to roadside vegetation in addition to the impacts to the grassed verge, in the south-western area of the roundabout where a shared use path is proposed.

Impacts relating to Grove Lodge Junction (E5) would be similar to those described for Option 1, except that no lane widening is proposed in Option 2. In addition, the provision of a shared use path on the eastern side of the A24 approach to the roundabout from the north, could potentially impact on a greater area of the grassed verge than in Option 1.

Much of the work proposed at the Lyons Way Sompting Junction (G1) is sited within an existing highway junction. The PRoW that follows the footway by Sompting Road as it runs into the retail park is not expected to be impacted by the construction works.

Given the existing narrow carriageway in the area of the Upper Brighton Road works (H1), care would need to be taken not to impact on adjacent hedgerows and nearby flint boundary walls, particularly where the road passes through rural landscapes between settlements. Narrow grass verges may also be impacted by the works to convert the route to a one-way system. The road lies in close proximity to the southern extent of Sompting Conservation Area and falls within the following landscape character areas:

- NCA 126 South Coast Plain
- West Sussex LCA SD3 Central Downs
- West Sussex LCA SC13 Worthing and Adur Fringes.

In Option 2, existing vegetation cover and surrounding built form would limit the extent to which the construction works would impact upon the wider landscape character around the proposed works.

Similar to Option 1, it is not predicted that the construction of Offington Corner Junction (C10), Grove Lodge Junction (E5), or Lyons Way Sompting Junction (G1), Upper Brighton Road (H1) would adversely impact on the areas of SDNP Dark Night Sky Zone E1b - Transition Zone, which lie adjacent to the settlement.

Impacts associated with audible tranquillity are predicted to be of a similar nature to Option 1, except that the extent of areas subject to construction works would be greater. This is due to proposed additional works at the Lyons Way Sompting Junction (G1) and along Upper Brighton Road (H1).

6.6.1.1.3 Option 3

The general potential landscape impacts described for Option 1 would also apply to the Option 3 interventions.

Impacts relating to the Offington Corner Junction (C10), Grove Lodge Junction (E5) and Upper Brighton Road (H1) would be similar to those described for Option 2.

Widening of the Busticle Lane Junction (J1) has the potential to impact on grassed verges as well as a small section of the field and associated boundary hedge within the SDNP to the north-west. The landscape adjacent to this section of the A27 comprises farmland falling within the SDNP that is located within the character areas listed below:

- NCA 125 South Downs, and SDNP LCT A: Open Downland and LCA A3: Arun to Adur Open Downs
- West Sussex LCA SD3 Central Downs

However, the area impacted is located at the interface of the urban area and would be limited in extent.

Existing vegetation cover and surrounding built form would, in most areas, limit the extent to which the construction works would impact upon the wider landscape character around the proposed works, including the National Park. However, further consideration may need to be given in particular to the detailed design and construction methods for the works at Upper Brighton Road (H1) and Busticle Lane (J1), given the proximity to farmed land, the Sompting Conservation Area and the National Park.

6.6.1.2 Visual

Potential visual impacts during construction, for each of the three scheme options are presented below.

6.6.1.2.1 Option 1

Visual impacts would be associated with the presence of construction activity, machinery and associated infrastructure in views to site, as well as the potential loss of vegetation which may otherwise provide visual screening or a green context to highway infrastructure. There may also be the potential for additional impacts associated with any construction compounds, pedestrian and task lighting, and haul routes. The locations of such elements are yet to be determined.

Users of the roads approaching and crossing each junction would have open views of the construction works.

There are residential and business properties located close to Offington Corner Junction (C10) and Grove Lodge Junction (E1), as well as other land uses such as

Durrington Cemetery (at Offington Corner Junction) and Worthing College (at Grove Lodge Junction).

However, potential views toward construction works for Offington Corner Junction (C10) and Grove Lodge Junction (E1) would be partially screened by the relatively high level of mature vegetation within private grounds and along the roadsides. Also, in these locations, properties are often set back from the A27 and local roads.

A small number of PRoW join the A27. Views to the construction works would be limited to short sections of path near the junction with the A27 and would be similar to those of road users.

Given the surrounding context of built development and vegetation to the proposed interventions, impacts on longer views from the wider built areas, road network and community buildings and spaces are expected to be limited.

Further details of the design, extent of required vegetation clearance and construction strategy have yet to be determined, however these will form important aspects of future assessment. However, no notable views to the construction works are predicted for the SDNP View Characterisation and Analysis viewpoints 72, 21 or 30. These viewpoints are illustrated in Appendix D.6.

6.6.1.2.2 Option 2

The general potential for visual impacts described for Option 1 would also apply to the Option 2 interventions.

As described for Option 1, open views of the construction works would be available to users of the roads approaching and crossing each junction

Similar to Option 1, potential views toward interventions at Offington Corner Junction (C10) and Grove Lodge Junction (E5) would be partially screened by the relatively high level of mature vegetation within private grounds and along the roadsides. While this is also the case for the western end of the Lyons Way Sompting Junction works (G1), in the eastern section of this intervention, more direct and open views are predicted from the residential and business properties around this junction.

Direct and open views of the works are also expected for residential receptors, a small number of businesses, occupants of four listed buildings and all road users around the works proposed at Upper Brighton Road (H1). In this location, a number of properties are set close to the roads, with relatively small gardens and limited vegetation. Roadside vegetation is also limited.

As with Option 1, given the surrounding context of built development and vegetation to all of the junctions, impacts on longer views from the wider built areas, road networks and community buildings and spaces are expected to be limited.

Further details of the design, extent of required vegetation clearance and construction strategy have yet to be determined, however these will form important aspects of further assessment. For example, further consideration should be given to the potential for views from the SDNP to the works at H1 Upper Brighton Road. However, no notable views to the construction works are predicted for the SDNP View Characterisation and Analysis viewpoints 72, 21 or 30.

6.6.1.2.3 Option 3

The general potential visual impacts described for Option 1 would also apply to the Option 3 interventions.

Similar to Options 1 and 2, potential views toward interventions at Offington Corner Junction (C10) and Grove Lodge Junction (E5) would be partially screened by the relatively high level of mature vegetation within private grounds and along the roadsides. In contrast, more direct and open views of the works are expected for receptors around the works proposed at Upper Brighton Road (H1) and Busticle Lane Junction (J1) where a number of residential properties are set close to the roads, with relatively small gardens and limited vegetation. Roadside vegetation is also limited. At Upper Brighton Road (H1) and in particular, Busticle Lane Junction (J1), visual receptors also include occupants of local businesses.

Further details of the design, extent of required vegetation clearance and construction strategy have yet to be determined, however these will form important aspects of future assessment. For example, further consideration should be given to the potential for views to the works at Upper Brighton Road (H1) and Busticle Lane Junction (J1), from the SDNP. However, no notable views to the construction works are predicted for the SDNP View Characterisation and Analysis viewpoints 72, 21 or 30.

6.6.2 Operation

6.6.2.1 Landscape

Potential landscape character impacts during operation, for each of the three scheme options are presented below.

6.6.2.1.1 Option 1

At Offington Corner Junction (C10) and Grove Lodge Junction (E1) the containment of new infrastructure within an already defined highway corridor would limit impacts upon neighbouring landscape features and characteristics. However, the proposed highway interventions in Offington Corner Junction (C10) and Grove Lodge Junction (E1), have the potential to result in permanent impacts on existing grassed verges and vegetation in order to accommodate the infrastructure. There would also be a slight increase in the urbanising effect of the existing road infrastructure.

Adverse impacts on the current status of the dark skies and change in tranquillity of the SDNP in proximity to the A27, are not predicted.

6.6.2.1.2 Option 2

Operational impacts are expected to be limited in extent given that the majority of the works would be at-grade and contained within the existing highway corridor. However, sections of grassed verges are expected to be permanently lost, further increasing the urbanising effect of the highway corridors. The potential for permanent impacts on other vegetation in these locations would depend on the specific requirements, such as any need for additional cabling, inspection cabinets, hard platforms and clear sight lines, associated with traffic signals, signs and cameras.

Operational impacts relating to the Offington Corner Junction (C10) and Grove Lodge Junction (E5) would be similar to those described for Option 1, except that the central landscaped area of the Grove Lodge Junction would not be reduced in size, avoiding impacts on the grassland and mature vegetation in this area.

The increase in the footprint of the highway infrastructure due to widening at the Lyons Way Sompting Junction (G1), is expected to result in an overall increased urbanising effect on the local area, which is already dominated by the existing road junction.

Operational impacts associated with Upper Brighton Road (H1) are not predicted based on the level of design detail currently available. There may be a slight beneficial impact on the character of the Sompting Conservation Area where traffic flows are changed to a single direction.

Adverse impacts on the current status of the dark skies and change in tranquillity of the SDNP in proximity to the A27, are not predicted.

6.6.2.1.3 Option 3

Operational impacts would be limited where works are at-grade and contained within the existing highway corridor at Offington Corner Junction (C10), Grove Lodge Junction (E5) and Upper Brighton Road (H1). However, sections of grassed verges are expected to be permanently lost in the long-term in all these locations, further increasing the urbanising effect of the highway corridor. Permanent impacts on other vegetation in these locations would depend on the options design, such as a need for power supplies and clear sight lines associated with traffic signals, cameras or signs.

In addition, widening of the highway at Busticle Lane Junction (J1), would result in a permanent loss of a small area of farmland within the SDNP.

Adverse impacts on the current status of the dark skies and change in tranquillity of the SDNP in proximity to the A27, are not predicted.

6.6.2.2 Visual

Potential visual impacts during operation, for each of the three scheme options are presented below.

6.6.2.2.1 Option 1

The presence of existing mature vegetation cover around the Offington Corner Roundabout (C10) and Grove Lodge Roundabout (E1), combined with many of the properties being set back from the road in these locations, is expected to reduce the level of visual impact experienced.

Further details of the extent of vegetation removal and any further additional infrastructure requirements, such as lighting, will form an important aspect of future assessment, including consideration of any potential for long-term, adverse visual impacts on users of the SDNP. However, no notable views to the scheme during operation are predicted for the SDNP View Characterisation and Analysis viewpoints 72, 21 or 30.

6.6.2.2.2 Option 2

During operation there is the potential for increased visual intrusion associated with the proposed interventions. Provision of additional capacity for vehicles at each junction, cycleway and pedestrian improvements and new traffic signals would increase the visual presence of infrastructure and potentially of moving vehicles as circulation improves. In particular, at the location of SRN intervention G1 Lyons Way Sompting Junction, the nearest receptors are expected to have views of an increased footprint of hard surfacing due to the widened junction and limited vegetation to provide screening.

The presence of a higher level of existing mature vegetation combined with many properties being set back from the road at the locations of SRN interventions Offington Corner Junction (C10), Grove Lodge Junction (E5) and the western section of Lyons Way Sompting Junction (G1), is expected reduce the level of visual impact experienced during operation.

Further details of vegetation removal, and any further additional infrastructure requirements, such as lighting, will form an important aspect of future assessment, including consideration of any potential for long-term, adverse visual impacts on users of the SDNP. However, no notable views to the scheme during operation are predicted for the SDNP View Characterisation and Analysis viewpoints 72, 21 or 30.

6.6.2.2.3 Option 3

During operation there is the potential for increased visual intrusion associated with the proposed interventions. Provision of additional capacity for vehicles at each junction, cycleway and pedestrian improvements and new traffic signals would increase the visual presence of infrastructure. The changes may also potentially

increase the perception of movement of vehicles with improved circulation for the nearest visual receptors.

The presence of a higher level of existing mature vegetation at the locations of SRN interventions Offington Corner Junction (C10) and Grove Lodge Junction (E5), and the set-back of many properties in these locations from the road, may reduce the level of visual impact experienced.

Further details of the road infrastructure, extent of vegetation removal and any further additional infrastructure requirements, such as lighting, will form an important aspect of future assessment, including consideration of any potential for adverse visual impacts on users of the SDNP. However, no notable views to the scheme during operation are predicted for the SDNP View Characterisation and Analysis viewpoints 72, 21 or 30.

6.7 Design, mitigation and enhancement measures

An Environmental Masterplan would be produced at PCF Stage 3 to accompany the design of the preferred option. Further assessment work would inform the environmental design, as well as any areas of improvement to the highway alignment and associated civils design. The overall strategy would also seek, where possible, to mitigate wider environmental impacts such as those upon noise, biodiversity and cultural heritage within the environmental design. It would also aim for a biodiversity net gain in the design, where practicable.

At this stage of scheme design, it is not possible to fully identify all impacts upon landscape character, views and visual amenity and potential associated mitigation measures. During future phases of assessment and design, further details would be established that would inform the development of appropriate environmental design measures. However, potential mitigation measures that may be appropriate, some of which are promoted through the landscape character assessments for the area, are set out below for the construction and operational stages.

6.7.1 Construction

Measures that would mitigate landscape, townscape and visual impacts during construction include:

- Keeping well-managed and tidy site and compounds
- Ensuring materials are delivered on an ‘as needed’ basis to avoid unnecessary stockpiles
- Minimising night-time working and the use of lighting. Any lighting that is required should be directional and turned off when possible
- Temporary site buildings and welfare facilities to be of a suitable scale and recessive colour to blend with the local area

- Making use of previously developed land where possible for site compounds and storage areas
- Limiting the extent of new haul routes away from existing hard surfaces and areas of mature vegetation as far as possible
- Limiting the duration for which temporary vertical elements are present within the landscape
- Protection of retained trees and vegetation during the construction phase

6.7.2 Operation

Measures that would mitigate landscape, townscape and visual impacts during construction include:

- Design review to reduce vegetation loss where possible
- Consideration of the design and appearance of upgraded highways and new permanent structures and assets, in order to integrate the scheme design within the surrounding context wherever possible
- Seeking opportunities to reduce the quantity of infrastructure by mounting multiple assets on single poles, where possible
- Where lighting is required to be moved or replaced, taking opportunity where possible, to select luminaires that could contribute to reducing the effects of lighting on dark skies, particularly in areas adjacent to the SDNP
- Reinstatement planting for losses and where practicable, new planting, using locally appropriate species to aid landscape integration and provide biodiversity benefits, as well as visual screening where required
- Integration of facilities for walkers, cyclists and other users not in motor vehicles

Mitigation planting would be implemented with the aim of reinstating any vegetation lost as part of the scheme, including temporary and permanent loss of vegetation to accommodate construction and permanent works. Given the necessary footprints of the scheme options, this may not fully rectify any loss of vegetation that currently provides a softened context to and partial screening of the highway network. Therefore, dependent on the extent of landscape and visual impacts, consideration may need to be given to the potential for additional supplementary planting beyond the highway boundary as mitigation for losses, to screen views, or to support biodiversity objectives.

6.8 Assessment of likely significant effects

For all three scheme options, the likely significant landscape and townscape effects during construction and operation are set out below.

6.8.1 Construction

Landscape

Table 6-7 below sets out the likely landscape and townscape effects during construction. This shows that no significant adverse effects are predicted. In Option 3, a small area of farmland and boundary hedge adjacent to the Busticle Lane junction would be impacted. This land falls within three character areas covering the national park. These are NCA 125 South Downs, SDNP LCA A3: Arun to Adur Open Downs and West Sussex LCA SD3 Central Downs. However, the area of land proposed to be used to construct the scheme would be very small compared to the scale of the character areas and there would be only very minor loss and alteration to the landscape.

Significant adverse effects during construction are not predicted for the townscape areas. However, effects are predicted to be slightly worse in townscape area 1 in Option 1, compared with Options 2 and 3. This would be as a result of predicted impacts on mature vegetation and grassland within the roundabout, required to enable the proposed road widening.

Further consideration may need to be given to impacts on existing vegetation during construction once further detail of the temporary works requirements are known. This should also consider vegetation required to be removed in the construction stage, in order to meet the permanent operational requirements of new assets, such as visibility splays.

Visual

Table 6-8 sets out the likely visual effects during construction. Based on the current designs, this shows that moderate adverse (significant) effects are anticipated for a limited number of residential receptors as follows:

- Residential receptors in the immediate area of Offington Corner Roundabout (Options 1, 2, 3)
- Residential receptors in the immediate area of Grove Lodge Roundabout (Option 1)
- Residential receptors in the immediate area of Lyons Way / Sompting Road Junction (Option 2)
- Residential receptors in the immediate area of Busticle Lane Junction (Option 3)

These residents are predicted to experience foreground views of a number of detracting features associated with the construction works. However, these effects would be temporary in nature. In addition, in summer views, many residents would benefit from a partial visual screen provided by existing garden planting. In a small number of locations, residents would also benefit from partial screening by roadside vegetation, notably in summer views.

Significant effects on views are not predicted for any other visual receptor during construction.

Table 6-7: Assessment of likely significant effects on landscape/townscape during construction

Landscape / townscape receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during construction	Mitigation	Significance of effect during construction (with mitigation)
NCA 125 South Downs	Very high	Option 1	Negligible	• Minimise vegetation loss through considered construction methods • Protect retained vegetation • Maintain a tidy site • As-needed delivery of materials to site • Minimise night working, use directional lighting and turn off construction lighting when not required. • Locate temporary working areas and routes within previously developed land where possible • Scale and colour of temporary buildings to blend in area • Limit the duration of temporary vertical elements present, such as cranes	Slight adverse, limited to indirect effects, that is, changes within the townscape bordering the NCA
		Option 2	Negligible		Slight adverse, limited to indirect effects, that is, changes within the townscape bordering the NCA
		Option 3	Negligible		Slight adverse, limited to a small area of the SNDP at the Busticle Lane junction, located close to the urban area; and indirect effect due to changes within the townscape bordering the NCA.
NCA 126 South Coast Plain	Medium	Option 1	Negligible		Slight adverse
		Option 2	Negligible		Slight adverse
		Option 3	Negligible		Slight adverse
SDNP LCA A3: Arun to Adur Open Downs	Very high	Option 1	Negligible		Slight adverse, limited to indirect effects, that is, changes within the townscape bordering the NCA
		Option 2	Negligible		Slight adverse, limited to indirect effects, that is, changes within the townscape bordering the NCA
		Option 3	Negligible		Slight adverse, limited to a small area of the SNDP at the Busticle Lane junction, located close to the urban area; and indirect effect due to

Landscape / townscape receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during construction	Mitigation	Significance of effect during construction (with mitigation)
					changes within the townscape bordering the NCA.
West Sussex LCA SD3	Very high	Option 1	Negligible		Slight adverse, limited to indirect effects, that is, changes within the townscape bordering the NCA
		Option 2	Negligible		Slight adverse, limited to indirect effects, that is, changes within the townscape bordering the NCA
		Option 3	Negligible		Slight adverse, limited to a small area of the SNDP at the Busticle Lane junction, located close to the urban area; and indirect effect due to changes within the townscape bordering the NCA
West Sussex LCA SC13 Worthing and Adur Fringes	Medium	Option 1	Negligible		No change
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Townscape area 1	Medium	Option 1	Minor		Slight adverse
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Townscape area 2	Low	Option 1	N/A		N/A
		Option 2	Minor		Slight adverse
		Option 3	N/A		N/A

Table 6-8: Assessment of likely significant effects on visual receptors during construction

Visual receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during construction	Mitigation	Significance of effect during construction (with mitigation)
Offington Corner Roundabout - Residential receptors	High	Option 1	Minor	• Minimise vegetation loss through considered construction methods • Protect retained vegetation • Maintain a tidy site • As-needed delivery of materials to site • Minimise night working, use directional lighting and turn off construction lighting when not required. • Locate temporary working areas and routes within previously developed land where possible • Scale and colour of temporary buildings to blend in area • Limit the duration of temporary vertical elements present, such as cranes	Moderate adverse
		Option 2	Minor		Moderate adverse
		Option 3	Minor		Moderate adverse
Offington Corner Roundabout - Users of Durrington Cemetery	Moderate	Option 1	Negligible		Slight adverse
		Option 2	Negligible		Slight adverse
		Option 3	Negligible		Slight adverse
Offington Corner Roundabout - Road users, including pedestrians and cyclists	Low	Option 1	Minor		Slight adverse
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Grove Lodge Roundabout - Residential receptors	High	Option 1	Minor		Moderate adverse
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Grove Lodge Roundabout - Users of Worthing College	Moderate	Option 1	Minor		Slight adverse
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Grove Lodge Roundabout - Users of business	Low	Option 1	Minor		Slight adverse
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
	Low	Option 1	Minor		Slight adverse

Visual receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during construction	Mitigation	Significance of effect during construction (with mitigation)
Grove Lodge Roundabout - Road users, including pedestrians and cyclists		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Lyons Way / Sompting Road Junction - Residential receptors	Low	Option 1	N/A		N/A
		Option 2	Moderate		Moderate adverse
		Option 3	N/A		N/A
Lyons Way / Sompting Road Junction - Users of businesses	Low	Option 1	N/A		N/A
		Option 2	Moderate		Slight adverse
		Option 3	N/A		N/A
Lyons Way / Sompting Road Junction - Road users, including pedestrians and cyclists	Low	Option 1	N/A		N/A
		Option 2	Moderate		Slight adverse
		Option 3	N/A		N/A
Busticle Lane Junction - Residential receptors	Low	Option 1	N/A		N/A
		Option 2	N/A		N/A
		Option 3	Moderate		Moderate adverse
Busticle Lane Junction - Users of businesses	Low	Option 1	N/A		N/A
		Option 2	N/A		N/A
		Option 3	Moderate		Slight adverse
Busticle Lane Junction - Road users	Low	Option 1	N/A		N/A
		Option 2	N/A		N/A
		Option 3	Moderate		Slight adverse

Visual receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during construction	Mitigation	Significance of effect during construction (with mitigation)
Upper Brighton Road - Residential receptors	High	Option 1	N/A		N/A
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse
Upper Brighton Road - Road users including pedestrians and cyclists	Low	Option 1	N/A		N/A
		Option 2	Minor		Slight adverse
		Option 3	Minor		Slight adverse

6.8.2 Operation

Landscape

Table 6-9 below sets out the likely landscape and townscape effects during operation. This shows that no significant adverse effects are predicted, on the assumption that the mitigation measures such as replacement planting are implemented. This includes the assumption that it will be possible to provide replacement or supplementary planting for the mature vegetation at Grove Lodge Roundabout, that is predicted to be impacted in Option 1 during construction of the scheme.

Visual

Table 6-10 sets out the likely visual effects during construction. Based on current available design information, this shows that significant visual effects during operation are not predicted. Further review may be required once the full operational details of all highway elements and associated assets are known, in order to determine whether residual significant landscape and visual effects may occur. This would be informed in particular by the extent of permanent land take and vegetation removals, and the viability of any mitigation planting proposals.

Table 6-9: Assessment of likely significant effects on landscape/townscape during operation

Landscape / townscape receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during operation	Mitigation	Significance of effect during operation (with mitigation)
NCA 125 South Downs	Very high	Option 1	No change	• Minimise vegetation loss through considered design • Consider design and appearance of highways and new assets to integrate with context • Minimise quantity of infrastructure by mounting multiple assets on single poles where possible • Where lighting is required to be moved or replace, select luminaries that could contribute to reduced effects of lighting on dark skies • Provide replacement planting • Integrate facilities to reduce severance caused by the A27 to pedestrians and other non-motorised users	Neutral
		Option 2	No change		Neutral
		Option 3	Negligible		Slight adverse
NCA 126 South Coast Plain	Medium	Option 1	No change		Neutral
		Option 2	No change		Neutral
		Option 3	No change		Neutral
SDNP LCA A3: Arun to Adur Open Downs	Very high	Option 1	No change		Neutral
		Option 2	No change		Neutral
		Option 3	Negligible		Slight adverse
West Sussex LCA SD3	Very high	Option 1	No change		Neutral
		Option 2	No change		Neutral
		Option 3	Negligible		Slight adverse
West Sussex LCA SC13 Worthing and Adur Fringes	Medium	Option 1	No change		Neutral
		Option 2	No change		Neutral
		Option 3	No change		Neutral
Townscape area 1	Medium	Option 1	Negligible		Neutral
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Townscape area 2	Low	Option 1	N/A		N/A

Landscape / townscape receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during operation	Mitigation	Significance of effect during operation (with mitigation)
		Option 2	Negligible		Neutral
		Option 3	N/A		N/A

Table 6-10: Assessment of likely significant effects on visual receptors during construction

Visual receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during operation	Mitigation	Significance of effect during operation (with mitigation)
Offington Corner Roundabout - Residential receptors	High	Option 1	Negligible	• Minimise vegetation loss through considered design • Consider design and appearance of highways and new assets to integrate with context • Minimise quantity of infrastructure by mounting multiple assets on single poles where possible • Where lighting is required to be moved or replace, select luminaries that could contribute to reduced effects of lighting on dark skies • Provide replacement planting	Slight adverse
		Option 2	Negligible		Slight adverse
		Option 3	Negligible		Slight adverse
Offington Corner Roundabout - Users of Durrington Cemetery	Moderate	Option 1	Negligible		Neutral
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Offington Corner Roundabout - Road users, including pedestrians and cyclists	Low	Option 1	Negligible		Neutral
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Grove Lodge Roundabout - Residential receptors	High	Option 1	Negligible		Slight adverse
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Grove Lodge Roundabout - Users of Worthing College	Moderate	Option 1	Negligible		Slight adverse
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Grove Lodge Roundabout - Users of business	Low	Option 1	Negligible		Neutral
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral

Visual receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during operation	Mitigation	Significance of effect during operation (with mitigation)
Grove Lodge Roundabout - Road users, including pedestrians and cyclists	Low	Option 1	Negligible		Slight adverse
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Lyons Way / Sompting Road Junction - Residential receptors	Low	Option 1	N/A		N/A
		Option 2	Minor		Slight Adverse
		Option 3	N/A		N/A
Lyons Way / Sompting Road Junction - Users of businesses	Low	Option 1	N/A		N/A
		Option 2	Minor		Neutral
		Option 3	N/A		N/A
Lyons Way / Sompting Road Junction - Road users, including pedestrians and cyclists	Low	Option 1	N/A		N/A
		Option 2	Minor		Neutral
		Option 3	N/A		N/A
Busticle Lane Junction - Residential receptors	Low	Option 1	N/A		N/A
		Option 2	N/A		N/A
		Option 3	Minor		Slight Adverse
Busticle Lane Junction - Users of businesses	Low	Option 1	N/A		N/A
		Option 2	N/A		N/A
		Option 3	Minor		Neutral
Busticle Lane Junction - Road users	Low	Option 1	N/A		N/A
		Option 2	N/A		N/A

Visual receptor	Sensitivity (susceptibility and value)	Option	Magnitude of effect (change) during operation	Mitigation	Significance of effect during operation (with mitigation)
		Option 3	Minor		Neutral
Upper Brighton Road - Residential receptors	High	Option 1	N/A		N/A
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral
Upper Brighton Road - Road users including pedestrians and cyclists	Low	Option 1	N/A		N/A
		Option 2	Negligible		Neutral
		Option 3	Negligible		Neutral

7 Biodiversity

7.1 Legislative and policy framework

7.1.1 International conventions

The construction and operational activities for the scheme must comply with International and European legislation. The following international conventions are relevant to this assessment:

- Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979)[65]
- Bonn Convention on the Conservation of Migratory Species of Wild Animals (1979)[66]
- The Habitats Directive (1992)[67]
- The Birds Directive (1979)[68]

7.1.2 National legislation

The construction and operational activities must comply with UK nature conservation legislation, and with national biodiversity policies. The key national legislation and policies which influence this assessment are:

- The Conservation of Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations 2017')[69]
- Wildlife and Countryside Act 1981 (as amended) ('the 1981 Act')[70]

[65] JNCC (1979). Convention on the Conservation of European Wildlife and Natural Habitats 1979 [online] available at: Bern Convention | JNCC - Adviser to Government on Nature Conservation (last accessed October 2022)
[66] JNCC (1979). Convention on the Conservation of Migratory Species or Wild Animals 1979 [online] available at: The Convention on the Conservation of Migratory Species of Wild Animals | JNCC - Adviser to Government on Nature Conservation (last accessed October 2022)
[67] European Commission (1992). The Habitats Directive 1992. [online] available at: EUR-Lex - 31992L0043 - EN - EUR-Lex (europa.eu) (last accessed October 2022)
[68] European Commission (2009). The Birds Directive 2009. [online] available at: EUR-Lex - 32009L0147 - EN - EUR-Lex (europa.eu) (last accessed October 2022)
[69] UK Government (2017). The Conservation of Habitats and Species Regulations 2017 [online] available at: The Conservation of Habitats and Species Regulations 2017 (legislation.gov.uk) (last accessed March 2022). This remains relevant within the UK post-Brexit – see https://www.legislation.gov.uk/uksi/2019/579/contents/made
[70] UK Government (2020). Wildlife and Countryside Act 1981 [online] available at: Wildlife and Countryside Act 1981 (legislation.gov.uk) (last accessed March 2022).

- The Natural Environmental and Rural Communities (NERC) Act 2006[71]
- Hedgerow Regulations 1997[72]
- Protection of Badgers Act 1992[73]
- National Planning Policy Framework (NPPF) (2021): Paragraphs 174-182[74]

7.1.3 Local policy

The scheme options fall within the areas covered by three local plans; the local plans of Adur District Council, Worthing Borough Council and the South Downs National Park Authority have all been reviewed and policies relevant to biodiversity and nature conservation are summarised below:

- Adur Local Plan 2017[75]: Policy 13 Adur's Countryside and Coast; Policy 30 Green Infrastructure; Policy 31 Biodiversity
- Draft Worthing Local Plan 2016-2033[76]: Policy CP19 Biodiversity and Policy CP20 Green Infrastructure
- South Downs Local Plan 2014-2033[77]: Strategic Policy SD9 Biodiversity and Geodiversity; Strategic Policy SD10 International Sites; Development Management Policy SD11 Trees Woodland and Hedgerows; Strategic Policy SD17 Protection of the Water Environment

7.2 Assessment methodology

The biodiversity assessment was undertaken in accordance with the following:

- Design Manual for Roads and Bridges (DMRB) LA 108 Biodiversity[78]

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[71] UK Government (2006). Natural Environment and Rural Communities Act 2006 [online] available at: Natural Environment and Rural Communities Act 2006 (legislation.gov.uk) (last accessed March 2022).
[72] UK Government (1997). The Hedgerow Regulations 1997 [online] available at: The Hedgerows Regulations 1997 (legislation.gov.uk) (last accessed March 2022).
[73] UK Government (1992). Protection of Badgers Act 1992 [online] available at: Protection of Badgers Act 1992 (legislation.gov.uk) (last accessed March 2022).
[74] UK Government (2021). National Planning Policy Framework. [online] available at: National Planning Policy Framework - Guidance - GOV.UK (www.gov.uk) (last accessed October 2022).
[75] Adur District Council (2017). Adur Local Plan [online] available at: Adur Local Plan 2017 (adopted) - Complete document (adur-worthing.gov.uk) (last accessed February 2022).
[76] Worthing Borough Council (2018). Draft Local Plan 2016 – 2033 [online] available at: Draft Worthing Local Plan Consultation - Whole document (adur-worthing.gov.uk) (last accessed February 2022).
[77] South Downs National Park Authority (2019). South Downs Local Plan [online] available at: SD_LocalPlan_2019_17Wb.pdf (southdowns.gov.uk) (last accessed February 2022).
[78] National Highways (2020) DMRB LA 108 Biodiversity Revision 1 [online] available at: af0517ba-14d2-4a52-aa6d-1b21ba05b465 (standardsforhighways.co.uk) (last accessed February 2022).

- DMRB LA 115 Habitats Regulations Assessment[79]
- DMRB LD 118 Biodiversity design[80]
- Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment (EcIA)[81]

This assessment uses structured, informed, and reasoned professional judgement, considering data derived from desk study and a site walkover. Future assessments, to include desk-based appraisals and targeted protected species surveys at a later Project Control Framework (PCF) stage, will allow the project ecologist to clarify the ecological importance and sensitivity of receptors which could be adversely impacted by the scheme. It will also enable refinement of any design, mitigation and enhancement measures to avoid significant effects on biodiversity.

The Department for Agricultural, Food and Rural Affairs' (Defra) Metric 2.0[82] tool will be used to produce a Biodiversity Net Gain (BNG) assessment for the scheme to comply with National Highways' biodiversity targets by the end of Road Investment Strategy Period 2 (RIS2) (2020 – 2025). It is acknowledged that this is not the most recent version of the tool, which is Metric 3.0[83] as of the time of writing. In order to keep biodiversity metric calculations consistent between all schemes that already have, or will start works in RIS2, use of Metric 2.0 has been instructed by National Highways as this version of the tool is detailed within LA 108 Biodiversity[84]. All activities will be required to maximise biodiversity delivery and all major projects are expected to report their performance against the Biodiversity Key Performance Indicators (KPI).

7.2.1 Significance criteria

In accordance with DMRB LA 108, the development of significance criteria has been informed by Chartered Institute of Ecology and Environmental Management (CIEEM's) Guidelines for EcIA. The assessment methodology utilises an approach

[79] National Highways (2020) DMRB Volume 11 LA 115 Habitats Regulations Assessment [online] available at: LA 115 - Habitats Regulations assessment - DMRB (standardsforhighways.co.uk) (last accessed February 2022).
[80] National Highways (2020). DMRB LD 118 Biodiversity design [online] available at: 9317652b-4cb8-4aaf-be57-b96d324c8965 (standardsforhighways.co.uk) (last accessed February 2022).
[81] CIEEM (2019). Guidelines for Ecological Impact Assessment in the UK and Ireland [online] available at: ECIA-Guidelines-2018-Terrestrial-Freshwater-Coastal-and-Marine-V1.1Update.pdf (cieem.net) (last accessed February 2022).
[82] Natural England (2019). The Biodiversity Metric 2.0 [online] available at The Biodiversity Metric 2.0 - JP029 (naturalengland.org.uk) (last accessed February 2022).
[83] Natural England (2021). The Biodiversity Metric 3.0 [online] available at: The Biodiversity Metric 3.0 - JP039 (naturalengland.org.uk) (last accessed March 2022).
[84] National Highways (2020). Guidance for CPF reporting for Metric 5.1 (B): RIS1, 2 and 3 schemes, version 0.4, October 2020.

to valuing ecological features that involves the use of professional judgement, based on available guidance and information.

7.2.1.1 Conservation importance (sensitivity)

The importance (sensitivity) of ecological features and resources of nature conservation importance will be assessed using the criteria outlined below in Table 7-1, which has been transposed from LA 108 Table 3.9.

Table 7-1: Criteria for determining the conservation importance of an ecological receptor

Resource importance		Typical Descriptors
International or European importance	Sites	European protected sites including Special Protection Areas (SPAs); potential SPAs (pSPAs); Special Areas of Conservation (SACs); candidate SACs (cSACs) or potential SACs (pSACs); Sites of Community Importance (SCIs) and Wetlands of International Importance (Ramsar sites). Biogenetic Reserves, World Heritage Sites and Biosphere Reserves. Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such.
	Habitats	N/A
	Species	Resident, or regularly occurring, populations of species which may be considered at an International or European level where: • the loss of these populations would adversely affect the conservation status or distribution of the species at this geographic scale • the population forms a critical part of a wider population at this scale • the species is at a critical phase of its life cycle at this scale
UK or National importance	Sites	Designated sites including: Sites of Special Scientific Interest (SSSIs); Marine Protected Areas (MPAs) including Marine Conservation Zones (MCZs); and National Nature Reserves (NNRs). Areas which meet the published selection criteria e.g. Joint Nature Conservation Committee (JNCC) (1998) for those sites listed above but which are not themselves designated as such[85].
	Habitats	Areas of key / priority habitats identified in the UK Biodiversity Action Plan (BAP), including those published in accordance with

[85] JNCC (2022). Guidelines for selection of SSSIs [online[available at: Guidelines for selection of SSSIs | JNCC - Adviser to Government on Nature Conservation (last accessed February 2022)

Resource importance		Typical Descriptors
		Section 41 of the NERC Act (2006) and those considered to be of principal importance for the conservation of biodiversity. Areas of Ancient Woodland for example woodland listed within the Ancient Woodland Inventory.
	Species	Resident, or regularly occurring, populations of species which may be considered at a UK or National level where: • the loss of these populations would adversely affect the conservation status or distribution of the species at this scale • the population forms a critical part of a wider population at this scale • the species is at a critical phase of its life cycle at this scale
Regional importance	Sites	Non-statutory designated sites, including heritage coasts.
	Habitats	Areas of key / priority habitats identified in the Regional BAP (where available); areas of key / priority habitat identified as being of Regional importance in the appropriate Natural Area Profile (or equivalent); and areas that have been identified by regional plans or strategies as areas for restoration or re-creation of priority habitats.
	Species	Resident, or regularly occurring, populations of species which may be considered at Regional level and key / priority species listed within the National Highways Biodiversity Plan where: • the loss of these populations would adversely affect the conservation status or distribution of the species at this scale • the population forms a critical part of a wider population • the species is at a critical phase of its life cycle • Species identified in regional plans or strategies
County or Unitary Authority Area importance	Sites	Wildlife / nature conservation sites designated at a county (or equivalent) level, including Sites of Nature Conservation Importance (SNCIs); County Wildlife Sites (CWSs); Local Wildlife Sites (LWSs); Local Nature Conservation Sites (LNCS); Sites of Importance for Nature Conservation (SINCs) and Local Nature Reserves (LNRs). Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such.

Resource importance		Typical Descriptors
	Habitats	Areas of key / priority habitats identified in the Local BAP; and areas of habitat identified in the appropriate Natural Area Profile (or equivalent).
	Species	Resident, or regularly occurring, populations of species which may be considered at County or Unitary Authority Area level where: • the loss of these populations would adversely affect the conservation status or distribution of the species across the County or Unitary Authority Area • the population forms a critical part of a wider population • the species is at a critical phase of its life cycle • Species identified in county or equivalent authority area plans or strategies.
Local importance	Sites	Wildlife / nature conservation sites designated at a local level, including Sites of Local Nature Conservation Importance (SLNCIs)
	Habitats	Areas of habitat considered to appreciably enrich the habitat resource within the local context, including features of importance for migration, dispersal, or genetic exchange. Trees that are protected by Tree Preservation Orders (TPOs).
	Species	Populations / communities of species considered to appreciably enrich the habitat resource within the local context (such as veteran trees), including features of importance for migration, dispersal or genetic exchange.

Source: DMRB LA 108, Table 3.9

7.2.1.2 Magnitude of impact

Following the determination of the resource importance, the characterisation of ecological impacts will be undertaken in accordance with LA 108, and will include consideration of the importance, integrity and conservation status of the resource affected, and a characterisation of the impact, which will consider:

- the probability of the impact occurring
- the complexity of the impact (direct, indirect, cumulative)
- the extent of the impact (for example the percentage of the resource affected)
- the size of the impact (for example complete loss or numbers of animals affected)

- the reversibility of the impact; the duration of the impact (permanent or temporary)
- the timing and frequency of the impact (considering seasonal / life cycle constraints)

The magnitude of impacts will also be informed by the outcomes of other environmental assessments, such as air quality and noise and vibration and the in-combination effects of these, when and where available. The magnitude of impact on ecological receptors will be based on Table 7-2 which has been transposed from Table 3.11 of LA 108.

Table 7-2: Magnitude and nature of impact on biodiversity resources and typical description

Level of impact (change)		Typical description
Major	Adverse	Permanent/irreversible damage to a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource.
	Beneficial	Permanent addition of, improvement to, or restoration of a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact positively affects the integrity or key characteristics of the resource.
Moderate	Adverse	Temporary/reversible damage to a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource.
	Beneficial	Temporary addition of, improvement to, or restoration of a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact positively affects the integrity or key characteristics of the resource.
Minor	Adverse	Temporary/reversible damage to a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource.
	Beneficial	Permanent addition of, improvement to, or restoration of a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource.
Negligible	Adverse	Reversible damage to a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource.
	Beneficial	Temporary addition of, improvement to, or restoration of a biodiversity resource; and The extent, magnitude, frequency, and/or timing of an impact does not affect the integrity of key characteristics of the resource.

Level of impact (change)	Typical description
No change	No observable impact, either positive or negative.

Source: DMRB LA 108, Table 3.11

7.2.1.3 Assessment of significance

The assessment of the significance of effect is undertaken by combining the sensitivity to change of an asset with an assessment of the magnitude of change put upon it. These effects can be beneficial or adverse, and temporary or permanent, depending on the nature of the development and the mitigation and any enhancement measures proposed. Table 7-3 below shows the significance matrix used to determine the level of significance of an effect. For the purposes of this assessment, impacts of Moderate Adverse or Beneficial and above are considered to be significant.

Table 7-3: Significance matrix

Resource importance	Level of impact					
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
	International or European importance	Neutral	Slight	Moderate or large	Large or very large	Very large
	UK or national importance	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
	Regional importance	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
	County or equivalent authority importance	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
	Local importance	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

Source: DMRB LA 108, Table 3.13

7.3 Assessment assumptions and limitations

The assessment has been undertaken based on the design information available at PCF Stages 1 and 2 and therefore the location of new infrastructure may be subject to change. The construction methods, timescales and spatial requirements including that needed for haul routes and construction compounds have yet to be determined, and therefore the full extent of the study area and associated receptors is yet to be confirmed. This will be identified and confirmed in PCF Stage 3.

The baseline information is based on a Preliminary Ecological Appraisal (PEA), which consists of a detailed desk study and an Extended Phase 1 Habitat Survey (hereafter referred to as 'Phase 1') to classify broad habitat types (Appendix E). This only includes information on confirmed species records within the study area and habitats with the potential to support these species. Section 7.4 below defines the study area. Recommendations for targeted surveys in the future are provided in Section 5 of the PEA (Appendix E), but it does not provide confirmation of species' presence or population sizes which could be impacted by the scheme. As such, only an indication on whether significant impacts would arise from construction and/or operation can be made. Targeted ecological surveys are anticipated to take place at PCF Stage 3.

The Phase 1 component of the PEA was limited by available access; only publicly accessible areas were used. This resulted in a significant limitation of approximately 40% of the study area (for all options) being accessible. However, these areas were predominantly urban and residential and so limited in their biodiversity importance. Furthermore, in the context of the scheme and it being largely contained within the existing highway boundary, the Phase 1 is considered to have included all areas which will be directly impacted by the scheme and therefore there are no significant limitations from these access restrictions.

Findings of future ecological surveys should be used to inform the scheme designs so that the mitigation hierarchy can be applied and where possible, construction and operational effects are eliminated, reduced, or where unavoidable can be adequately compensated for or enhancements made.

It should be noted that the absence of certain protected or rare species from future targeted ecological surveys does not preclude their presence on a site. Surveys can only confidently identify species' presence at the time they are undertaken and there is always potential that any species, particularly those which are elusive or scarce, are not detected within the survey period. Some species which are particularly mobile may also colonise areas in which they were previously thought likely to be absent, in the period between surveys and subsequent stages of the scheme.

The assessment of likely significant effects, Section 7.8, is based on the current knowledge of the biodiversity baseline and general design, mitigation, and enhancement measures, outlined in Section 7.7. It is assumed that measures detailed here, particularly during construction and relating to machinery, will be 'best practice' measures and do not constitute proposed mitigation for any protected/notable species, habitats, or designated sites. The absence of targeted ecological surveys and detailed design precludes the proposal of specific mitigation measures at this stage of the scheme.

7.4 Study area

In accordance with DMRB LA 108[86], the study area is based on the following:

- The scheme boundary, including any potential off-site works or areas
- The potential construction footprint, including potential construction compounds, haul routes, borrow pits and temporary land take, in as much detail as is known at this stage of the scheme.
- The scheme's Zone of Influence (ZoI) on biodiversity resources

Assumptions and limitations surrounding the scheme boundary and construction footprint at this stage have been addressed in Section 7.3 above. As the ZoI varies depending on the biodiversity resource, the following study areas have been used to gather information on the ecological receptors with the potential to be affected by the scheme:

- 2km from the boundary of all options for internationally designated nature conservation sites, including Special Areas of Conservation (SAC), candidate or possible SACs (cSACs or pSACs), Special Protection Areas (SPA), potential SPAs (pSPAs) and Ramsar Sites in line with DMRB LA 115 Habitats Regulations Assessment Revision 1 section 3.7. Nationally designated sites such as Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNRs) were also identified up to 2km from the scheme
- Within the relevant impact risk zone87 (IRZ) of SSSI as per Multi-Agency Geographic Information for the Countryside (MAGIC) v3.0, in line with DMRB LA 115 Habitats Regulations Assessment section 3.7
- 30km from the boundary of all options for SACs designated for bat populations in line with LA 115 Habitats Regulations Assessment section 3.7
- Any internationally designated nature conservation sites which are linked hydrologically to watercourses potentially affected by the scheme
- 1km from the boundary of all options for locally designated nature conservation sites, including Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and areas of ancient woodland. This study area has been defined by professional judgement to ensure that all potential effects were identified within the ZoI
- 200m from the boundary of all options and their Affected Road Networks (ARN) for habitats of principal importance (HPI), which may be directly or indirectly impacted by the scheme as a result of reductions in air quality. The ARN is defined from traffic modelling information for the operational phase of the

[86] National Highways (2020) DMRB LA 108 Biodiversity Revision 1 [online] available at: af0517ba-14d2-4a52-aa6d-1b21ba05b465 (standardsforhighways.co.uk) (last accessed February 2022).
[87] Natural England (2021). Natural England's Impact Risk Zones for Sites of Special Scientific Interest [online] available at: SSSI IRZ User Guidance MAGIC.pdf (defra.gov.uk). (last accessed February 2022).

scheme options. Section 5.4 within the air quality chapter sets out the definition of the ARN, as specified by DMRB.

- 2km from the boundary of all options has also been used to obtain biological records, which will include protected species, species of principal importance (SPI) and invasive species. This distance is used for a lower resolution overview of what has recently (within 10 years) been recorded in the area and is not used as the study area, or ZoI, for targeted species surveys
- The ZoI not only varies between designated sites, but also for species. Table 7-4 below details the proposed study areas for all potential targeted surveys. These distances were proposed prior to the production of the PEA and not all ecological receptors are present within the study area. Those receptors which may be impacted are detailed in Section 7.6.

Table 7-4: Differentiation in study area between ecological receptors for survey

Ecological receptor	Study area
Badger	All land within the footprint of the scheme + 50m buffer
Bats (all survey types)	All land within the footprint of the scheme + 50m buffer
Botanical surveys (Phase 2 NVC for HPI)	All land within the footprint of the scheme + 200m buffer
Breeding birds	All land within the footprint of the scheme + 100m buffer
Great crested newt (GCN)	All land within the footprint of the scheme + 250m buffer
Hazel dormouse	All land within the footprint of the scheme + 50m buffer
Non-native invasive species (Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) and Invasive Species Orders 2019)	All study areas – no specific survey but recorded incidentally
Otter	All land within the footprint of the scheme + 250m buffer
Overwintering birds	All land within the footprint of the scheme + 100m buffer
Phase 1 Habitat Survey (extended)	All land within the footprint of the scheme + 100m buffer
Reptiles	All land within the footprint of the scheme + 50m buffer
Terrestrial invertebrates	All land within the footprint of the scheme + 50m buffer
Water vole	All land within the footprint of the scheme + 250m buffer

Source: Mott MacDonald

The study areas have been defined using reasoned professional judgement in the context of the scheme and the surrounding area. As the scheme is not adjacent to, nor crosses over, any watercourses, all effects on aquatic invertebrates, including white-clawed crayfish *Austropotamobius pallipes*, and fish were scoped out in the Environmental Scoping Report (ESR) (HE608509-MMD-EGN-OP00-RP-LE-0003) and are not included within this report. Section 7.5 below details the results of the PEA, which includes recommendations for further assessment concluded from the desk study and Phase 1 components. Some of the ecological receptors included in

Table 7.4 above may subsequently have been scoped out following assessment. This is stated within the baseline where applicable.

Further refinement of the study area may be undertaken in further stages of the assessment at PCF Stage 3, taking into consideration the findings of field studies and any inputs from the competent authority or key stakeholders. The emphasis would be on a proportionate and reasonable approach to the area over which the effects of the scheme are considered.

7.5 Baseline conditions

7.5.1 Data sources

The following resources have been used to produce the baseline for the scheme, in addition to the Phase 1 habitat survey:

- Defra MAGIC online mapping software[88]
- Ebernoe Common SAC conservation objectives[89]
- The Mens SAC conservation objectives[90]
- Singleton and Cocking Tunnels SAC conservation objectives[91]
- Cissbury Ring SSSI citation[92]
- Adur Estuary SSSI citation[93]
- Sussex Biological Records Centre (SxBRC) Biological Records Data Search
- Woodland Trust Ancient Tree Inventory (ATI)[94]

[88] DEFRA (2021). Multi-Agency Geographic Information for the Countryside (MAGIC) online mapping software. Available online at: https://magic.defra.gov.uk/MagicMap.aspx (last accessed February 2022).
[89] Natural England (2019). European Site Conservation Objectives for Ebernoe Common SAC (UK0012715) [online] available at: European Site Conservation Objectives for Ebernoe Common SAC - UK0012715 (naturalengland.org.uk) (last accessed February 2022).
[90] Natural England (2019). European Site Conservation Objectives for The Mens SAC (UK0012716) [online] available at: European Site Conservation Objectives for The Mens SAC - UK0012716 (naturalengland.org.uk) (last accessed February 2022).
[91] Natural England (2019). European Site Conservation Objectives for Singleton and Cocking Tunnels SAC (UK0030337) [online] available at: European Site Conservation Objectives for Singleton and Cocking Tunnels SAC - UK0030337 (naturalengland.org.uk) (last accessed February 2022).
[92] Natural England (2021). Designated Sites View, Cissbury Ring SSSI [online] available at: 1004162 (naturalengland.org.uk) (last accessed March 2022).
[93] Natural England (2021). Designated Sites View, Adur Estuary SSSI [online] available at: 1003359 (naturalengland.org.uk) (last accessed February 2022).
[94] Woodland Trust (2022). Ancient Tree Inventory – Tree search [online] available at: Tree Search - Ancient Tree Inventory (woodlandtrust.org.uk) (last accessed February 2022).

- Adur and Worthing Councils Planning Map[95]

7.5.2 Designated sites

Several nationally and locally designated sites occur within the study area, as shown in Table 7.5. There are no internationally designated sites within 2km of the scheme options, however, three SACs designated for bat populations exist within 30km of the scheme options. The SACs are within 30km of all scheme options, but only the closest point to the combined scheme options is noted.

These sites in the context of the scheme options are shown in Appendix C of the appended PEA.

Table 7-5: Designated sites within the study area

Scheme option	Designated sites	Resource importance
All options	The Mens SAC is approximately 18.6km north-east of the scheme at its closest point.	International
	Ebernoe Common SAC is approximately 24.1km north-east of the scheme at its closest point.	International
	Singleton and Cocking Tunnels SAC is approximately 26km north-west of the scheme at its closest point.	International
	Cissbury Ring SSSI is approximately 1.7km north of the scheme at its closest point.	National
	Offington Cemetery LWS is approximately 150m west of the scheme at its closest point.	Local
	Worthing and Hill Barn Golf Courses (including Deep Bottom and Vineyard Hill LWSs) is approximately 200m east of the scheme at its closest point.	Local
	The Gallops and No Man's Land LWS is approximately 530m north-west of the scheme at its closest point.	Local
	Tenants Hill and Reservoirs LWS is approximately 930m north-east of the scheme at its closest point.	Local
Options 2 and 3	In addition to the sites within the study area of all options: Cokeham Brooks LWS is approximately 1km south-east of the scheme options at its closest point. Confirmation of an extension to this site has been provided by Adur and Worthing Council in September 2021[96], in line with the	Local

[95] Adur and Worthing Councils (2022). Interactive Plan Maps [online] available at: -- Adur Local Plan map 2017 -- - Adur & Worthing Councils (adur-worthing.gov.uk) (last accessed February 2022).
[96] Adur & Worthing Councils (2021). Go-ahead for new homes and green spaces in West Sompting [online] available at: News - Adur & Worthing Councils (adur-worthing.gov.uk). (Last accessed March 2022).

Scheme option	Designated sites	Resource importance
	2017 Adur Local Plan (Policy 6)[97]. This means that the revised LWS will be approximately 800m south-east of scheme option at its closest point.	
	The Sanctuary, High Salvington LWS is approximately 700m north of the scheme options at its closest point.	Local
	Clapham Wood LWS is approximately 750m north-west of the scheme options at its closest point.	Local
Option 3	Lancing Ring LNR and LWS is approximately 350m north-east of the scheme option at its closest point.	Local

Source: Mott MacDonald

7.5.3 Habitats

7.5.3.1 Option 1

Based on the Phase 1 undertaken in October 2021, the following habitats were identified within the study area surrounding Option 1:

- Unimproved calcareous grassland: This comprises a section of grassland to the north-west of Offington Corner Junction, representing a large proportion of the Offington Cemetery LWS. It comprises a rich mosaic of grasslands of varying sward lengths, wildflower diversity and management levels.
- Semi-natural broadleaved woodland: This comprised two sections of woodland to the east of Offington Corner Junction and a stand of woodland to the north-west of Grove Lodge Junction.
- Running water: This habitat is assumed from background imagery and was not identified within the accessible Phase 1 areas. South of West Street/Upper Brighton Road, behind the residential properties, it appears there is a network of drains/ditches which extends to the south. Without visual confirmation, it is not possible to determine whether these are wet or dry, and any species which may be associated. For the purpose of this report, a worst-case scenario is applied, and the highest possible biodiversity assumed.
- Eutrophic standing water: This habitat is assumed from background imagery and was not identified within the accessible Phase 1 areas. South of West Street/Upper Brighton Road, behind the residential properties, it appears there

[97] Adur Local Plan (2017). Policy 6: Land at West Sompting (Page 34) [online] available at Microsoft Word - Adur Local Plan 2017 (adopted) - Part 2.doc (adur-worthing.gov.uk). (Last accessed March 2022).

is a network of drains/ditches which extends to the south. Without visual confirmation, it is not possible to determine whether these are wet or dry, and any species which may be associated. For the purpose of this report, a worst-case scenario is applied, and the highest possible biodiversity assumed.

- Semi-improved calcareous grassland: The area of Offington Cemetery which is not part of the LWS is considered to be semi-improved calcareous grassland, due to its location and higher species diversity than a 'poor' semi-improved grassland. Due to time constraints during the survey, it was not possible to produce a relative floral abundance (DAFOR) scale and species list for this area, but classification as semi-improved calcareous grassland represents the maximum possible importance. The area is largely unmanaged, but some regular mowing and nutrient inputs are expected due to its nature as a cemetery.
- Semi-natural mixed woodland: The area of semi-natural broadleaved woodland to the north-west of the Grove Lodge Junction transitions into semi-natural mixed woodland, as coniferous species such as yew *Taxus baccata* and scots pine *Pinus sylvestris* become more frequent. Without access for detailed assessment, this area has been classified as its highest possible habitat importance, although confirmation is required to determine whether this is plantation coniferous woodland or not.
- Scrub: This comprises the dense scrub to the south-west of Offington Corner Junction and the scattered scrub within Offington Cemetery LWS and the dense hazel *Corylus avellana* scrub to the south of Grove Lodge Junction.
- Scattered trees: This habitat comprised scattered trees forming tree lines bordering the A24 and A27 connecting to Offington Corner Junction.
- Hedgerow: This comprised a section of intact hedgerow interspersed with trees, situated to the north of Grove Lodge Junction. Native hedgerows are HPI.
- Improved grassland: This comprises the grassland representing Worthing golf course situated to the east of Offington Corner Junction.
- Artificial exposure: This comprises a chalk spoil heap located within the Offington cemetery LWS. The spoil heap itself has limited biodiversity importance, but may be a component of a mosaic which could provide opportunities for reptiles, small mammals and terrestrial invertebrates.
- Introduced shrub: This comprises two areas of non-native ornamental species, the first of which is located within the north-eastern corner of the Offington roundabout and the second located along the southern boundary of Worthing college playing fields to the north of Grove Lodge roundabout.
- Buildings: There were many residential properties which were not accessible during the Phase 1. These habitats may support protected and notable species such as roosting birds and bats.

- Amenity grassland: This comprises two areas surrounding Grove Lodge Junction - Worthing college playing fields to the north and Broadwater Green to the south of the junction.
- Hardstanding: This encompasses all roads and pavements within the study area. These areas have no importance to biodiversity and have been omitted from Table 7-6 below.

Table 7-6: Habitat importance within the Option 1 study area

Broad habitat type	Resource importance	Justification
Unimproved calcareous grassland	County	This is an HPI and part of the Offington Cemetery LWS. Calcareous grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. Unimproved calcareous grassland is considered to be the most species-rich grassland habitat in the UK, and this area may support diverse and notable floral species.
Semi-natural broadleaved woodland	Local	This is an HPI. Semi-natural broadleaved woodland may provide important habitats for breeding birds, commuting bats, dormouse, badger, reptiles, amphibians and terrestrial invertebrates. They may also include notable or rare plant species.
Running water (possible)	District	This is an HPI. This habitat may be important for amphibians, water voles and aquatic invertebrates. Background imagery indicates there are numerous drains/ditches within the study area, a habitat which is uncommon throughout the Worthing district.
Eutrophic standing water (possible)	District	This is an HPI. This habitat may be important for amphibians, water voles and aquatic invertebrates. Background imagery indicates there are numerous drains/ditches within the study area, a habitat which is uncommon throughout the Worthing district.
Semi-improved calcareous grassland	District	Calcareous grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. Grassland which has not been subject to agricultural improvement and increased nutrient loads may support diverse and notable floral species.
Semi-natural mixed woodland	Local	This is an HPI. Semi-natural mixed woodland may provide important habitats for breeding birds, commuting bats, badger, reptiles, amphibians and terrestrial invertebrates. They may also include notable or rare plant species.

Broad habitat type	Resource importance	Justification
Scrub	Local	This is an undesignated habitat with some local biodiversity interest. Scrub may provide important habitat for breeding birds, commuting bats, dormouse, badger, reptiles, amphibians and terrestrial invertebrates.
Scattered trees	Local	This is an undesignated habitat with some local biodiversity interest. Some individual trees may support protected and notable species such as birds, bats and terrestrial invertebrates.
Hedgerows	Local	This is an HPI. Hedgerows may provide important habitats for breeding birds, commuting bats, dormouse, badger and terrestrial invertebrates. They may also include notable or rare plant species.
Improved grassland	Site	Undesignated habitats with some local biodiversity interest.
Artificial exposure	Site	This habitat has limited biodiversity importance.
Introduced shrub	Site	This habitat has limited biodiversity importance.
Buildings	Site	Some buildings may have features which can support roosting bats and birds.
Amenity grassland	N/A	This habitat has limited biodiversity importance.

Source: Mott MacDonald

7.5.3.2 Option 2

Based on the Phase 1 undertaken in October 2021, the following habitats were identified within the study area surrounding Option 2:

- Unimproved calcareous grassland: This comprises a section of grassland to the north-west of Offington Corner Junction, representing a large proportion of the Offington Cemetery LWS. It comprises a rich mosaic of grasslands of varying sward lengths, wildflower diversity and management levels.
- Semi-natural broadleaved woodland: This comprises two sections of woodland to the east of Offington Corner Junction and a stand of woodland to the north-west of Grove Lodge Junction. In addition to these sections, a large area of broadleaved woodland with some pockets of scrub can be found north of Lyons Way Sompting Junction, adjacent to the retail park, and a small cluster of semi-mature broadleaved trees to the east of the Lyons Way Sompting Junction to the north of the A27 are also found within the study area of Option 2.
- Running water: This habitat is assumed from background imagery and was not identified within the accessible Phase 1 areas. South of West Street/Upper Brighton Road, behind the residential properties, it appears there is a network

of drains/ditches which extends to the south. Without visual confirmation, it is not possible to determine whether these are wet or dry, and any species which may be associated. For the purpose of this report, a worst-case scenario is applied, and the highest possible biodiversity assumed.

- Eutrophic standing water: This habitat is assumed from background imagery and was not identified within the accessible Phase 1 areas. South of West Street/Upper Brighton Road, behind the residential properties, it appears there is a network of drains/ditches which extends to the south. Without visual confirmation, it is not possible to determine whether these are wet or dry, and any species which may be associated. For the purpose of this report, a worst-case scenario is applied, and the highest possible biodiversity assumed.
- Traditional orchard: This comprises an inaccessible area to the north of Upper Brighton Road, in fields behind houses bordering the A27. The habitat appears to have previously been an orchard at some time, with lots of apple *Malus domestica* and wild cherry between scrub and scattered trees. It is unknown whether any of this HPI remains here, or a lack of management has resulted in succession over time.
- Semi-improved calcareous grassland: The area of Offington Cemetery which is not part of the LWS is considered to be semi-improved calcareous grassland, due to its location and higher species diversity than a 'poor' semi-improved grassland. Due to time constraints during the survey, it was not possible to produce a DAFOR scale and species list for this area, but classification as semi-improved calcareous grassland represents the maximum possible importance. The area is largely unmanaged, but some regular mowing and nutrient inputs are expected due to its nature as a cemetery. Additionally, on the southern border of West Street/Upper Brighton Road, an area of inaccessible grassland existed which may be semi-improved calcareous grassland. Due to the seasonality of the survey and no access, it was not possible to determine whether it is semi-improved calcareous grassland, or another semi-improved grassland type. This has been classified as the highest possible importance habitat as a worst-case scenario.
- Semi-natural mixed woodland: The area of semi-natural broadleaved woodland to the north-west of the Grove Lodge Junction transitions into semi-natural mixed woodland, as coniferous species such as yew *Taxus baccata* and Scott's pine *Pinus sylvestris* become more frequent. Without access for detailed assessment, this area has been classified as its highest possible habitat importance, although confirmation is required to determine whether this is plantation coniferous woodland or not.
- Scrub: This comprises the dense scrub to the south-west of Offington Corner Junction and the scattered scrub within Offington Cemetery LWS and the dense hazel (*Corylus avellana*) scrub to the south of Grove Lodge Junction. In addition to these areas, an area of dense continuous scrub lies north of Lyons Way Sompting Junction, adjacent to the retail park and further areas of scattered scrub exist within amenity grassland to the west of Upper Brighton Road, within

a small residential area and also amongst the fields to the north of Upper Brighton Road, behind houses bordering the A27.

- Scattered trees: The sections of this habitat comprised scattered trees forming tree lines bordering the A24 and A27 connecting to Offington Corner Junction, some scattered mature trees to the east of the Retail Park located to the north of Lyons Way Sompting Junction, and scattered trees to the north-east of Upper Brighton Road/West Street within the divided horse paddocks.
- Hedgerow: This comprises a section of intact hedgerow interspersed with trees situated to the north of Grove Lodge Junction. It also includes a section of hedgerow to the north-east of Lyons Way Sompting Junction bordering the Retail Park and another to the east of the junction bordering the A27, intact hedgerows bordering the fields to the south-west of Upper Brighton Road/West Street and also bordering Upper Brighton Road from Lambleys Lane. Native hedgerows are HPI.
- Semi-improved grassland: This comprises an area of semi-improved grassland to the south of Upper Brighton Road which, due to the seasonality of the survey and no access, was not possible to determine whether the field is semi-improved calcareous grassland, and a field to the east of the West Street / Church Lane junction divided into different paddocks for grazing horses.
- Tall ruderal: This habitat type was present as an unmanaged section of the arable field located to the south of Upper Brighton Road, where tall ruderal species had been allowed to grow undisturbed.
- Improved grassland: This comprises the grassland representing Worthing golf course situated to the east of Offington Corner Junction, a large agricultural field to the east of the Lyons Way Sompting Junction and a number of paddocks to the north and south of Upper Brighton Road/West Street, with grazing horses.
- Artificial exposure: This comprises a chalk spoil heap located within the Offington Cemetery LWS, likely created as a suitable habitat for reptiles, small mammals and specialised invertebrates. The spoil heap itself has limited biodiversity importance, but may be a component of a mosaic which does provide opportunities for the aforementioned species.
- Arable field: This comprises an arable field at the western end of West Street/Upper Brighton Road on its southern border, and another large arable field, bordered by some trees and defunct hedgerow at the eastern end of West Street, on its southern side.
- Introduced shrub: This comprises three areas of non-native ornamental species. An area of introduced shrub is located within the north-eastern corner of the Offington roundabout and a second area located along the southern boundary of Worthing college playing fields to the north of Grove Lodge roundabout. Finally, a number of small sections of introduced shrub exist within the car park and bordering buildings of the retail park to the north of Lyons Way Sompting Junction.

- Buildings: There were many residential properties which were not accessible during the Phase 1. These themselves do not hold any biodiversity importance but may support protected and notable species such as roosting birds and bats.
- Amenity grassland: This comprises two areas surrounding Grove Lodge Junction - Worthing college playing fields to the north and Broadwater Green to the south of the junction, small areas of amenity grassland adjacent to the footpaths surrounding the retail park to the north of Lyons Way Sompting Junction, and an area to the west of Upper Brighton Road, surrounded by a residential area.
- Hardstanding: This encompasses all roads and pavements within the study area. These areas have no importance to biodiversity and have been omitted from Table 7-7 below.

Table 7-7: Habitat importance within the Option 2 study area

Broad habitat type	Resource importance	Justification
Unimproved calcareous grassland	County	This is an HPI and part of the Offington Cemetery LWS. Calcareous grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. Unimproved calcareous grassland is considered to be the most species-rich grassland habitat in the UK, and this area may support diverse and notable floral species.
Semi-natural broadleaved woodland	Local	This is an HPI. Semi-natural broadleaved woodland may provide important habitats for breeding birds, commuting bats, dormouse, badger, reptiles, amphibians and terrestrial invertebrates. They may also include notable or rare plant species.
Running water (possible)	Local	This is an HPI. This habitat may be important for amphibians, water voles and aquatic invertebrates. Background imagery indicates there are numerous drains/ditches within the study area, a habitat which is uncommon throughout the Worthing district.
Eutrophic standing water (possible)	Local	This is an HPI. This habitat may be important for amphibians, water voles and aquatic invertebrates. Background imagery indicates there are numerous drains/ditches within the study area, a habitat which is uncommon throughout the Worthing district.
Semi-improved calcareous grassland	Local	Calcareous grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. Grassland which has not been subject to agricultural

Broad habitat type	Resource importance	Justification
		improvement and increased nutrient loads may support diverse and notable floral species.
Traditional orchard (possible)	Local	This is an HPI. This habitat may be important for birds, bats, badgers and terrestrial invertebrates.
Semi-natural mixed woodland	Local	This is an HPI. Semi-natural mixed woodland may provide important habitats for breeding birds, commuting bats, badger, reptiles, amphibians and terrestrial invertebrates. They may also include notable or rare plant species.
Scrub	Local	This is an undesignated habitat with some local biodiversity interest. Scrub may provide important habitat for breeding birds, commuting bats, dormouse, badger, reptiles, amphibians and terrestrial invertebrates.
Scattered trees	Local	This is an undesignated habitat with some local biodiversity interest. Some individual trees may support protected and notable species such as birds, bats and terrestrial invertebrates.
Hedgerows	Local	This is an HPI. Hedgerows may provide important habitats for breeding birds, commuting bats, dormouse, badger and terrestrial invertebrates. They may also include notable or rare plant species.
Poor semi-improved grassland	Site	Undesignated habitats with some local biodiversity interest. Grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. However, the extent of grassland within the study area is unlikely to support protected or notable species due to its size.
Tall ruderal	Site	This is a common habitat found within the surrounding area, with little or no biodiversity interest.
Improved grassland	Site	Undesignated habitats with some local biodiversity interest.
Artificial exposure	Site	This habitat has limited biodiversity importance.
Arable field	Site	This habitat has limited biodiversity importance, but large open fields may provide suitable habitat for breeding and overwintering birds. Arable field margins may support significant floral diversity and important foraging and dispersal corridors for species such as badger, amphibians, reptiles and terrestrial invertebrates.
Introduced shrub	Site	This habitat has limited biodiversity importance.

Broad habitat type	Resource importance	Justification
Buildings	N/A	Some buildings may have features which can support roosting bats and birds.
Amenity grassland	N/A	This habitat has limited biodiversity importance.

Source: Mott MacDonald

7.5.3.3 Option 3

Based on the Phase 1 undertaken in October 2021, the following habitats were identified within the study area surrounding Option 3:

- Unimproved calcareous grassland: This comprises a section of grassland to the north-west of Offington Corner Junction, representing a large proportion of the Offington Cemetery LWS. It comprises a rich mosaic of grasslands of varying sward lengths, wildflower diversity and management levels.
- Semi-natural broadleaved woodland: Multiple sections of this habitat can be found within the study area of Option 3. These comprise two sections of woodland to the east of Offington Corner Junction and a stand of woodland to the north-west of Grove Lodge Junction.
- Running water: This habitat is assumed from background imagery and was not identified within the accessible Phase 1 areas. South of West Street/Upper Brighton Road, behind the residential properties, it appears there is a network of drains/ditches which extends to the south. Without visual confirmation, it is not possible to determine whether these are wet or dry, and any species which may be associated. For the purpose of this report, a worst-case scenario is applied, and the highest possible biodiversity assumed.
- Eutrophic standing water: This habitat is assumed from background imagery and was not identified within the accessible Phase 1 areas. South of West Street/Upper Brighton Road, behind the residential properties, it appears there is a network of drains/ditches which extends to the south. Without visual confirmation, it is not possible to determine whether these are wet or dry, and any species which may be associated. For the purpose of this report, a worst-case scenario is applied, and the highest possible biodiversity assumed.
- Traditional orchard: This comprises an inaccessible area to the north of Upper Brighton Road, in fields behind houses bordering the A27. The habitat appears to have previously been an orchard at some time, with lots of apple *Malus domestica* and wild cherry between scrub and scattered trees. It is unknown whether any of this HPI remains here, or a lack of management has resulted in succession over time.
- Semi-improved calcareous grassland: The area of Offington Cemetery which is not part of the LWS is considered to be semi-improved calcareous grassland, due to its location and higher species diversity than a ‘poor’ semi-improved

grassland. Due to time constraints during the survey, it was not possible to produce a DAFOR scale and species list for this area, but classification as semi-improved calcareous grassland represents the maximum possible importance. The area is largely unmanaged, but some regular mowing and nutrient inputs are expected due to its nature as a cemetery. Additionally, on the southern border of West Street/Upper Brighton Road, an area of inaccessible grassland existed which may be semi-improved calcareous grassland. Due to the seasonality of the survey and no access, it was not possible to determine whether is semi-improved calcareous grassland, or another semi-improved grassland type. This has been classified as the highest possible importance habitat as a worst-case scenario.

- Semi-natural mixed woodland (potential): The area of semi-natural broadleaved woodland to the north-west of the Grove Lodge Junction transitions into semi-natural mixed woodland, as coniferous species such as yew *Taxus baccata* and Scott's pine *Pinus sylvestris* become more frequent. Without access for detailed assessment, this area has been classified as its highest possible habitat importance, although confirmation is required to determine whether this is plantation coniferous woodland or not.
- Scrub: Multiple sections of this habitat can be found within Option 3 study area. These comprise the dense scrub to the south-west of Offington Corner Junction and the scattered scrub within Offington Cemetery LWS, and the dense hazel (*Corylus avellana*) scrub to the south of Grove Lodge Junction. In addition to these, areas of scattered scrub exist within amenity grassland to the west of Upper Brighton Road, within a small residential area and also amongst the fields to the north of Upper Brighton Road, behind houses bordering the A27. A small area of dense scrub is also located on the north-western corner of the Busticle Lane Junction, with scrub extending northwards along a field boundary. Finally, a separate area of scrub borders the southern side of the A27, to the north-west of the Busticle Lane Junction.
- Scattered trees: The sections of this habitat comprised scattered trees forming tree lines bordering the A24 and A27 connecting to Offington Corner Junction, and scattered trees to the north-east of Upper Brighton Road/West Street within the divided horse paddocks.
- Hedgerow: Multiple sections of this habitat can be found within Option 3 study area. These comprise a section of intact hedgerow interspersed with trees situated to the north of Grove Lodge Junction. It also includes intact hedgerows bordering the fields to the south-west of Upper Brighton Road/West Street and also bordering Upper Brighton Road from Lambleys Lane. Finally, to the north-west of the Busticle Lane Junction, a section of species poor, intact hedgerow extends along the A27, bordering an arable field. Native hedgerows are HPI.
- Semi-improved grassland: This comprises an area of semi-improved grassland to the south of Upper Brighton Road which, due to the seasonality of the survey and no access, was not possible to determine whether the field is semi-improved calcareous grassland, and a field to the east of the West Street /

Church Lane junction divided into different paddocks for grazing horses. Finally, within the vicinity of the Busticle Lane Junction, two thin margins of semi-improved grassland border the A27 on both sides, to the west of the junction.

- Tall ruderal: This comprises an unmanaged section of the arable field located to the south of Upper Brighton Road, where tall ruderal species had been allowed to grow undisturbed.
- Improved grassland: This comprises the grassland representing Worthing golf course situated to the east of Offington Corner Junction. Additionally, fields of improved grassland comprising of a number of paddocks to the north and south of Upper Brighton Road/West Street exist, with grazing horses.
- Artificial exposure: This comprises a chalk spoil heap located within the Offington cemetery LWS, likely created as a suitable habitat for reptiles, small mammals and specialised invertebrates. The spoil heap itself has limited biodiversity importance, but may be a component of a mosaic which does provide opportunities for the aforementioned species.
- Arable field: This comprises an arable field at the western end of West Street / Upper Brighton Road on its southern border, and another large arable field, bordered by some trees and defunct hedgerow at the eastern end of West Street, on its southern side. A third large arable field sits to the north-west of the Busticle Lane Junction, bordered to the south by hedgerow and the A27.
- Introduced shrub: This comprises two areas of non-native ornamental species, the first of which is located within the north-eastern corner of the Offington roundabout and the second located along the southern boundary of Worthing college playing fields to the north of Grove Lodge roundabout.
- Buildings: There were many residential properties which were not accessible during the Phase 1. These themselves do not hold any biodiversity importance but may support protected and notable species such as roosting birds and bats.
- Amenity grassland: This comprises two areas surrounding Grove Lodge Junction - Worthing college playing fields to the north and Broadwater Green to the south of the junction and an area to the west of Upper Brighton Road, surrounded by a residential area.
- Hardstanding: This encompasses all roads and pavements within the study area. These areas have no importance to biodiversity and have been omitted from Table 7-8 below.

Table 7-8: Habitat importance within the Option 3 study area

Broad habitat type	Resource importance	Justification
Unimproved calcareous grassland	County	This is an HPI and part of the Offington Cemetery LWS. Calcareous grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates.

Broad habitat type	Resource importance	Justification
		Unimproved calcareous grassland is considered to be the most species-rich grassland habitat in the UK, and this area may support diverse and notable floral species.
Semi-natural broadleaved woodland	Local	This is an HPI. Semi-natural broadleaved woodland may provide important habitats for breeding birds, commuting bats, dormouse, badger, reptiles, amphibians and terrestrial invertebrates. They may also include notable or rare plant species.
Running water (possible)	Local	This is an HPI. This habitat may be important for amphibians, water voles and aquatic invertebrates. Background imagery indicates there are numerous drains/ditches within the study area, a habitat which is uncommon throughout the Worthing district.
Eutrophic standing water (possible)	Local	This is an HPI. This habitat may be important for amphibians, water voles and aquatic invertebrates. Background imagery indicates there are numerous drains/ditches within the study area, a habitat which is uncommon throughout the Worthing district.
Semi-improved calcareous grassland	Local	Calcareous grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. Grassland which has not been subject to agricultural improvement and increased nutrient loads may support diverse and notable floral species.
Traditional orchard (possible)	Local	This is an HPI. This habitat may be important for birds, bats, badgers and terrestrial invertebrates.
Semi-natural mixed woodland	Local	This is an HPI. Semi-natural mixed woodland may provide important habitats for breeding birds, commuting bats, badger, reptiles, amphibians and terrestrial invertebrates. They may also include notable or rare plant species.
Scrub	Local	This is an undesignated habitat with some local biodiversity interest. Scrub may provide important habitat for breeding birds, commuting bats, dormouse, badger, reptiles, amphibians and terrestrial invertebrates.
Scattered trees	Local	This is an undesignated habitat with some local biodiversity interest. Some individual trees may support protected and notable species such as birds, bats and terrestrial invertebrates.

Broad habitat type	Resource importance	Justification
Hedgerows	Local	This is an HPI. Hedgerows may provide important habitats for breeding birds, commuting bats, dormouse, badger and terrestrial invertebrates. They may also include notable or rare plant species.
Poor semi-improved grassland	Site	Undesignated habitats with some local biodiversity interest. Grassland may provide important habitats for breeding and overwintering birds, foraging bats, badger, reptiles, amphibians, and terrestrial invertebrates. However, the extent of grassland within the study area is unlikely to support protected or notable species due to its size.
Tall ruderal	Site	This is a common habitat found within the surrounding area, with little or no biodiversity interest.
Ephemeral/short perennial	Site	Undesignated habitats with some local biodiversity interest.
Improved grassland	Site	Undesignated habitats with some local biodiversity interest.
Artificial exposure	Site	This habitat has limited biodiversity importance.
Arable field	Site	This habitat has limited biodiversity importance, but large open fields may provide suitable habitat for breeding and overwintering birds. Arable field margins may support significant floral diversity and important foraging and dispersal corridors for species such as badger, amphibians, reptiles and terrestrial invertebrates.
Introduced shrub	Site	This habitat has limited biodiversity importance.
Buildings	Site	Some buildings may have features which can support roosting bats and birds.
Amenity grassland	N/A	This habitat has limited biodiversity importance.

Source: Mott MacDonald

7.5.4 Protected and notable species

Information regarding protected and notable species has been included based on the conclusions drawn within the PEA. Aquatic invertebrates, including white-clawed crayfish, and fish, had previously been scoped out of further assessment within the ESR and are not included further within this report. This is because none of the scheme options would directly or indirect impact upon watercourses or waterbodies.

7.5.4.1 Bats

All species of bats in the UK are fully protected as European Protected Species (EPS) under the Habitats Regulations 2017 and afforded additional protected under the 1981 Act.

The following species are also SPI under Section 41 (S41) of the NERC Act 2006:

- Barbastelle *Barbastella barbastellus*
- Bechstein's bat *Myotis bechsteinii*
- Brown long-eared bat *Plecotus auritus*
- Greater horseshoe *Rhinolophus ferrumequinum*
- Lesser horseshoe *Rhinolophus hipposideros*
- Noctule *Nyctalus noctula*
- Soprano pipistrelle *Pipistrellus pygmaeus*

The desk study returned 84 bat records within 2km of the scheme, including the following species: myotis species *Myotis sp*., noctule, common pipistrelle *Pipistrellus pipistrellus*, soprano pipistrelle, serotine *Eptesicus serotinus*, grey long-eared *Plecotus austriacus* and brown long-eared bat. Serotine and grey long-eared bat are classified as Vulnerable[98] and Endangered[99], respectively, in Great Britain. Globally, both species have been classified as 'Least Concern' by the International Union for Conservation of Nature (IUCN) Red list. These species are therefore of greater conservation concern in Great Britain than the other species returned from the desk study.

There were no EPS bat licences identified within the study area.

There is the potential for bats to be present within the study area for all options, utilising mature trees, buildings and structures for roosts and linear features such as tree lines and hedgerows for commuting and foraging. Due to the urban and residential nature of the immediate scheme surrounds, the habitat is generally of low suitability for bats. However, this does not mean individuals and small populations will not be present.

7.5.4.2 Birds

All wild birds in the UK, their eggs, nests and young are protected by the 1981 Act Additionally, those rarer or particularly vulnerable species are listed on Schedule 1

[98] The Mammal Society (2018). Serotine Bat *Eptesicus serotinus* [online] available at: Serotine.pdf (mammal.org.uk) (last accessed March 2022).
[99] The Mammal Society (2018). Grey Long-Eared Bat *Plecotus austriacus* [online] at: Grey-Long-Eared-Bat.pdf (mammal.org.uk) (last accessed March 2022).

of the 1981 Act, which afford them enhanced protection from disturbance whilst near their nests or whilst they have dependent young.

The desk study requested only records of protected and/or notable bird species for the purpose of this assessment. Notable bird species are defined as those which are listed in Schedule 1 of the 1981 Act , SPI under Section 41 of the NERC Act 2006 and listed as Red or Amber Birds of Conservation Concern (BoCC)[100].

The desk study returned 4,979 records of notable bird species within 2km of the scheme, from 87 species and subspecies. Of these, there are 24 Schedule 1 species forming 1,049 records. A list of these protected and notable species can be found within Appendix D of the PEA. A separate list of Schedule 1 bird species is available within Section 3.3.1 of the PEA.

Habitats are present within the study area of all options with the potential to support breeding and nesting birds; hedgerow, woodland, scrub, scattered trees and buildings may all provide opportunities for many species.

None of the habitats within the study area for all options are considered to be suitable for supporting significant populations of overwintering birds. Whilst there are some arable fields, their locations are either surrounded by unsuitable habitats or next to main roads and are not deemed to be suitable for large aggregations of wildfowl, waders or overwintering thrushes.

7.5.4.3 Great crested newt

The great crested newt (GCN) *Triturus cristatus* is fully protected as an EPS under the Habitats Regulations 2017 and afforded additional protection under the 1981 Act. GCN are also an S41 SPI.

A total of six waterbodies have been identified within 250m of the scheme options. Four of these waterbodies are to the north of Upper Brighton Road and the A27 highway and therefore presents a barrier to movement of GCN. It is considered that a live highway would inhibit GCN from travelling southwards in the path of construction activities associated with Upper Brighton Road. There are additional construction activities associated with the scheme, to the north of the A27, however these are located over 1km from the nearest waterbody and are therefore discounted due to their distance from the scheme. As such, only two waterbodies are considered in this assessment.

Seven records of GCN were returned from the desk study within 2km of the scheme with the most recent being documented in 2020.

[100] British Trust for Ornithology (BTO) (2021). Birds of Conservation Concern 5 [online] available at: bocc-5-a5-4pp-single-pages.pdf (bto.org) (last accessed February 2022).

Three EPS GCN licences were identified within 2km of the scheme. Two of these were to the west of the scheme, approximately 1km and 1.4km at their closest points, respectively. A separate class licence return was found from 2016 surveys approximately 1.1km south-west of the scheme extent at its closest point.

An additional licence was identified approximately 1.6km north of the scheme at its closest point. This licence exists within the study area of Lyons Way Sompting and Busticle Lane Junction, which are within the footprint of Options 2 and 3 respectively. This is outside of the study area for all interventions within Option 1.

Background mapping and imagery indicates there are no ponds within the study area for any interventions associated with the options, although there are potential drains and ditches within the study area at Upper Brighton Road (Options 2 and 3). These watercourses were inaccessible during the Phase 1 but may offer additional breeding habitat. There are potential suitable terrestrial habitats between these drains and ditches and the proposed construction area. It is very unlikely at this stage that GCN, if present, would be impacted by the scheme, but it cannot be ruled out until the watercourses are accessed. Suitable terrestrial habitats include semi-improved grassland, tall ruderal and scrub, which provide suitable foraging and commuting opportunities for this species.

A Habitat Suitability Index (HSI) is recommended for all waterbodies within 250m of the scheme, unless significant barriers to dispersal within the study area exists (for example fast flowing water or road infrastructure). If these waterbodies are deemed to be suitable to support GCN, a water sample should be taken to test for GCN environmental DNA (eDNA). Further GCN assessment may be required dependent on the results of these assessments.

7.5.4.4 Hazel dormouse

The hazel dormouse *Muscardinus avellanarius* (hereafter referred to as ‘dormouse’) is fully protected as an EPS under the Habitats Regulations 2017 and afforded additional protection under the 1981 Act. Dormouse is also an S41 SPI.

One record of dormouse was returned from the desk study within 2km of the scheme in the form of a nest in 2011.

There are habitats which are suitable for this species within the study area, such as hedgerows and small woodland stands. However, none of these areas are connected to the wider landscape and other areas of suitable habitat, largely due to the isolation provided by the road infrastructure and urban surroundings. Therefore, dormouse is very unlikely to be impacted by any of the scheme options and can be scoped out of further assessment.

7.5.4.5 Otter

The Eurasian otter *Lutra lutra* is fully protected as an EPS under the Habitats Regulations 2017 and afforded additional protection under the 1981 Act. The otter is also an S41 SPI.

No records of otter were returned from the desk study within 2km of the scheme.

None of the suitable terrestrial habitats for otter are close enough or connected to a river source to be used by otters. Even though there were inaccessible potential watercourses within the study area, these are unlikely to be used by otter due to their proximity to residential areas. Therefore, otter is very unlikely to be impacted by any of the scheme options and can be scoped out of further assessment.

7.5.4.6 Water vole

The water vole *Arvicola amphibius* is fully protected under the 1981 Act. The water vole is also an S41 SPI.

No records of water vole were returned from the desk study within 2km of the scheme.

The inaccessible watercourses within the study areas at Upper Brighton Road (Options 2 and 3) may be suitable to support water voles. The distance of these watercourses to the proposed works area makes it very unlikely for water vole to be impacted even if present, therefore water vole can be scoped out of further assessment.

7.5.4.7 Badger

Badgers *Meles meles* and their setts are protected under the Protection of Badgers Act 1992. SxBRC do not hold detailed records of badgers and therefore no records were returned from the desk study.

Badgers may construct their setts within woodland, scrub, field margins and hedgerows, meaning there is potential for this species to be present within the study area. Badgers are a highly mobile species and can rapidly colonise new areas.

During the Phase 1, no incidental evidence of badger activity was recorded. However, conclusions on presence or likely absence within the study area cannot be made until additional access and assessment is undertaken. Walkovers of the study area which was previously inaccessible are recommended to identify field signs of badger presence. Further assessment may be required depending on walkover results.

7.5.4.8 Reptiles

The UK has six native species of terrestrial reptiles, all of which are partially protected under the 1981 Act. Two of these species, the sand lizard *Lacerta agilis* and smooth snake *Coronella austriaca*, are also EPS and fully protected under the Habitats Regulations 2017 (as amended). The four more widespread reptiles are grass snake *Natrix helvetica*, adder *Vipera berus*, common lizard *Zootoca vivipara,* and slow worm *Anguis fragilis*. All UK reptile species are SPI.

The desk study returned 52 reptile records within 2km of the scheme, including one record of a sand lizard. Records were returned for all four of the more common reptile species within the UK; common lizard, slow worm, grass snake and adder.

There are habitats within the study area with the potential to support widespread reptiles, including woodland, scrub, grassland, tall ruderal and open mosaic habitat on previously developed land. The presence of herptile fencing within Offington Cemetery LWS indicated the presence of reptiles in the area. Further assessment of inaccessible areas is recommended to enable targeted reptile survey locations to be identified, based on the preferred option. Even where suitable reptile habitats are not anticipated to be directly impacted by the scheme, reptiles may still move into the construction area and be impacted.

7.5.4.9 Terrestrial invertebrates

Some UK invertebrate species, both terrestrial and aquatic, are afforded protection under the Habitats Regulations 2017 and/or the 1981 Act. Nearly 400 invertebrate species are listed as S41 SPI.

The desk study returned 10,260 records from 159 species of notable terrestrial invertebrates, which includes European and UK protected species, nationally rare, International Union for Conservation of Nature (IUCN) Red List species, Red Data Book species and Sussex rare species. There were 111 moth species, five hymenopteran (ants, bees and wasps) species, 15 beetle species, six true bugs, three flies, three spiders, two grasshoppers and crickets, one earwig, one snail and 12 butterfly species.

There were no EPS records returned within the study area. There were eight species protected under the 1981 Act within the UK and 68 SPIs.

There are habitats within the study area which are suitable for supporting terrestrial invertebrate species; open mosaic habitats, semi-improved grassland, scrub, broadleaved woodland, tall ruderal and ephemeral/short perennial all offer some importance to invertebrates in general and with the potential to support a diverse assemblage. The potential for SPI associated with the unimproved calcareous grassland and open mosaic habitat on previously developed land is of particular note at Offington Corner. Further assessment of suitable terrestrial invertebrate habitats is recommended where impacts are anticipated.

7.5.4.10 Other notable species

The Western European hedgehog *Erinaceus europaeus* is an SPI and 151 records were returned from the desk study. No incidental evidence of this species' presence was recorded during the Phase 1 habitat Survey, but suitable habitats such as road verges, scrub, woodland and grassland exists within the study area.

The brown hare *Lepus europaeus* is an SPI and six records were returned from the desk study. Very few habitats within the study area are suitable for brown hare, and these are limited to the arable fields and grassland in more rural areas. This

species typically prefers farmland or a mosaic of open fields and woodland. As such, this species has been scoped out of further assessment, with suitable habitats unlikely to be impacted by any of the scheme options.

The desk study returned six records of two marine mammal species within 2km of the scheme; grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* which are both SPIs. Neither of these species are likely to be impacted by the scheme, as there is no anticipated impact pathway on the marine environment.

A record of a red squirrel *Sciurus vulgaris* was returned from 2021 in Worthing, approximately 1.7km south-west of the scheme extent at is closest point. This species is protected under the 1981 Act and is an SPI. Whilst woodland habitats were present, they were contained in relatively small pockets and often bordering roads or residences. As such, the presence of red squirrel is unlikely and has been scoped out of further assessment.

There were 55 notable or rare plant species, including 13 nationally scarce species returned from the desk study within 2km of the scheme. The only notable plant species identified during the October 2021 Phase 1 was the bluebell *Hyacinthoides non-scripta.*

There were three notable or veteran trees within the study area, including two oaks and an ash tree to the south-west of Grove Lodge junction, identified through the Ancient Tree Inventory[101]. No Tree Preservation Orders (TPOs) were identified from the desk study.

7.5.4.11 Invasive and non-native species

A total of 14 species invasive non-native species (INNS) listed in Schedule 9 of the 1981 Act or Schedule 2 of The Invasive Alien Species Order 2019 (IASO) were returned from the desk study. Japanese knotweed *Fallopia japonica* is listed in Schedule 9 of the 1981 Act, whilst Himalayan Balsam *Impatiens glandulifera* and giant hogweed *Heracleum mantegazzianum* are listed on Schedule 2 of the IASO.

Other non-native species records from the desk study include bird species such as Egyptian goose *Alopochen aegyptiacus* (IASO, Schedule 2), Canada goose *Branta canadensis* and Mandarin Duck *Aix galericulata* (both Schedule 9 of the 1981 Act). Records of non-native mammals included grey squirrel *Sciurus carolinensis* (IASO, Schedule 2) and one non-native reptile wall lizard *Podarcis muralis* (Schedule 9 of the 1981 Act). All INNS within 2km of the scheme options are detailed within Appendix D of the PEA.

A total of 14 species listed as Sussex INNS were also returned from the desk study. These species are not subject to the same national legislation as those

[101] Woodland Trust (2022). Ancient Tree Inventory Tree search [online] available at: Tree Search - Ancient Tree Inventory (woodlandtrust.org.uk) (last accessed March 2022).

within Schedule 9 of the 1981 Act and do not legally need to be eradicated from the ecosystem. Of the Sussex INNS, holm oak *Quercus ilex* and cherry laurel *Prunus laurocerasus* were identified within the study area.

No other evidence of INNS was recorded during the Phase 1 habitat survey.

7.6 Potential impacts

The sections below are an indicative summary of the potential construction and operational impacts considered likely to occur, at this stage of the scheme.

7.6.1 General construction impacts

Construction impacts may be short-term, long-term, temporary, or permanent in nature, jeopardising the fitness and survival of populations. Sources of potential impacts on biodiversity applicable to all scheme options during construction include:

- Presence and movement of construction traffic, plant and equipment
- Additional noise associated with construction activities and heavy plant
- Increased air pollution associated with construction activities
- Demolition and site clearance, including vegetation clearance, resulting in habitat loss
- Earthworks and changes in the landform of the site
- Artificial lighting for works during low daylight levels or at night

7.6.2 General operational impacts

Operational impacts may be short-term, long-term, temporary, or permanent in nature, jeopardising the fitness and survival of populations. Sources of potential impacts on biodiversity applicable to all scheme options during operation include:

- Permanent loss of habitats, including mature vegetation
- Increased baseline air pollution and noise levels
- Increased traffic volume, resulting in greater collision risk and higher levels of nutrient run-off into adjacent environments
- Permanent additional artificial lighting within areas subject to a reduced lighting regime, for example along west street, Sompting Village

7.6.3 Option 1

The tables below identify the potential impacts from construction and operation of Option 1 on biodiversity, based on the current baseline and in the absence of targeted mitigation measures.

7.6.3.1 Designated sites

Potential impacts on all designated sites, both statutory and non-statutory, are detailed in Table 7-9 below.

Table 7-9: Summary of potential impacts on designated sites during construction and operation of Option 1

Potential construction impacts	Potential operational impacts
Special Areas of Conservation (SACs)	
A Habitats Regulations Assessment (HRA) Stage 1 Screening was undertaken (HE608509-MMD-EBD-OP00-RP-LE-0001) and has concluded a finding of no significant effects for all options on each of the three sites: Ebernoe Common SAC, The Mens SAC and Singleton and Cocking Tunnels SAC. A Sussex bat SAC planning and landscape enhancement protocol[102] was development by Natural England and the South Downs National Park (SDNP) authority which outlined a 12km buffer around the SACs which encompasses the full extent of foraging areas required by the qualifying species. As all scheme options, including the ARN are outside of this buffer, there are unlikely to be impacts on the sites during construction.	Due to the distance of Option 1 and the ARN to all three SACs, there are unlikely to be impacts on the sites during operation.
Sites of Special Scientific Interest (SSSI)	
Due to the distance from Option 1 and the ARN, and no impact pathways, there are unlikely to be any impacts on Cissbury Ring SSSI during construction.	Due to the distance from Option 1 and the ARN, and no impact pathways, there are unlikely to be any impacts to the SSSIs during operation.
Local Wildlife Sites (LWS)	
There is potential for adverse impacts on Offington Cemetery LWS and Worthing and Hill Barn Golf Course LWS through NO_2 emissions from an increase in construction plant. This could lead to increased levels of nitrogen deposition on unimproved calcareous grassland, broadleaved woodland and vascular plant species.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on these sites. The current baseline is greater than the critical load for these sites' associated habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.
Due to the distance from Option 1, and no impact pathways, there are unlikely to be any	Due to the distance from Option 1, and no impact pathways, there are unlikely to be

[102] Natural England & South Downs National Park Authority. Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2018/04/TLL-15-Draft-Sussex-Bat-SAC-Protocol.pdf

Potential construction impacts	Potential operational impacts
impacts on The Gallops and No Man's Land LWS and Tenants Hill and Reservoirs LWS during construction.	any impacts on The Gallops and No Man's Land LWS and Tenants Hill and Reservoirs LWS during operation.

Source: Mott MacDonald

7.6.3.2 Habitats

Potential impacts on habitats within the Option 1 study area are detailed in Table 7-10 below.

Table 7-10: Summary of potential impacts on habitats during construction and operation of Option 1

Potential construction impacts	Potential operational impacts
There is potential for adverse impacts through NO_2 emissions from an increase in construction plant, which could lead to increased levels of nitrogen deposition on any sensitive habitats and vascular plant species.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on adjacent habitats. The current baseline is greater than the critical load for sensitive habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.
In the absence of mitigation, the proposed works for the scheme are not anticipated to result in the loss of HPI as works are largely confined within the existing highways boundary. However, there is anticipated to be a small amount of land take from outside of this boundary. Until more information on working areas and compound locations is known, this cannot be confirmed.	A BNG assessment will be undertaken in accordance with Chief Highway Engineer Memorandum 422/18, facilitated through The Department for Agriculture, Food and Rural Affairs' (DEFRA) Metric 2.0[103] tool. The draft Worthing Local Plan 2016-2033 outlines the requirement for new developments to demonstrate at least a 10% gain in biodiversity.
Undesignated habitats, such as amenity grassland and scattered trees, which have localised importance, are anticipated to be lost during the construction phase. These habitats will be permanently lost but are widespread in the local area.	There is potential for created habitats to fail if not monitored or maintained regularly. If this occurs, there is a risk that biodiversity targets are not met. Only after a period of establishment post-development, which varies depending on the habitat, can it be determine whether the BNG target of this scheme has been achieved. Failing to achieve this target would therefore be considered as an operational impact, rather than a construction impact.
Works in close proximity to trees have the potential to adversely affect them through ground compaction and root damage.	

[103] Natural England (2019). The Biodiversity Metric 2.0 [online] available at: The Biodiversity Metric 2.0 - JP029 (naturalengland.org.uk) (last accessed February 2022).

Source: Mott MacDonald

7.6.3.3 Protected and notable species

Potential impacts on protected and/or notable species within the Option 1 study area are detailed in Table 7-11 below. Species scoped out of further assessment in the PEA have not been included. This includes aquatic invertebrates, dormouse, fish, otter, overwintering birds, water vole and white-clawed crayfish for this option.

Table 7-11: Summary of potential impacts on protected and notable species during construction and operation of Option 1

Potential construction impacts	Potential operational impacts
Badger: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat. Construction works during both day and night may directly disturb and/or displace this species because of increased lighting pollution, noise and vibration.	Due to the location of the Option 1 interventions, within an existing road corridor and subject to existing artificial lighting and noise, no impacts are anticipated on this species during operation.
Bats: Vegetation clearance for construction and temporary construction compounds could adversely impact these species, resulting in loss of roosting, foraging and commuting habitat. Construction works during both day and night may directly disturb and/or displace these species because of increased lighting pollution, noise and vibration.	Due to the location of the Option 1 interventions, within an existing road corridor and subject to existing artificial lighting and noise, no impacts are anticipated on these species during operation.
Breeding birds: Vegetation clearance for construction and temporary construction compounds could adversely impact breeding wild birds, through loss of terrestrial habitat. Breeding birds may be adversely impacted through disturbance from increased lighting pollution, noise and vibration during construction. This may result in adverse impacts on foraging, breeding success and future survival.	Due to the location of the Option 1 interventions, within an existing road corridor and subject to existing artificial lighting and noise, no impacts are anticipated on these species during operation.
Reptiles: Vegetation clearance for construction and temporary construction compounds could adversely impact these species, through loss of terrestrial habitat or killing/injury to individuals.	Due to the location of the Option 1 interventions, within an existing road corridor and subject to existing artificial lighting and noise, no impacts are anticipated on these species during operation.
Terrestrial invertebrates:	Results from the air quality assessment indicate that, even though there would be a reduction in

Potential construction impacts	Potential operational impacts
Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat. Increased NO_2 emissions from construction plant may adversely impact these species. Increased nitrogen deposition as a result may irreversibly damage HPI used for foraging by these species, therefore affecting future survival.	air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on HPI. The current baseline is greater than the critical load for these habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.

Source: Mott MacDonald

7.6.4 Option 2

The tables below identify the potential impacts from construction and operation of Option 2 on biodiversity, based on the current baseline and in the absence of targeted mitigation measures.

7.6.4.1 Designated sites

Potential impacts on all designated sites, both statutory and non-statutory, are detailed in Table 7-12 below.

Table 7-12: Summary of potential impacts on designated sites during construction and operation of Option 2

Potential construction impacts	Potential operational impacts
Special Areas of Conservation (SACs)	
A Habitats Regulations Assessment (HRA) Stage 1 Screening was undertaken (HE608509-MMD-EBD-OP00-RP-LE-0001) and has concluded a finding of no significant effects for all options on each of the three sites: Ebernoe Common SAC, The Mens SAC and Singleton and Cocking Tunnels SAC. A Sussex bat SAC planning and landscape enhancement protocol[104] was development by Natural England and the South Downs National Park (SDNP) authority which outlined a 12km buffer around the SACs which encompasses the full extent of foraging areas required by the qualifying species. As all scheme options and the ARN are outside of this buffer, there are unlikely to be impacts on the sites during construction.	Due to the distance of Option 2 and the ARN to all three SACs, there are unlikely to be impacts on the sites during operation.

[104] Natural England & South Downs National Park Authority. Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2018/04/TLL-15-Draft-Sussex-Bat-SAC-Protocol.pdf

Potential construction impacts	Potential operational impacts
Sites of Special Scientific Interest (SSSI)	
Due to the distance from Option 2 and the ARN, and no impact pathways, there are unlikely to be any impacts on Cissbury Ring SSSI during construction.	Due to the distance from Option 2 and the ARN, and no impact pathways, there are unlikely to be any impacts to the SSSIs during operation.
Local Wildlife Sites (LWS)	
There is potential for adverse impacts on Offington Cemetery LWS and Worthing and Hill Barn Golf Course LWS through NO_2 emissions from an increase in construction plant. This could lead to increased levels of nitrogen deposition on unimproved calcareous grassland, broadleaved woodland and vascular plant species.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on these sites. The current baseline is greater than the critical load for these sites' associated habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.
Due to the distance from Option 2, and no impact pathways, there are unlikely to be any impacts on The Sanctuary, High Salvington LWS, Clapham Wood LWS, , The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs and Cokeham Brooks LWS during construction.	Due to the distance from Option 2, and no impact pathways, there are unlikely to be any impacts on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs and Cokeham Brooks LWS during operation.

Source: Mott MacDonald

7.6.4.2 Habitats

Potential impacts on habitats within the Option 2 study area are detailed in Table 7-13 below.

Table 7-13: Summary of potential impacts on habitats during construction and operation of Option 2

Potential construction impacts	Potential operational impacts
There is potential for adverse impacts through NO_2 emissions from an increase in construction plant, which could lead to increased levels of nitrogen deposition on any sensitive habitats and vascular plant species.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on adjacent habitats. The current baseline is greater than the critical load for sensitive habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.
In the absence of mitigation, the proposed works for the scheme are not anticipated to result in the loss of HPI as works are largely confined within the existing highways boundary. However, there is anticipated to be a small amount of land take from outside of this boundary. Until more information on	The BNG assessment will be undertaken in accordance with Chief Highway Engineer Memorandum 422/18, facilitated through The

Potential construction impacts	Potential operational impacts
working areas and compound locations is known, this cannot be confirmed.	Department for Agriculture, Food and Rural Affairs' (DEFRA) Metric 2.0 tool.
Undesignated habitats, such as amenity grassland and scattered trees, which have localised importance, are anticipated to be lost during the construction phase. These habitats will be permanently lost but are widespread in the local area.	The draft Worthing Local Plan 2016-2033 outlines the requirement for new developments to demonstrate at least a 10% gain in biodiversity. There is potential for created habitats to fail if not monitored or maintained regularly. If this occurs, there is a risk that biodiversity targets are not met. Only after a period of establishment post-development, which varies depending on the habitat, can it be determine whether the BNG target of this scheme has been achieved. Failing to achieve this target would therefore be considered as an operational impact, rather than a construction impact.
Works in close proximity to trees have the potential to adversely affect them through ground compaction and root damage.	

Source: Mott MacDonald

7.6.4.3 Protected and notable species

Potential impacts on protected and/or notable species within the Option 2 study area are detailed in Table 7-14 below. Species scoped out of further assessment in the PEA have not been included. This includes aquatic invertebrates, dormouse, fish, otter, overwintering birds, water vole and white-clawed crayfish for this option.

Table 7-14: Summary of potential impacts on protected and notable species during construction and operation of Option 2

Potential construction impacts	Potential operational impacts
Badger: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat. Construction works during both day and night may directly disturb and/or displace this species because of increased lighting pollution, noise and vibration.	Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact this species, through disturbance during periods of activity (at night).
Bats: Vegetation clearance for construction and temporary construction compounds could adversely impact these species, resulting in loss of roosting, foraging and commuting habitat. Construction works during both day and night may directly disturb and/or displace these species because of increased lighting pollution, noise and vibration.	Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact these species, through disturbance during periods of activity (at night).
Breeding birds:	Any permanent increase in artificial lighting within Upper Brighton Road may adversely

Potential construction impacts	Potential operational impacts
Vegetation clearance for construction and temporary construction compounds could adversely impact these species, through loss of terrestrial habitat. Breeding birds may be adversely impacted through disturbance from increased lighting pollution, noise and vibration during construction. This may result in adverse impacts on foraging, breeding success and future survival.	impact birds during the breeding season. This may also adversely impact nocturnal species such as barn owl, when foraging, even outside of the breeding season.
Great crested newt: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat or injury to individuals.	Due to the location of the Option 2 interventions within existing road corridors, no impacts are anticipated on this species during operation.
Reptiles: Vegetation clearance for construction and temporary construction compounds could adversely impact these species, through loss of terrestrial habitat or injury to individuals.	Due to the location of the Option 2 interventions within existing road corridors, no impacts are anticipated on these species during operation.
Terrestrial invertebrates: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat. Increased NO_2 emissions from construction plant may adversely impact these species. Increased nitrogen deposition as a result may irreversibly damage HPI used for foraging by these species, therefore affecting future survival.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on HPI. The current baseline is greater than the critical load for these sites' associated habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation. Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact terrestrial invertebrates when foraging, particularly nocturnal species such as moths.

Source: Mott MacDonald

7.6.5 Option 3

The tables below identify the potential impacts from construction and operation of Option 3 on biodiversity, based on the current baseline and in the absence of targeted mitigation measures.

7.6.5.1 Designated sites

Potential impacts on all designated sites, both statutory and non-statutory, are detailed in Table 7-21Table 7-15 below. Ancient woodland is defined as a designated site hereafter and is separated from other habitats within the study area due to its greater resource importance.

Table 7-15: Summary of potential impacts on designated sites during construction and operation of Option 3

Potential construction impacts	Potential operational impacts
Special Areas of Conservation (SACs)	
A Habitats Regulations Assessment (HRA) Stage 1 Screening was undertaken (HE608509-MMD-EBD-OP00-RP-LE-0001) and has concluded a finding of no significant effects for all options on each of the three sites: Ebernoe Common SAC, The Mens SAC and Singleton and Cocking Tunnels SAC. A Sussex bat SAC planning and landscape enhancement protocol[105] was development by Natural England and the South Downs National Park (SDNP) authority which outlined a 12km buffer around the SACs which encompasses the full extent of foraging areas required by the qualifying species. As all scheme options are outside of this buffer, there are unlikely to be impacts on the sites during construction. As all scheme options, including the ARN, are outside of this buffer, there are unlikely to be impacts on the sites during construction.	Due to the distance of Option 3 and the ARN to all three SACs, there are unlikely to be impacts on the sites during operation.
Sites of Special Scientific Interest (SSSI)	
Due to the distance from Option 3 and the ARN, and no impact pathways, there are unlikely to be any impacts on Cissbury Ring SSSI during construction.	Due to the distance from Option 3 and the ARN, and no impact pathways, there are unlikely to be any impacts to the SSSIs during operation.
Local Nature Reserve (LNR)	
Due to the distance from Option 3 and the ARN, and no impact pathways, there are unlikely to be any impacts on Lancing Ring LNR during construction.	Due to the distance from Option 3 and the ARN, and no impact pathways, there are unlikely to be any impacts on Lancing Ring LNR during operation.
Local Wildlife Sites (LWS)	
There is potential for adverse impacts on Offington Cemetery LWS and Worthing and Hill Barn Golf Course LWS through NO_2 emissions from an increase in construction plant. This could lead to increased levels of nitrogen deposition on unimproved calcareous grassland, broadleaved woodland and vascular plant species.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on these sites. The current baseline is greater than the critical load for these sites' associated habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.
Due to the distance from Option 3, and no impact pathways, there are unlikely to be any impacts on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs, Cokeham Brooks LWS and Lancing Ring LWS during construction.	Due to the distance from Option 3, and no impact pathways, there are unlikely to be any impacts on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs, Cokeham Brooks LWS and Lancing Ring LWS during operation.

Source: Mott MacDonald

7.6.5.2 Habitats

Potential impacts on habitats within the Option 3 study area are detailed in Table 7-16 below.

Table 7-16: Summary of potential impacts on habitats during construction and operation of Option 3

Potential construction impacts	Potential operational impacts
There is potential for adverse impacts through NO_2 emissions from an increase in construction plant, which could lead to increased levels of nitrogen deposition on any sensitive habitats and vascular plant species.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on sensitive habitats. The current baseline is greater than the critical load for these habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation.
In the absence of mitigation, the proposed works for the scheme are not anticipated to result in the loss of HPI as works are largely confined within the existing highways boundary. However, there is anticipated to be a small amount of land take from outside of this boundary. Until more information on working areas and compound locations is known, this cannot be confirmed.	A BNG assessment will be undertaken in accordance with Chief Highway Engineer Memorandum 422/18, facilitated through The Department for Agriculture, Food and Rural Affairs' (DEFRA) Metric 2.0[106] tool. The draft Worthing Local Plan 2016-2033 outlines the requirement for new developments to demonstrate at least a 10% gain in biodiversity.
Undesignated habitats, such as amenity grassland and scattered trees, which have localised importance, are anticipated to be lost during the construction phase. These habitats will be permanently lost but are widespread in the local area.	There is potential for created habitats to fail if not monitored or maintained regularly. If this occurs, there is a risk that biodiversity targets are not met. Only after a period of establishment post-development, which varies depending on the habitat, can it be determine whether the BNG target of this scheme has been achieved. Failing to achieve this target would therefore be considered as an operational impact, rather than a construction impact.
Works in close proximity to trees have the potential to adversely affect them through ground compaction and root damage.	

[105] Natural England & South Downs National Park Authority. Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2018/04/TLL-15-Draft-Sussex-Bat-SAC-Protocol.pdf

[106] Natural England (2019). The Biodiversity Metric 2.0 [online] available at: The Biodiversity Metric 2.0 - JP029 (naturalengland.org.uk) (last accessed February 2022).

Source: Mott MacDonald

7.6.5.3 Protected and notable species

Potential impacts on protected and/or notable species within the Option 3 study area are detailed in Table 7-17 below. Species scoped out of further assessment in the PEA have not been included. This includes aquatic invertebrates, dormouse, fish, otter, overwintering birds, water vole and white-clawed crayfish for this option.

Table 7-17: Summary of potential impacts on protected and notable species during construction and operation of Option 3

Potential construction impacts	Potential operational impacts
Badger: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat. Construction works during both day and night may directly disturb and/or displace this species because of increased lighting pollution, noise and vibration.	Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact this species, through disturbance during periods of activity (at night).
Bats: Vegetation clearance for construction and temporary construction compounds could adversely impact these species, resulting in loss of roosting, foraging and commuting habitat. Construction works during both day and night may directly disturb and/or displace these species because of increased lighting pollution, noise and vibration.	Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact these species, through disturbance during periods of activity (at night).
Breeding birds: Vegetation clearance for construction and temporary construction compounds could adversely impact these species, through loss of terrestrial habitat. Breeding birds may be adversely impacted through disturbance from increased lighting pollution, noise and vibration during construction. This may result in adverse impacts on foraging, breeding success and future survival.	Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact birds during the breeding season. This may also adversely impact nocturnal species such as barn owl, when foraging, even outside of the breeding season.
Great crested newt: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat or injury to individuals.	Due to the location of the Option 3 interventions within existing road corridors, no impacts are anticipated on this species during operation
Reptiles: Vegetation clearance for construction and temporary construction compounds could	Due to the location of the Option 3 interventions within existing road corridors, no impacts are anticipated on these species during operation

Potential construction impacts	Potential operational impacts
adversely impact these species, through loss of terrestrial habitat or injury to individuals.	
Terrestrial invertebrates: Vegetation clearance for construction and temporary construction compounds could adversely impact this species, through loss of terrestrial habitat. Increased NO_2 emissions from construction plant may adversely impact these species. Increased nitrogen deposition as a result may irreversibly damage HPI used for foraging by these species, therefore affecting future survival.	Results from the air quality assessment indicate that, even though there would be a reduction in air quality and an increase in nitrogen deposition from NO_2 emissions, this would not have a significant impact on HPI. The current baseline is greater than the critical load for these habitats, and given the proximity to the existing A27, no additional significant impact is anticipated during operation. Any permanent increase in artificial lighting within Upper Brighton Road may adversely impact terrestrial invertebrates when foraging, particularly nocturnal species such as moths.

Source: Mott MacDonald

7.7 Design, mitigation and enhancement measures

The mitigation hierarchy will be considered for all ecological features throughout the scheme's lifecycle. The mitigation hierarchy is based on a series of essential, sequential steps undertaken throughout the scheme's lifecycle to limit any adverse impacts on biodiversity and has the following steps in order of priority:

1. Avoidance
2. Minimisation
3. Mitigation
4. Compensation

7.7.1 Construction

Appropriate mitigation measures to control potentially adverse impacts on all ecological receptors during construction will be included within an Environmental Management Plan (EMP) for the scheme. At this stage of the scheme design, it is not possible to fully identify all impacts upon biodiversity and therefore determine specific mitigation measures. The potential mitigation measures which may be appropriate through construction are detailed below. This will need reviewing once the final option is known, and in light of any potential cumulative effects from increased noise, atmospheric pollution, hydrology and lighting, for example. The results of targeted ecological surveys will also inform any mitigation proposals.

7.7.1.1 Designated sites

7.7.1.1.1 International sites

The Habitats Regulations Assessment (HRA) Stage 1 Screening (HE608509-MMD-EBD-OP00-RP-LE-0001) concluded a finding of no significant effects for all scheme options on each of the three SACs, Ebernoe Common, The Mens and

Singleton and Cocking Tunnels. As all scheme options are outside of this buffer, no mitigation for these SACs is required during construction.

It is not anticipated that any other European protected sites will be impacted by components of the scheme, either directly or indirectly. However, if this changes, all relevant documentation, including this report, will be updated accordingly and mitigation measures may be required.

7.7.1.1.2 National sites - SSSIs

Due to the distance of Cissbury Ring SSSI from the scheme options it is unlikely to be directly or indirectly impacted during construction. None of the scheme options exist within this site's IRZ and therefore no mitigation is required.

None of the scheme options are hydrologically connected to SSSIs and so it is not anticipated that pollution prevention measures are required during construction.

7.7.1.1.3 Local sites

Significant impacts from reduced air quality were scoped out in the ESR, due to the small scale and temporary nature of the site plant, as well as a construction period of less than two years; the latter is unlikely to cause a significant effect, in line with DMRB LA 105[107]. However, to minimise indirect adverse impacts, even if not significant, on Offington Cemetery LWS and Worthing and Hill Barn Golf Courses LWS, good site practice and innovative technology would be implemented throughout construction. Good site practice includes the use of appropriately sized plant and turning off engines when not in use. Innovative construction methods may include the use of hybrid, electric, and low sulphur powered vehicles to reduce the noise and vibration disturbance to ecological receptors as well as reducing the impacts of air pollution. During night works, hoods would be used to direct lighting away from the Offington Cemetery LWS.

During construction, measures to mitigate the effects of dust on the sensitive habitats, including HPI, at these sites, would include the use of screens and sediment booms. Cutting, grinding or sawing equipment would be fitted with, or in conjunction with, suitable dust suppression techniques such as water sprays or local extraction (for example suitable local exhaust ventilation systems). Materials that have potential to produce dust would be removed from site as soon as possible, unless being re-used on site. Stockpiles being re-used would be seeded or fenced to prevent wind whipping.

None of the other local designated sites within the study area are likely to be impacted during construction or operation due to their distance from all scheme options. Therefore, no mitigation for these sites is required.

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[107] National Highways (2019) LA 105 – Air quality Revision [online] available at: 10191621-07df-44a3-892e-c1d5c7a28d90 (standardsforhighways.co.uk) (last accessed March 2022).

7.7.1.2 Habitats

A detailed habitat mitigation strategy will need to be developed alongside the BNG assessment to replace any habitats permanently lost as a result of the scheme. This strategy would replace lost habitat in order to achieve National Highways' BNG targets. The strategy will include the creation of diverse habitat corridors around the scheme, providing links to offsite habitats where possible. Habitat loss for this scheme is anticipated to be minimal due to the limited land take outside of the existing highways boundary.

No HPI are anticipated to be directly impacted by the scheme, but if they are, attempts to avoid this would be made. If HPI are lost, these would be recreated with new areas of habitats incorporated into the landscape design in PCF Stage 3 with additional habitat created to achieve BNG. Retained HPI, such as hedgerows, would be protected during construction by putting up screening barriers to protect habitats from dust and pollution.

Construction areas which are adjacent to hedgerows and trees should avoid direct damage through root compaction by heavy plant. An arboricultural assessment to identify Root Protection Zones (RPZ) is required prior to works to ensure direct damage to trees is avoided or mitigated appropriately.

During construction, measures to mitigate the effects of dust on sensitive habitats would include the use of screens and sediment booms. Cutting, grinding or sawing equipment would be fitted with, or in conjunction with, suitable dust suppression techniques such as water sprays or local extraction (for example suitable local exhaust ventilation systems). Materials that have the potential to produce dust would be removed from site as soon as possible, unless being re-used on site. Stockpiles being re-used would be seeded or fenced to prevent wind whipping. All vehicles would be required to switch off engines when stationary to mitigate air pollution, noise and vibration disturbance during construction.

7.7.1.3 Protected and notable species

Targeted ecology surveys are not only required to identify the presence or likely absence of protected species, but also to inform appropriate and proportional mitigation for all protected species and SPI. Specific mitigation would be dependent on the results of these surveys and likely disturbance as a result of the scheme, ultimately with the aim of maintaining favourable conservation status of all species potentially impacted by the scheme.

Likely mitigation would include the following:

- Vegetation clearance and earthworks would be supervised by a suitably experienced ecologist in areas confirmed to have protected species present or habitat considered to have high potential for protected species.

- Toolbox Talks (protected species and invasive species with potential to be encountered on site) would be prepared and delivered on site to all personnel prior to any works by a suitably experienced ecologist.

All vehicles would be required to switch off engines when stationary to mitigate air pollution, noise and vibration disturbance during construction. During night works, hoods would be used to direct artificial lighting away from features and habitat considered to be suitable for protected species, such as scrub and woodland. Ecological input should be sought during all lighting design processes.

If the presence of protected species, such as bats, badgers or GCN, is confirmed and impacts are predicted but cannot be removed through avoidance or mitigation, a Natural England licence will be applied for. In the context of the scheme options and existing levels of disturbance (i.e. through noise, lighting and isolated habitats), it is considered unlikely that licences will be required. However, in the absence of targeted species survey information this cannot be ruled out. Licences, if required, will specify detailed mitigation to ensure favourable conservation status and ecological functionality of the affected species is maintained. The licence conditions and the requirement of 'no net loss in biodiversity' in line with the NPPF and National Highways' targets will guide the landscape planting required for the scheme. In addition to habitat enhancement for protected species, mitigation, and compensation with regards to offsetting habitat loss would also be required.

7.7.1.3.1 Bats

Due to unconfirmed presence and unknown impacts at this stage, details of mitigation cannot currently be specified. Once the preferred option has been identified, a more detailed Preliminary Roost assessment is advised. This would highlight the need for targeted further surveys based on an assessment of the likelihood of potential effects to roosts, for example from the loss of or disturbance to roadside trees or adjacent buildings and also the fragmenting of potential commuting routes.

Sensitive working methods would ensure that the risk of killing, injuring or disturbing bats is minimised. If any bat roosts are anticipated to be adversely affected by the works, a comprehensive mitigation strategy including a sensitive working method and a habitat replacement package would be required to accompany a licence application to Natural England.

If night works are required and temporary lighting is required, above and beyond the existing lighting conditions, it would be kept to a minimum to reduce effects on bats and other protected species, following the guidance produced by the Bat

Conservation trust (BCT) and Institution of Lighting professionals (ILP)[108]. The following would be considered during the lighting design process:

- No bat roost, including access points, would be directly illuminated. If it is considered necessary to illuminate an area near a roost or roost access point the lighting would be positioned to avoid the sensitive area.
- Use of low UV emitting light source. A warm white light source with a colour temperature lower than 2,700 kelvin is advised.
- Luminaires should feature peak wavelengths higher than 550nm to avoid the component of light most disturbing to bats.
- Area lighting luminaires would be specified to restrict disability glare and minimise obtrusive light. Generally, luminaries would be mounted at a zero-degree tilt to further assist in the reduction of light pollution.
- Lighting would be directed to where it is needed, and light spill avoided. This can be achieved by the design of the luminaire and when required using accessories such as hoods, cowls, louvres and shields to assist in directing the light to the intended areas.
- The height of lighting columns in general would be as low as possible as the light at a low level reduces the ecological effects. However, there are cases where taller columns would enable light to be directed downwards at a more acute angle and therefore reduce horizontal light spill.

All works likely to impact bats would be supervised and Toolbox Talks would be given by a suitably qualified ecologist to all operatives, prior to any works commencing. Once the design has been finalised, the scale and quality of habitat suitable for bats would be assessed to confirm whether bat boxes would be installed or habitat enhancement would be recommended as compensation; loss of suitable roosting, foraging or commuting habitat from construction would need replacing to create a long-term net gain in bat foraging, commuting and roosting habitats.

7.7.1.3.2 Birds

Due to unconfirmed presence and unknown impacts at this stage, details of mitigation cannot currently be specified. Any vegetation clearance would be avoided during the bird nesting season (generally taken as March to August inclusive but can be earlier or later depending upon local conditions and the species). If any clearance is required during the breeding season, sensitive working methods, to minimise the impacts on nesting birds would be implemented. If works commence in the bird breeding season, a suitably experienced ecologist would carry out a nesting bird check on any vegetation to be cleared, or vegetation to be retained, but which is directly adjacent to major works, no more than 24 hours

[108] BCT and ILP (2018). Guidance note 01/18 bats and artificial lighting in the UK [online] available at: layout (bats.org.uk) (last accessed February 2022).

prior to works commencing. If any active nests are identified, a suitable buffer would be set up around the nest, the extent of which would be species dependent. This buffer would remain in-situ until the nest has been confirmed as no longer active by an experienced ecologist.

Loss of suitable nesting bird habitat would be mitigated by replacement planting of hedgerows, woodland and scrub habitats along with the creation of areas of rough grassland for ground nesting birds, and the installation of bird boxes in woodland and hedgerows to replace lost habitats. Exact locations, including whether these areas would be on or off-site, cannot be determine at this stage. Surveys for breeding birds would be required to understand species and assemblages at risk of impact and the appropriate mitigation required.

7.7.1.3.3 Great crested newt

Due to unconfirmed presence and unknown impacts at this stage, details of mitigation cannot currently be specified. Further surveys would be required and, if identified, sensitive working methods would ensure that the risk of killing, injuring or disturbing GCN is minimised. No potential breeding habitats would be impacted by the scheme, but if any suitable terrestrial GCN habitats, such as hedgerows, are anticipated to be adversely affected, directly or indirectly by the works, a comprehensive mitigation strategy including a sensitive working method and a habitat replacement package would be required and there is a potential Natural England licence requirement. All works likely to impact GCN would be supervised, and Toolbox Talks would be given by a suitably qualified ecologist to all operatives, prior to any works commencing.

7.7.1.3.4 Badger

Due to unconfirmed presence and unknown impacts at this stage, details of mitigation cannot currently be specified. However, works that directly affect active badger setts would require a Natural England licence which would only be granted for works outside of the breeding season (November – June). Considering the context of the scheme options in an urban corridor, suitable sett-building habitat which would be directly impacted is limited, but the presence of setts which may be impacted or disturbed cannot be ruled out at this stage. Habitats adjacent to works such as hedgerows, woodland and scrub may provide opportunities for sett creation. This is more likely to result in disturbance, rather than destruction, of setts.

Affected setts would need to be closed under licence and badgers permanently excluded from their setts to prevent them re-entering. If any main setts are impacted by the works, an artificial main sett may need to be created in suitable habitat, normally within 200m of the affected sett, at least six months prior to construction starting. Artificial setts are only required where there are no other suitable setts in the same territory for badger social groups to move to, and this will be determined from targeted surveys.

Any open trenches should be covered overnight during works to prevent badgers from becoming trapped, with open excavations to have 45-degree inclines at either end allowing the safe egress of mammals. If this is not possible, a suitable means of escape should be installed to allow any trapped mammals to escape safely.

7.7.1.3.5 Reptiles

Due to unconfirmed presence and unknown impacts at this stage, details of mitigation cannot currently be specified. However, sensitive working methods would ensure that the risk of killing or injuring reptiles is minimised. Such methods typically require that vegetation clearance and construction activities likely to harm reptiles are undertaken in a phased manner and supervised by a suitably experienced ecologist and all site operatives shall receive a Toolbox Talk prior to works commencing.

Further surveys are recommended in areas to be lost/disturbed which have the potential to support reptiles, such as grassland verges. If reptiles are discovered, dependent on the numbers of reptiles present on site and the degree of vegetation clearance, a combination of habitat manipulation and translocation may be required to prevent significant harm to reptile populations. Exclusion fencing would also be required to prevent reptiles re-entering the construction area. A suitable receptor site would need to be identified and would need to meet a list of criteria to determine its suitability including habitat suitability and carrying capacity. Considering the location of the scheme options and the small areas of suitable reptile habitat anticipated to be lost/disturbed, it is unlikely that large populations of reptiles will be present. Mitigation will seek to provide a net gain in reptile habitat through the creation of new habitats and enhancement of existing habitats.

7.7.1.3.6 Invertebrates

A minimum of three surveys between April and August are recommended for terrestrial invertebrates, in suitable habitat which is anticipated to be impacted such as hedgerows and verges. Specific invertebrate mitigation would be dependent on the results of detailed surveys. Ideally, mitigation for terrestrial invertebrates would include the creation of diverse mosaics of habitats with varied topography with habitats including species-rich grassland, native hedgerows and scrub, along with areas of bare ground, together with the retention of and creation of standing and fallen deadwood. The landscape strategy for the scheme will seek to increase the area of high-quality habitats, providing habitat piles around the scheme, in suitable areas, to improve opportunities for dispersal, including specific measures for any notable invertebrate populations which may be present in the area. In the context of the scheme options, the creation of these habitats within the scheme extent is unlikely given the constraints of the existing highways boundary. However, there may be an opportunity to enhance habitats outside of the scheme extent and improve connectivity to suitable terrestrial invertebrate habitats.

7.7.2 Operation

Any replacement habitats required would be implemented through planting works in the first season available following completion of construction works. Any opportunities for early planting in areas that would not be affected during construction will be explored at PCF Stage 3.

A minimum five-year aftercare period would follow completion of the works for the scheme. The majority of the works are anticipated to be undertaken within the existing road alignment with minimal land take from outside the current highway boundary. During the initial aftercare period, maintenance activities would be undertaken to ensure the successful establishment of planting and provision of new habitats. This aftercare period would be extended for habitats which take longer to establish, such as woodland.

Maintenance and monitoring tasks would be described in the first iteration of the EMP. This would include information on the replacement of failed or defective plants. Long-term maintenance objectives and activities would be provided in the third iteration of the EMP which would be refined at the end of the construction period. The third iteration would detail maintenance for the initial aftercare period (0-5 years) and long-term monitoring for Years 5-20. This would be consistent with the wider landscape and habitat management routine of the surrounding highway network. This document would ensure the ongoing success of habitat reinstatement to maturity.

Additional artificial lighting would only be included in the design for the scheme if it is essential for safety reasons. It is likely that species present within or near the scheme extent are already habituated to existing lighting conditions at the junctions, but additional lighting in areas which are currently dark, such as Upper Brighton Road, may have significant adverse impacts on nocturnal species, such as bats, badgers, barn owls and invertebrates such as moths. Please refer to 7.7.1.3.1 for lighting guidance to reduce impacts on protected species and SPI.

7.8 Assessment of likely significant effects

At this stage, in the absence of targeted ecological surveys and further assessments, it is not possible to incorporate specific mitigation measures into assessments of likely significant effects. Instead, following the assumptions in section 7.3 and the general design, mitigation and enhancement measures in section 7.7, the following likely significant effects are detailed. It must be noted that the overall magnitude and significance of impacts from the scheme are subject to change as more information becomes available from subsequent biodiversity assessments and design reiterations, including the design of the preferred option. Current assessments are based on a worst-case scenario for protected species, taking into consideration their likely maximum populations sizes/resource importance in the context of available habitats within the study area.

7.8.1 Option 1

Table 7-18 identifies the likely significant residual effects from construction and operation of Option 1 on biodiversity.

Table 7-18: Likely significant effects during construction and operation of Option 1

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
Special Areas of Conservation (SACs)			
There are no likely significant effects on Ebernoe Common, The Mens and Singleton and Cocking Tunnels SACs during construction, due to the distance of these sites from Option 1 and no effect pathways present. All scheme options are outside of the 12km buffer around these SACs, outlined by the Sussex bat SAC planning and landscape enhancement protocol[109].	No change, neutral significance	There are no likely significant effects during operation, due to the distance of Ebernoe Common, The Mens and Singleton and Cocking Tunnels SACs from Option 1 and no effect pathways present.	No change, neutral significance
Sites of Special Scientific Interest (SSSI)			
There are no likely significant effects on Cissbury Ring SSSI during construction, due to the distance of this site from Option 1 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on Cissbury Ring SSSI during operation, due to the distance of this site from Option 1 and no effect pathways present.	No change, neutral significance
Local Wildlife Sites (LWS)			
There are no likely significant effects from sediment, pollution or dust as best practice measures and sediment control would ensure that Offington Cemetery LWS and Worthing and Hill Barn Golf Courses	No change, neutral significance	Results from the air quality assessment indicate that, despite an increase in traffic, there would be no significant effects from reduced air quality on these sites. The current baseline is greater than the critical load for these sites' associated	No change, neutral significance

[109] Natural England & South Downs National Park Authority. Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2018/04/TLL-15-Draft-Sussex-Bat-SAC-Protocol.pdf

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
LWS are not adversely affected.		habitats and no additional significant impact is anticipated during operation. However, it is recommended that if this option is progressed to PCF Stage 3, targeted surveys at these sites are undertaken to confirm that there are no species sensitive to nitrogen deposition present.	
There are no likely significant effects on The Gallops and No Man's Land LWS and Tenants Hill and Reservoirs during construction, due to the distance of these sites from Option 1 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on The Gallops and No Man's Land LWS and Tenants Hill and Reservoirs during operation, due to the distance of these sites from Option 1 and no effect pathways present.	No change, neutral significance
Habitats			
There are no likely significant effects from sediment, pollution or dust on HPI such as calcareous grassland, woodland and hedgerows, as best practice measures and sediment control would ensure that these habitats are not adversely impacted.	No change, neutral significance	Results from the air quality assessment indicate that, despite an increase in traffic, there would be no significant effects from reduced air quality on these sites, The current baseline is greater than the critical load for HPI and no additional significant impact is anticipated during operation. However, it is recommended that if this option is progressed to PCF Stage 3, targeted surveys for these habitats are undertaken to confirm that there are no species sensitive to nitrogen deposition present.	No change, neutral significance

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
There are likely to be significant effects on undesignated habitats, such as modified grassland and scattered trees, during vegetation clearance and earthworks. These habitats would be permanently lost but are widespread in the local area.	Major adverse, slight significance	Any habitats lost will be replaced with those of equal or greater importance, in order to comply with National Highways' biodiversity targets. There will therefore be no likely significant effects during operation.	No change, neutral significance
Protected and notable species			
There is the potential for adverse effects, such as killing and injuring of protected species through the vegetation clearance and the temporary severance of commuting and foraging habitat. The likelihood of these effects cannot be assessed at this stage and further surveys are needed to assess the status of populations and likelihood of significant effects on protected species.	Moderate adverse, slight significance	Due to the location of the Option 1 interventions within existing road corridors, habitat fragmentation and displacement of protected species is considered unlikely. Traffic modelling data predicts an increase in traffic on the network during operation. With scheme targets to reduce congestion, this means traffic would be moving faster, which in turn would increase the risk of killing and injuring of protected and/or notable species through traffic collisions. Further surveys are needed to assess status of populations and likelihood of significant effects on protected species.	Minor adverse, neutral or slight significance
Artificial lighting associated with night works may significantly disturb nocturnal species. The likelihood of this effect cannot be assessed at this stage.	Moderate adverse, slight significance	As the junctions within Option 1 are already subject to lighting, it is not anticipated that there would be any additional effects on protected and/or notable species during operation. Additional permanent lighting is unlikely to be required for this scheme option, but cannot be confirmed at this stage.	Negligible adverse, neutral significance

Source: Mott MacDonald

7.8.2 Option 2

Table 7-19 identifies the likely significant residual effects from construction and operation of Option 2 on biodiversity.

Table 7-19: Likely significant effects during construction and operation of Option 2

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
Special Areas of Conservation (SACs)			
There are no likely significant effects on Ebernoe Common, The Mens and Singleton and Cocking Tunnels SACs during construction, due to the distance of these sites from Option 2 and no effect pathways present. All scheme options are outside of the 12km buffer around these SACs, outlined by the Sussex bat SAC planning and landscape enhancement protocol[110].	No change, neutral significance	There are no likely significant effects during operation, due to the distance of Ebernoe Common, The Mens and Singleton and Cocking Tunnels SACs from Option 2 and no effect pathways present.	No change, neutral significance
Sites of Special Scientific Interest (SSSI)			
There are no likely significant effects on Cissbury Ring SSSI during construction, due to the distance of this site from Option 2 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on Cissbury Ring SSSI during operation, due to the distance of this site from Option 2 and no effect pathways present.	No change, neutral significance
Local Wildlife Sites (LWS)			
There are no likely significant effects from sediment, pollution or dust as best practice measures and sediment control would ensure that Offington Cemetery LWS and Worthing and Hill Barn Golf Courses	No change, neutral significance	Results from the air quality assessment indicate that, despite an increase in traffic, there would be no significant effects from reduced air quality on these sites, The current baseline is greater	No change, neutral significance

[110] Natural England & South Downs National Park Authority. Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2018/04/TLL-15-Draft-Sussex-Bat-SAC-Protocol.pdf

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
LWS are not adversely affected.		than the critical load for these sites' associated habitats and no additional significant impact is anticipated during operation. However, it is recommended that if this option is progressed to PCF Stage 3, targeted surveys at these sites are undertaken to confirm that there are no species sensitive to nitrogen deposition present.	
There are no likely significant effects on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs and Cokeham Brooks LWS during construction, due to the distance of these sites from Option 2 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs and Cokeham Brooks LWS during operation, due to the distance of these sites from Option 2 and no effect pathways present.	No change, neutral significance
Habitats			
There are no likely significant effects from sediment, pollution or dust on HPI such as calcareous grassland, woodland and hedgerows, as best practice measures and sediment control would ensure that these habitats are not adversely impacted.	No change, neutral significance	Results from the air quality assessment indicate that, despite an increase in traffic, there would be no significant effects from reduced air quality on these sites. The current baseline is greater than the critical load for HPI and no additional significant impact is anticipated during operation. However, it is recommended that if this option is progressed to PCF Stage 3, targeted surveys for these habitats are undertaken to confirm that there are no species sensitive to nitrogen deposition present	No change, neutral significance

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
There are likely to be significant effects on undesignated habitats, such as modified grassland and scattered trees, during vegetation clearance and earthworks. These habitats would be permanently lost but are widespread in the local area.	Major adverse, slight significance	In order to comply with National Highways biodiversity targets, a net gain in biodiversity would be achieved by the scheme. Any habitats lost would be replaced with those of equal or greater importance.	No change, neutral significance
Protected and notable species			
There is the potential for adverse effects, such as killing and injuring, of protected species through the vegetation clearance and the temporary severance of commuting and foraging habitat. The likelihood of these effects cannot be assessed at this stage and further surveys are needed to assess the status of populations and likelihood of significant effects on protected species.	Moderate adverse, slight significance	Due to the location of the Option 2 interventions within existing road corridors, habitat fragmentation and displacement of protected species is considered unlikely. Traffic modelling data predicts an increase in traffic on the network during operation. With scheme targets to reduce congestion, this means traffic would be moving faster, which in turn would increase the risk of killing and injuring of protected and/or notable species through traffic collisions. Further surveys are needed to assess status of populations and likelihood of significant effects on protected species.	Minor adverse, neutral or slight significance
Artificial lighting associated with night works may significantly disturb nocturnal species. The likelihood of this effect cannot be assessed at this stage.	Moderate adverse, slight significance	Additional permanent lighting is unlikely to be required for most junctions within this scheme option, but cannot be confirmed at this stage. It is possible that additional permanent lighting would be required within Upper Brighton Road. Therefore, the potential for long-term adverse effects on	Minor adverse, neutral or slight significance

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
		nocturnal species from permanent artificial lighting increases cannot be assessed at this stage.	

Source: Mott MacDonald

7.8.3 Option 3

Table 7-20 below identifies the likely significant residual effects from construction and operation of Option 3 on biodiversity.

Table 7-20: Likely significant effects during construction and operation of Option 3

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
Special Areas of Conservation (SACs)			
There are no likely significant effects on Ebernoe Common, The Mens and Singleton and Cocking Tunnels SACs during construction, due to the distance of these sites from Option 3 and no effect pathways present. All scheme options are outside of the 12km buffer around these SACs, outlined by the Sussex bat SAC planning and landscape enhancement protocol[111].	No change, neutral significance	There are no likely significant effects during operation, due to the distance of Ebernoe Common, The Mens and Singleton and Cocking Tunnels SACs from Option 3 and no effect pathways present.	No change, neutral significance
Sites of Special Scientific Interest (SSSI)			
There are no likely significant effects on Cissbury Ring SSSI during construction, due to the distance of this site from Option 3 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on Cissbury Ring SSSI during operation, due to the distance of this site from Option 3 and no effect pathways present.	No change, neutral significance

[111] Natural England & South Downs National Park Authority. Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol [online] available at: https://www.southdowns.gov.uk/wp-content/uploads/2018/04/TLL-15-Draft-Sussex-Bat-SAC-Protocol.pdf

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
Local Nature Reserve (LNR)			
There are no likely significant effects on Lancing Ring LNR during construction, due to the distance of this site from Option 3 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on Lancing Ring LNR during operation, due to the distance of this site from Option 3 and no effect pathways present.	No change, neutral significance
Local Wildlife Sites (LWS)			
There are no likely significant effects from sediment, pollution or dust as best practice measures and sediment control would ensure that Offington Cemetery LWS and Worthing and Hill Barn Golf Courses LWS are not adversely affected.	No change, neutral significance	Results from the air quality assessment indicate that, despite an increase in traffic, there would be no significant effects from reduced air quality on these sites. The current baseline is greater than the critical load for these sites' associated habitats and no additional significant impact is anticipated during operation. However, it is recommended that if this option is progressed to PCF Stage 3, targeted surveys at these sites are undertaken to confirm that there are no species sensitive to nitrogen deposition present.	No change, neutral significance
There are no likely significant effects on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs, Cokeham Brooks LWS and Lancing Ring LWS during construction, due to the distance of these sites from Option 3 and no effect pathways present.	No change, neutral significance	There are no likely significant effects on The Sanctuary, High Salvington LWS, Clapham Wood LWS, The Gallops and No Man's Land LWS, Tenants Hill and Reservoirs, Cokeham Brooks LWS and Lancing Ring LWS during operation, due to the distance of these sites from Option 3 and no effect pathways present.	No change, neutral significance
Habitats			

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
There are no likely significant effects from sediment, pollution or dust on HPI such as calcareous grassland, woodland and hedgerows, as best practice measures and sediment control would ensure that these habitats are not adversely impacted.	No change, neutral significance	Results from the air quality assessment indicate that, despite an increase in traffic, there would be no significant effects from reduced air quality on these sites, The current baseline is greater than the critical load for HPI and no additional significant impact is anticipated during operation. However, it is recommended that if this option is progressed to PCF Stage 3, targeted surveys for these habitats are undertaken to confirm that there are no species sensitive to nitrogen deposition present.	No change, neutral significance
There are likely to be significant effects on HPI, such as woodland, during vegetation clearance and earthworks. These habitats would be permanently lost but are widespread in the local area.	Major adverse, slight significance	In order to comply with National Highways biodiversity targets, a net gain in biodiversity would be achieved by the scheme. Any habitats lost would be replaced with those of equal or greater importance.	No change, neutral significance
There are likely to be significant effects on undesignated habitats, such as modified grassland and scattered trees, during vegetation clearance and earthworks. These habitats would be permanently lost but are widespread in the local area.	Major adverse, slight significance		
Protected and notable species			
There is the potential for adverse effects, such as killing and injuring, of protected species through the vegetation clearance and the temporary severance of commuting and foraging habitat. The likelihood of these effects cannot be	Moderate adverse, slight significance	Due to the location of the Option 3 interventions within existing road corridors, habitat fragmentation and displacement of protected species is considered unlikely. Traffic modelling data predicts an increase	Minor adverse, neutral or slight significance

Likely significant construction effects	Likely magnitude and significance	Likely significant operational effects	Likely magnitude and significance
assessed at this stage and further surveys are needed to assess the status of populations and likelihood of significant effects on protected species.		in traffic on the network during operation. With scheme targets to reduce congestion, this means traffic would be moving faster, which in turn would increase the risk of killing and injuring of protected and/or notable species through traffic collisions. Further surveys are needed to assess status of populations and likelihood of significant effects on protected species.	
Artificial lighting associated with night works may significantly disturb nocturnal species. The likelihood of this effect cannot be assessed at this stage.	Moderate adverse, slight significance	Additional permanent lighting is unlikely to be required for most junctions within this scheme option but cannot be confirmed at this stage. It is possible that additional permanent lighting would be required within Upper Brighton Road. Therefore, the potential for long-term adverse effects on nocturnal species from permanent artificial lighting increases cannot be assessed at this stage.	Minor adverse, neutral or slight significance

Source: Mott MacDonald

7.8.4 Further surveys

In summary, Table 7-21 details the ecological receptors which have been scoped in for further survey, based on the questions posed in DMRB LA 108, section 3.2. For these receptors, likely significant effects arising from the scheme cannot be ruled out at this stage. Further information and survey data is required to determine this.

Offington Cemetery LWS and Worthing and Hill Barn Golf Courses LWS are unlikely to be indirectly impacted by reductions in air quality and airborne pollutants during the operation of all scheme options. However, it is recommended that targeted surveys at these sites are undertaken at PCF Stage 3 to confirm that there are no species sensitive to nitrogen deposition present.

Recommendations for targeted species and/or habitat surveys are detailed within the appended PEA report and summarised in section 8.5 above. Coincidentally, there are no differences between options when it comes to scoping ecological receptors in. As such, the table below represents a combined approach for all options.

Table 7-21: Summary of ecological receptors requiring further survey

Ecological receptor	Scoped in / out	Justification
Offington Cemetery LWS	Scoped In	This site is approximately 100m north-west of all options and may be indirectly impacted by NO2 emissions during operation. It is recommended that targeted surveys at these sites are undertaken at PCF Stage 3 to confirm that there are no species sensitive to nitrogen deposition present.
Worthing and Hill Barn Golf Courses LWS	Scoped In	This site is approximately 200m north-east of all options and may be indirectly impacted by NO2 emissions during operation. It is recommended that targeted surveys at these sites are undertaken at PCF Stage 3 to confirm that there are no species sensitive to nitrogen deposition present.
Badger	Scoped In	There are suitable habitats for this species within the study area.
Bats (all survey types)	Scoped In	There are suitable habitats for these species within the study area. Trees which are anticipated to be lost may have suitable roosting features.
Botanical surveys (Phase 2 NVC)	Scoped In	There are HPI within 200m of all options which may be indirectly impacted by NO_2 emissions. It is recommended that targeted surveys for these habitats are undertaken at PCF Stage 3 to confirm that there are no species sensitive to nitrogen deposition present.
Breeding birds	Scoped In	There are suitable habitats for these species within the study area.
Great crested newt (GCN)	Scoped In	There are suitable habitats for this species within the study area.
Reptiles	Scoped In	There are suitable habitats for these species within the study area.
Terrestrial invertebrates	Scoped In	There are suitable habitats for these species within the study area.

Source: Mott MacDonald

8 Material assets and waste

8.1 Legislative and policy framework

The principal legislative and planning context in relation to the assessment of the environmental effects of the scheme on material assets and waste generation is discussed below.

8.1.1 European Legislation

The overarching European Directives that are applicable to the assessment of material resource use and waste generation are set out below. Whilst it is acknowledged that the UK has left the European Union (EU) it should be noted that existing legislation which transposes these Directives remains in force. English and Welsh law was updated on 1 October 2020 to include changes to the Waste Framework Directive made in 2018, through the Waste (Circular Economy) (Amendment) Regulations 2020. The Waste and Environmental Permitting etc (Legislative Functions and Amendment etc) (EU Exit) Regulations 2020[112] were implemented in December 2020, which make amendments to ensure that the waste and environmental permitting regimes continue to operate effectively from 1 January 2021.

8.1.1.1 Waste Framework Directive (2008/98/EC)[113]

The Waste Framework Directive sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling and recovery. It defines when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Waste Framework Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular, without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest.

The Waste Framework Directive sets out a five-step waste hierarchy as to how waste should be managed as an important requirement which applies to anyone who produces or manages waste. The waste hierarchy requires that waste is dealt with in the following order of priority:

- Prevention

[112] Waste and Environmental Permitting etc (Legislative Functions and Amendment etc) (EU Exit) Regulations 2020 [online] available at: https://www.legislation.gov.uk/uksi/2020/1540/made (last accessed February 2022)
[113] Waste Framework Directive (2008/98/EC) [online] available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098 (last accessed March 2022)

- Preparing for reuse
- Recycling
- Other recovery (for example energy recovery)
- Disposal, only as a last resort

The following considerations must be taken into account:

- Environmental protection principles of precaution and sustainability
- Proximity principle for treatment and disposal of waste to be as close to its source as possible
- Technical feasibility and economic viability
- Protection of resources
- The overall environmental, human health, economic and social impacts

The Waste Framework Directive stipulates the requirement for Member States to reuse, recycle or recover a minimum of 70% of non-hazardous construction and demolition waste by weight by 2020.

8.1.1.2 Landfill Directive (1999/31/EC)[114]

The Landfill Directive aims to prevent, or reduce as far as possible, negative effects on the environment from the landfilling of waste and was implemented by Member States in 2001.

8.1.1.3 Hazardous Waste Directive (91/689/EEC)[115]

This Directive lays down strict controls and requirements for controlling hazardous wastes. Hazardous waste is any waste with hazardous properties that may make it harmful to human health and the environment and is defined by the European Waste Catalogue.

8.1.2 National Legislation

The following sections set out the main national legislation likely to be applicable to the scheme. There are a number of other statutes which may govern material resource use and waste management, including legislative changes. However, it is unlikely these would alter the outcome of the assessment.

[114] Landfill Directive (1999/31/EC) [online] available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31999L0031 (last accessed March 2022).
[115] Hazardous Waste Directive (91/689/EEC) [online] available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01991L0689-20081212&from=EN (last accessed January 2022).

8.1.2.1 The Environmental Protection Act 1990 (as amended)[116]

This Act defines the fundamental structure and authority for waste management and control of emissions into the environment. It legislates for:

- The meaning of waste
- The requirements of the duty of care in respect of waste and transferral of waste
- A prohibition on the unauthorised or harmful depositing, treatment, or disposal of waste on land
- Waste collection and waste disposal authorities and their roles

8.1.2.2 The Waste (England and Wales) Regulations 2011 (as amended)[117]

These regulations make provision for waste prevention programmes and impose duties in relation to the improved use of waste as a resource, including the application of the waste hierarchy. Site Waste Management Plans[118] (SWMPs) are no longer mandatory for projects commencing after 1 December 2013. They are, however, recommended and the principles behind the regulations remain best practice.

8.1.2.3 Hazardous Waste (England and Wales) Regulations 2005 (as amended)[119]

These regulations provide for the control of hazardous wastes and their movements. A consignment note is required prior to the removal of any hazardous waste. Hazardous waste is waste that exhibits certain properties (for example, it is potentially flammable, toxic or carcinogenic) such that it is or may (at or above certain concentrations) be detrimental to human health or the environment.

8.1.2.4 Environmental Permitting (England and Wales) Regulations 2016 (as amended)[120]

These regulations introduce a streamlined system of environmental permitting in England and Wales for certain installations, waste operations and mobile plants. It is an offence to operate a regulated facility or to cause or knowingly permit a water

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[116] The Environmental Protection Act 1990 [online] available at: http://www.legislation.gov.uk/ukpga/1990/43/contents (last accessed March 2022).
[117] The Waste (England and Wales) Regulations 2011, No.988 [online] available at: https://www.legislation.gov.uk/uksi/2011/988/contents (last accessed March 2022).
[118] Department for Environment, Food and Rural Affairs (2008), Non-statutory guidance for site waste management plans [online] available at: https://www.ihsti.com/CIS/document/267008 (last accessed March 2022).
[119] The Hazardous Waste (England and Wales) Regulations 2005, No. 894 [online] available at: https://www.legislation.gov.uk/uksi/2005/894/contents/made (last accessed March 2022).
[120] The Environmental Permitting (England and Wales) Regulations 2016 No. 1154 [online] available at: https://www.legislation.gov.uk/uksi/2016/1154/contents/made (last accessed March 2022).

discharge or groundwater activity except under and in accordance with an environmental permit.

8.1.2.5 Waste Electrical and Electronic Equipment (England and Wales) Regulations, 2013[121]

The Waste Electrical and Electronic Equipment (WEEE) Regulations 2013 apply to all Electrical and Electronic Equipment placed on the market in the UK covered by the scope of the regulations. There are 10 broad categories of WEEE currently outlined within the regulations (see Schedules 1 and 2 of the regulations). Relevant categories for the scheme are:

- Lighting equipment, for example straight and compact fluorescent tubes and high intensity discharge lamps
- Electrical and electronic tools, for example drills, saws and sewing machines, electric lawnmowers
- Monitoring and control equipment, for example smoke detectors, thermostats, heating regulators

8.1.2.6 Controlled Waste (England and Wales) Regulations 2012 (SI 2012/811)[122]

The Controlled Waste (England and Wales) Regulations 2012 came into force in April 2012, replacing the Controlled Waste Regulations 1992. They define household, industrial and commercial waste for environmental permitting purposes. The regulations replaced Schedule 1 of the 1992 regulations with an updated schedule defining household waste, still by reference to its origin, but introducing some exceptions.

The regulations also specify that waste from construction or demolition works, including preparatory works, should be “treated as household waste for the purposes of section 34(2) and (2A) of the [EPA 1990] only (disapplication of section 34(1) and duty on the occupier of domestic property to transfer household waste only to an authorised person or for authorised transport purposes)”.

[121] Waste Electrical and Electronic Equipment (WEEE) (England and Wales) Regulations, 2013 [online] available at: https://www.legislation.gov.uk/uksi/2013/3113/made (last accessed March 2022).
[122] Controlled Waste (England and Wales) Regulations 2012 [online] available at: www.legislation.gov.uk/uksi/2012/811/contents/made (last accessed March 2022).

8.1.3 National Policy

8.1.3.1 National Planning Policy Framework 2021[123]

The National Planning Policy Framework (NPPF) sets out policies for development and how these should be implemented but makes specific reference to the Government's policy for the sustainable use of minerals (Chapter 17) and waste (paragraphs 4 and 20).

8.1.3.2 National Planning Policy for Waste 2014[124]

The National Planning Policy for Waste sets out detailed waste planning policies and maintains the core principles of the 'plan led' approach with a continued focus of moving waste up the waste hierarchy.

The document sets out detailed waste planning policies to facilitate a more sustainable and efficient approach to resource use and management. When determining planning applications for non-waste development, the policy requires that local planning authorities should, to the extent appropriate to their responsibilities, ensure that:

- The likely impact of proposed, non-waste related development on existing waste management facilities, and on sites and areas allocated for waste management, is acceptable and does not prejudice the implementation of the waste hierarchy and/or the efficient operation of such facilities.
- New, non-waste development makes sufficient provision for waste management and promotes good design to secure the integration of waste management facilities with the rest of the development and, in less developed areas, with the local landscape.
- The handling of waste arising from the operation of developments maximises reuse/recovery opportunities and minimises off-site disposal.

8.1.3.3 The Government's 25 Year Environment Plan[125]

The Government's 25 Year Environment Plan sets out government action to help the natural world regain and retain good health. The proposals aim to tackle a

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[123] Ministry of Housing, Communities and Local Government (2021), National Planning Policy Framework [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf (last accessed March 2022).
[124] Department for Communities and Local Government (2014), National Planning Policy for Waste. [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/364759/141015_National_Planning_Policy_for_Waste.pdf (last accessed March 2022).
[125] Department for Environment, Food and Rural Affairs (2018), A Green Future: Our 25 Year Plan to Improve the Environment [online] available at: https://www.gov.uk/government/publications/25-year-environment-plan (last accessed March 2022).

number of growing problems including waste. It aims to champion sustainable development, lead in environmental science, innovate to achieve clean growth and increase resource efficiency to provide benefits to both our environment and economy. In doing so, the Government's 25 Year Environment Plan has identified six key areas on which to focus action. The policy area relevant to the assessment of waste and material resource is set out in Chapter 4 of the 25-Year Plan on increasing resource efficiency and reducing pollution and waste.

A number of goals and targets are set out in the 25-Year Plan. These include the aim of minimising waste, reusing materials as much as possible, and managing materials at the end of their life to minimise the impact on the environment. This is intended to be done by:

- Working towards the ambition of zero avoidable waste by 2050
- Working to a target of eliminating avoidable plastic waste by the end of 2042
- Meeting all existing waste targets – including those on landfill, reuse and recycling – and developing ambitious new future targets and milestones
- Seeking to eliminate waste crime and illegal waste sites over the lifetime of the plan, prioritising those of highest risk. Delivering a substantial reduction in litter and littering behaviour
- Substantially reducing and, where possible, preventing all kinds of marine plastic pollution – in particular material that came originally from land

8.1.3.4 Our Waste, Our Resources: A Strategy for England, 2018[126]

The strategy complements and helps deliver the 25-Year Plan, the Clean Growth Strategy, the Industrial Strategy, and the Litter Strategy. It is guided by two overarching objectives:

- To maximise the value of resource use
- To minimise waste and its impact on the environment

The strategy features the government's approach to sustainable production, consumer participation, recovering resources, and managing waste, waste crime, food waste, international leadership, research and innovation, and monitoring and evaluation of the strategy.

The strategy will be delivered through policies, actions and commitments, and it will contribute to the delivery of the following strategic ambitions:

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[126] His Majesty's Government (2018), Our waste, our resources: A strategy for England. [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765914/resources-waste-strategy-dec-2018.pdf (last accessed March 2022).

- Working towards all plastic packaging placed on the market being recyclable, reusable or compostable by 2025
- Eliminating food waste to landfill by 2030
- Zero avoidable plastic waste by 2042
- Doubling of resource productivity by 2050
- Zero avoidable waste by 2050

8.1.3.5 The Waste Management Plan for England, 2021[127]

The Department for Environment, Food & Rural Affairs (Defra) published the latest Waste Management Plan for England in January 2021, superseding the 2013 version[128]. The plan provides an overview of waste management in England. It outlines the waste hierarchy as a guide to sustainable waste management and sets out the government's ambition to work towards a more sustainable and efficient approach to resource use and management. Positive planning plays a pivotal role in delivering England's waste ambitions through ensuring the reuse, recovery or disposal of waste is undertaken without endangering human health or harming the environment and delivering sustainable development and resource efficiency through all schemes.

8.1.3.6 The Waste Prevention Programme for England, 2013[129]

The Waste Prevention Programme for England 2013 sets out the roles and actions for government and others to reduce the amount of waste produced in England. It was updated in July 2020 by the Waste and Resources Action Programme (WRAP) on behalf of Defra. The review[130] of the Waste Prevention Programme for England 2013 evaluates the actions taken in the six years since the Waste Prevention Programme was published. It also outlines progress on the ongoing programme of work as part of the Resources and Waste Strategy for England,

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[127] Department for Environment Food & Rural Affairs (2021), Waste Management Plan for England. [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955897/waste-management-plan-for-england-2021.pdf (last accessed March 2022).
[128] Department for Environment Food & Rural Affairs (2013), Waste Management Plan for England. [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/265810/pb14100-waste-management-plan-20131213.pdf (last accessed March 2022).
[129] Department for Environment Food & Rural Affairs (2013), Waste prevention programme for England [online] available at: https://www.gov.uk/government/publications/waste-prevention-programme-for-england (last accessed March 2022).
[130] Waste and Resources Action Programme (2020), Review of the Waste Prevention Programme for England 2013: Summary Report [online] available at: https://wrap.org.uk/sites/default/files/2021-03/WRAP-review-waste-prevention-programme-england-summary-report.pdf (last accessed March 2022).

2018. This strategy will be supplemented by a new waste prevention programme, to help move to a more circular economy model.

8.1.3.7 Waste Prevention Programme for England – Consultation Version, 2021[131]

The revised Waste Prevention Programme will help embed the five principles outlines in the Resources and Waste Strategy by setting out steps towards:

- Transforming product design and supporting factors such as spare part provision
- Making it easier for consumers to make sustainable purchasing decisions
- Using extended producer responsibility and other financial incentives to ensure the polluter pays principle is embedded
- Aligning the regulatory framework with a circular economy approach
- Integrating the strategic principles into industrial policy and giving first movers the recognition they deserve

8.1.4 Local Policy

The local planning framework comprises a number of documents that form the statutory development plans for the local planning authority area in which the scheme is located.

8.1.4.1 West Sussex Joint Minerals Local Plan, 2018[132]

West Sussex County Council and the South Downs National Park Authority (SDNPA) developed the Joint Minerals Local Plan, which was adopted in July 2018. The plan covers the period to 2033 and sets out the vision and strategic objectives associated with minerals supply developments in West Sussex. It includes strategies for minerals planning and use-specific policies to deliver those strategies, together with generic development management policies against which proposals for minerals development will be assessed. The plan also provides the basis for making consistent land-use planning decisions on minerals development proposals, as well as taking into account other policies and programmes that influence the development and use of land.

The strategic objectives are defined as those matters which need to be achieved over the plan period if the vision is to be realised. Implementation of the policies of this plan will contribute to the achievement of these objectives.

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[131] Department for Environment, Food & Rural Affairs (2021) Waste Prevention Programme for England – Consultation Version. [online] available at: Waste Prevention Programme for England consultation document.pdf (defra.gov.uk) (last accessed January 2022).
[132] West Sussex County Council and the South Downs National Park Authority (published in 2018 and partial review in 2021) West Sussex Joint Minerals Local Plan [online] available at: https://www.westsussex.gov.uk/media/11736/mlp_adoption.pdf (last accessed February 2022).

The Joint Minerals Local Plan includes the following relevant strategic objectives and policies:

- Strategic Objective 2 highlights the need to maximise and prioritise the supply and use of secondary and recycled aggregates before supply and use of primary sources; in particular to reduce reliance on land-won aggregates.
- Strategic Objective 3 addresses the importance of making provision for soft sand, silica sand and sharp sand and gravel, to meet the identified need, from outside the South Downs National Park, where possible.
- Strategic Objective 5 emphasizes the need to safeguard potential economically viable mineral resources from sterilisation.
- Strategic Objective 10 refers to the need to maximise the use of rail and water transport for the movement of minerals and to minimise lorry movements and the use of local roads for minerals.
- Policy M9 ('Safeguarding Minerals') and Policy M10 ('Safeguarding Minerals Infrastructure') address the safeguarding of existing minerals extraction sites and sites hosting minerals infrastructure respectively.
- Policy M26 ('Maximising the use of Secondary and Recycled Aggregates') states that proposals for development will be permitted provided that opportunities for the use of secondary and recycled aggregates, and building products made from secondary and recycled aggregates are maximised.

8.1.4.2 West Sussex Waste Local Plan, 2014[133]

The Waste Local Plan was adopted in 2014 and prepared by the joint authorities of West Sussex Council and the SDNPA. The plan sets out the vision and strategic objectives for waste development in West Sussex until 2031. It outlines the waste planning strategies and use-specific policies to deliver these strategies, together with generic development management policies against which proposals for waste development will be assessed. It also allocates strategic waste sites for new commercial facilities and includes a monitoring and implementation framework.

The Waste Local Plan includes the following relevant strategic objectives and policies:

- Strategic Objective 2 supports the need to enable the progressive movement of non-municipal waste up the waste hierarchy away from landfill.
- Strategic Objective 4 underlines the importance of protecting the network of waste management sites and infrastructure.

[133] West Sussex County Council and the South Downs National Park Authority (2014) West Sussex Waste Local Plan [online] available at: https://www.westsussex.gov.uk/media/3241/waste_local_plan_april2014.pdf (last accessed February 2022).

- Strategic Objective 6 states the aspiration to only make provision for a declining amount of landfill over the plan period with 'zero waste to landfill' by 2031.
- Strategic Objective 7 emphasises the need to maximise the use of rail and water transport for the movement of waste and to minimise lorry movements and the use of local roads for the movement of waste.
- Strategic Objective 11 outlines the intention to conserve and safeguard the County's important mineral resources.
- Policy W2 ('Safeguarding Waste Management Sites and Infrastructure') outlines criteria used to safeguard existing waste management sites and infrastructure at non-waste sites that are essential for the sustainable transportation of waste materials.
- Policy W8 ('Recovery Operations involving the Depositing of Inert Waste to Land') outlines the criteria that need to be met for proposals for recovery operations involving the depositing of inert waste to land (including for the continuation in duration, or the physical extension of, existing operations) to be permitted.
- Policy W23 ('Waste Management within Development') states that proposals for development will be permitted provided that:
  - the waste generated during construction, demolition and excavation is minimised and that opportunities for re-using and recycling of waste are maximised.
  - waste management facilities of an appropriate type and scale are an integral part of the development.

8.1.4.3 Minerals and Waste Development Scheme[134]

The Minerals and Waste Development Scheme sets out the minerals and waste planning policy documents that West Sussex County Council proposes to prepare, and the existing plans it intends to save over the period 2021-2024.

The scheme sets out how the Council will prepare these policy documents, the programme for their preparation and when the various stages will be carried out. It provides the starting point for communities and stakeholders to get involved and find out about current planning policies.

[134] West Sussex County Council (2021), West Sussex Minerals and Waste Development Scheme 2021-2024 [online] available at: https://www.westsussex.gov.uk/media/9029/mwds.pdf (last accessed February 2022).

8.1.4.4 Monitoring Report 2019/20[135]

The West Sussex County Council and SDNPA Monitoring Report 2019/20 outlines the Council's waste management capacity by facility type in the period 1 April 2019 to 31 March 2020, and provides a list of aggregate and mineral facilities within the sub-region. The report contains figures relating to the supply and sale of aggregate, landbank requirements, and information on relevant aggregate planning permissions within the sub-region.

8.1.4.5 Local Aggregate Assessment 2019[136]

The West Sussex and SDNPA Local Aggregate Assessment 2019 assesses the demand for and supply of aggregates. It includes a list of operating mineral extraction sites, and figures on aggregate production, sales, and import in and export out from the respective catchment areas.

The NPPF requires Mineral Planning Authorities (MPAs) to prepare an annual Local Aggregate Assessment. However, due to the impact of the Covid-19 pandemic, it was not possible to prepare a full update to the Local Aggregate Assessment. Instead, the South East England Aggregates Working Party (SEEAWP) agreed that each MPA submit a Local Aggregate Assessment dashboard making use of any data available, coupled with the application of estimates where there were data gaps. The West Sussex Local Aggregate Assessment Dashboard 2020[137] provides the most up-to-date picture of aggregate supply in West Sussex. The next iteration of the Local Aggregate Assessment (2021) will be a full report as previous years, that will take account of the finalised National Aggregates Survey data for 2019, as well as data collated for 2020.

8.1.4.6 Minerals and Waste Safeguarding Guidance (2020)[138]

This document provides guidance on how the safeguarding of minerals resources and infrastructure associated with minerals supply (for example wharves, railheads, processing plants) and waste management will take place in West Sussex. It explains how the safeguarding policies in the West Sussex Joint

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[135] West Sussex County Council and the South Downs National Park Authority (2021) West Sussex Joint Minerals Local Plan and Waste Local Plan: Monitoring Report 2019/20 [online] available at: https://www.westsussex.gov.uk/media/15975/monitoring_report_2019to2020.pdf (last accessed February 2022).

[136] West Sussex County Council (2020), Assessment of Need for Aggregates: Local Aggregate Assessment 2019 [online] available at: https://www.westsussex.gov.uk/media/14377/laa_may2020.pdf (last accessed February 2022).

[137] West Sussex County Council (2021), Assessment of Need for Aggregates: Local Aggregate Assessment Dashboard 2020 [online] available at: https://www.westsussex.gov.uk/media/15638/laa_dashboard_2020.pdf (last accessed February 2022).

[138] West Sussex County Council and the South Downs National Park Authority (2020) West Sussex Joint Minerals Local Plan and Waste Local Plan: Minerals and Waste Safeguarding Guidance. [online] available at: https://www.westsussex.gov.uk/media/13437/mw_safeguarding_guidance.pdf (last accessed February 2022).

Minerals Local Plan 2018 and the West Sussex Waste Local Plan 2014 will be implemented in practice.

8.1.5 Other Standards, Policy and Guidance

8.1.5.1 Design Manual for Roads and Bridges (DMRB) LA 110 'Sustainability and Environment Appraisal – Material Assets and Waste'[139]

This document sets out the requirements for assessing and reporting the effects on material assets and waste from the delivery of motorway and all-purpose trunk road projects.

8.1.5.2 Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009)[140]

This code of practice provides relevant advice on the use of soil in construction projects.

8.1.5.3 Contaminated Land Applications in Real Environments (CL:AIRE)

CL:AIRE is an independent, non-profit organisation that aims to encourage the sustainable remediation of contaminated land and groundwater throughout the UK, for effective social and economic use. This is achieved by increasing awareness and confidence in practical, sustainable remedial solutions.

8.2 Assessment methodology

8.2.1 Assessment approach

No surveys were carried out for this assessment. For the purposes of the assessment, material assets and waste discusses:

- The provision and use of material resources, including primary, secondary, recycled and manufactured materials
- The generation and management of waste

The scope of the materials and waste assessment was presented in Chapter 11 Material Assets and Waste of the Environmental Scoping Report (HE608509-MMD-EGN-OP00-RP-LE-0003). For the assessment of material resource use, an assessment against the UK national demand has been undertaken. The

[139] National Highways (2019), DMRB LA 110 – Material assets and waste [online] available at: https://standardsforhighways.co.uk/dmrb/search/6a19a7d4-2596-490d-b17b-4c9e570339e9 (last accessed February 2022).
[140] Department for Environment, Food and Rural Affairs (2009), Construction Code of Practice for the Sustainable Use of Soils on Construction Sites [online] available at: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites (last accessed March 2022).

assessment for waste was based on the availability of suitable waste management infrastructure and capacity in West Sussex and the South East England region.

Specific information for this assessment has been obtained from the design team, where available.

The assessment has considered the following:

- Types of materials required for the scheme, where known
- Details of the source or origin of materials, site-won materials to replace virgin materials, materials from secondary or recycled sources, or virgin or non-renewable sources, if known
- Cut and fill balance (no import of fill material is currently envisaged)
- Surplus materials and waste falling under regulatory controls
- Waste that requires storage on site prior to reuse, recycling and disposal
- Waste to be pre-treated on site for re-use within the scheme
- Waste requiring treatment or disposal off-site
- The impacts that would arise from the issues identified in relation to materials and waste
- Identification of mitigation measures based on identified impacts
- Conclusion based on nature and magnitude of impacts

The assessment of effects on material resources and waste generation encompasses effects arising during excavation and demolition activities and the construction of the scheme up until the point when it becomes operational.

The effect on material resources and waste infrastructure for the operation of the scheme in relation to maintenance for the lifetime of the scheme has been scoped out of further assessment.

DMRB LA 110[139] has been used to identify significance criteria and to support professional judgement. DMRB LA 110 is primarily intended for motorway and all-purpose trunk road projects.

8.2.2 Significance criteria

The effect categories and typical descriptors for material assets and waste are provided in Table 8.1 and the level of significance (stated as Significant or Not Significant) are provided in Table 8.2. For both of these tables “Region” comprises West Sussex and South East England. “Primary materials” describes materials that are from a non-renewable source. Professional judgement will be applied in determining significance. Professional judgement will also be used, where appropriate, to provide an assessment of effects based on several factors, including:

- The availability of the material resources
- The type of materials required, for example primary / virgin materials, manufactured materials, recycled materials
- The type of waste generated, for example inert, non-hazardous, hazardous
- The availability of suitable facilities within close proximity to the scheme elements to treat the waste generated
- Compatibility of the Best Practicable Environmental Option for the waste within the context of the waste hierarchy, i.e. whether generation of the waste can be minimised, the waste can be recycled, landfilled, etc.

Significant environmental effects are more likely to arise from those materials or waste which:

- Are associated with the largest quantities
- Are primary / virgin materials
- Have hazardous properties

Table 8-1: Effect categories and typical descriptors for material assets and waste generation

Effect	Description
Neutral	Material assets: • Project achieves >99% overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition (C&D) waste to substitute use of primary materials. • Aggregates required to be imported to site comprise >99% reused / recycled content. Waste generation: • No reduction or alteration in the capacity of waste infrastructure within the region.
Slight	Material assets: • Project achieves 70-99% overall material recovery / recycling (by weight) of non-hazardous C&D waste to substitute use of primary materials. • Aggregates required to be imported to site comprise reused/recycled content in line with the relevant regional percentage target. Waste generation: • ≤1% reduction or alteration in the regional capacity of landfill; and • Waste infrastructure has sufficient capacity to accommodate waste from a project, without compromising integrity of the receiving infrastructure (design life or capacity) within the region.
Moderate	Material assets: • Project achieves less than 70% overall material recovery / recycling (by weight) of non-hazardous C&D waste to substitute use of primary materials.

Effect	Description
	• Aggregates required to be imported to site comprise reused / recycled content below the relevant regional percentage target. Waste generation: • >1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from a project. • 1-50% of project waste requires disposal outside of the region.
Large	Material assets: • Project achieves <70% overall material recovery / recycling (by weight) of non-hazardous C&D waste to substitute use of primary materials. • Aggregates required to be imported to site comprise <1% reused / recycled content. • Project sterilises ≥1 mineral safeguarding site and/or peat resource. Waste generation: • >1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from a project. • >50% of project waste for disposal outside of the region.
Very Large	Material assets: • No criteria: use criteria for Large category above; Waste generation: • >1% reduction or alteration in the national capacity of landfill as a result of accommodating waste from a project. • Construction of new (permanent) waste infrastructure is required to accommodate waste from the project.

Source: National Highways (2019), DMRB LA 110, Table 3.13[139]

Table 8-2: Significance criteria for material assets and waste generation

Significance	Description
Not Significant	Material assets: Category description met for Neutral or Slight effect Waste generation Category met for Neutral or Slight effect
Significant (one or more criteria met)	Material assets: Category description met for Moderate or Large effect Waste generation: Category met for Moderate, Large or Very Large effect

Source: National Highways (2019), DMRB LA 110, Table 3.14[139]

8.3 Assessment assumptions and limitations

This assessment does not consider the environmental effects associated with the off-site extraction of raw materials used for the off-site manufacture of products. These stages of the products or materials lifecycles are outside of the scope of the assessment due to the range of unknown variables associated with the processes involved and are not considered to form part of the scheme.

The use of material resources and the generation of waste would also have the potential to generate adverse environmental effects through the transportation of materials (for use on-site) and waste (to appropriate waste facilities off-site), such as detrimental impacts to air quality and increase in local noise levels. The effects of these activities are more appropriately covered in Chapter 5 Air quality and Chapter 9 Noise and vibration.

The procurement strategy for the materials required for the construction of the scheme is unknown at this stage. For the purposes of the assessment, it will be assumed that not all materials would be available to be sourced regionally (within South East England), and that the majority would be sourced nationally (within the UK). This will represent the (environmentally) worst case scenario. It is also assumed that all aggregate material sourced either regionally or nationally will meet the regional target for the recycled and secondary aggregate where technically appropriate and economically feasible.

It is assumed that the scheme will aim to minimise the generation of waste and that, in the worst-case scenario, all waste identified for disposal will be sent to landfill. It is assumed that all acceptable excavated topsoil will be reused in landscaping activities either within the scheme or in neighbouring schemes.

Information on permitted capacity of waste management facilities has been based on current publicly available data at the time of writing. However, it should be noted that the capacity information obtained from the Environment Agency for the sites and regions identified does not necessarily mean that the capacity detailed would be available for use by the scheme.

It is noted that any future changes to the permitted capacity and throughput are uncertain. It is also difficult to assess the available capacity due to the commercial sensitivity of existing contracts and the timescales over which waste would be produced. It is likely that additional capacity would become available. However, it is not currently possible to predict the timeframes for when these new waste management facilities would become available and, therefore, how many of these sites would be available to accommodate waste arisings from the scheme. Similarly, it is also possible that some of the existing waste management facilities might close or be unavailable.

8.4 Study area

Design Manual for Roads and Bridges (DMRB) LA 110 Material assets and waste Revision 0, section 3.5 provides definitions for two geographically different study areas to examine and assess the use of material assets (and resource use) and waste generation. For all three scheme options, the study areas considered appropriate are set out below.

The first study area is based on the area of the completed works within the individual boundary of the three scheme options, as this constitutes the area within

which construction materials would be consumed (used, reused and recycled) and waste would be generated.

The second study area focuses on an area sufficient to identify the suitable waste infrastructure that could accept arisings or waste generated by the scheme options, and feasible sources and availability of construction materials typically required for the works. This is as follows:

8.4.1 Construction materials

The study area for the sources and availability of construction materials would be the county of West Sussex and, where necessary, the South East England region.

8.4.2 Waste generation

8.4.2.1 Management of generated waste

The study area to sufficiently identify suitable waste infrastructure including landfills, considering the proximity principle and value for money, has been assessed based on an initial search area of 10km from the scheme. Where sufficient capacity is not available the search area has been extended accordingly, based on professional judgment, but kept within the boundaries of the South East England region. Since no permitted landfills with remaining capacity have been identified within 10km of the scheme, the range of the search area has been extended to 50km.

8.5 Baseline conditions

8.5.1 Use of material resources

Information on the demand for key construction materials within the UK and within West Sussex has been used to provide the baseline for material resources. This information has been determined through a desk-study using a number of readily available resources, in particular from the British Geological Society (BGS), World Steel Association, and West Sussex County Council.

Table 8.3 outlines the demand in Great Britain, in terms of sales, of minerals and mineral products in 2019 and table 8.4 outlines the production of minerals within England in 2020 and available mineral workings.

Table 8-3: Great Britain demand of materials and minerals / mineral products

Mineral / mineral product	Great Britain Demand (2019, unless otherwise stated)
Primary Aggregates, of which:	175.8 million tonnes
• Crushed rock	116.6 million tonnes
• Sand and gravel	59.2 million tonnes
Recycled and secondary aggregates (2018)	71 million tonnes

Mineral / mineral product	Great Britain Demand (2019, unless otherwise stated)
Cementitious products (UK), of which	15.2 million tonnes
• Cement	11.6 million tonnes
• Fly ash and granulated blast furnace slag	3.6 million tonnes
Ready-mixed concrete	16.4 million cubic metres
Concrete products (2018)	32 million tonnes
Asphalt	22.7 million tonnes
Dimension stone (2014)	1 million tonnes
China Clay (UK, 2018)	0.996 million tonnes
Slag (UK, 2018)	2.5 million tonnes
Apparent steel use (UK)	11.2 million tonnes

Source: British Geological Society (2021)[141] Mineral Products Association (2020)[142] and World Steel Association (2020)[143]

Table 8-4: England production of minerals in 2020

Mineral	UK Production in Tonnes	Number of Mineral Workings in England	Number of Mineral Workings in South East England
Igneous rock	129.3 million*	36	0
Limestone and dolomite		233	11
Sandstone		157	5
Sand and gravel	66.8 million	369	85

Source: British Geological Society (2021)[141]

Note: *Includes marine-dredged landings at foreign ports

The West Sussex Local Aggregate Assessment 2019[144] and South East England Aggregate Working Party Annual Monitoring Report 2019[145] assess the demand for

[141] British Geological Society (2021), United Kingdom Minerals Yearbook 2020 [online] available at: https://www2.bgs.ac.uk/mineralsuk/download/ukmy/UKMY2020.pdf (last accessed February 2022)
[142] Mineral Products Association (2020), Profile of the UK Mineral - Products Industry [online] available at: https://mineralproducts.org/MPA/media/root/Publications/2021/Profile_of_the_UK_Mineral_Products_Industry_2020_Spread.pdf (last accessed February 2022)
[143] World Steel Association (2020), Steel Statistical Yearbook 2020 [online] available at: https://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook.html (last accessed February 2022)
[144] West Sussex County Council (2020), Assessment of Need for Aggregates: Local Aggregate Assessment 2019 [online] available at: https://www.westsussex.gov.uk/media/14377/laa_may2020.pdf (last accessed February 2022)
[145] South East England Aggregates Working Party (2021), Annual Report 2019 [online] available at: https://documents.hants.gov.uk/see-awp/SEEAWP-aggregates-monitoring-report-2019.pdf (last accessed February 2022)

and supply of aggregates in the study area of the scheme options. The West Sussex Local Aggregate Assessment Dashboard 2020[146] provides the most up-to-date picture of aggregate supply in West Sussex. The South East England Aggregate Working Party Annual Monitoring Report provides data for each of the sub-regions in South East England:

- Berkshire
- Buckinghamshire
- East Sussex
- Hampshire
- Isle of Wight
- Kent
- Oxfordshire
- Surrey
- West Sussex

The West Sussex sub-region comprises West Sussex County Council.

Table 8-5 outlines the aggregate sales and reserves in West Sussex and the South East England region respectively for 2019, which is the latest available information. Raw aggregates extracted across West Sussex include sand, gravel and crushed rock.

There are sufficient reserves of sharp sand and gravel to meet forecasted demand for this aggregate type and therefore no requirement for additional facilities (for example quarries, wharves, or railheads) are planned for through the Joint Minerals Local Plan.

The required landbank in West Sussex at the end of 2019 stood at nine years or 7.4 years depending on the Local Aggregate Assessment (LAA) rate applied, and 6.6 years for crushed rock. For crushed rock, the required landbank remains below the threshold of 10 years identified in the NPPF[147].

[146] West Sussex County Council (2021), Assessment of Need for Aggregates: Local Aggregate Assessment Dashboard 2020 [online] available at: https://www.westsussex.gov.uk/media/15638/laa_dashboard_2020.pdf (last accessed February 2022)

[147] Ministry of Housing, Communities & Local Government (2019), National Policy Planning Framework [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf (last accessed February 2022)

Table 8-5: The 10 year and 3 year total land won primary aggregate sales average (to 2019) for West Sussex

Aggregate	10 year average aggregate sales (Mtpa*)	3 year average aggregate sales (Mtpa)	Annual sales, 2019 (Mt)	Existing permitted reserves at end of 2019 (Mt)	Landbank at end of 2019 (years)**
Sand and gravel	0.053	0.099	0.100	Confidential	9/7.4
Soft sand	0.287	0.297	0.303	2.457	6.6
Recycled / Secondary aggregates	0.444	0.421	0.391	-	-
Marine sand and gravel	1.152	1.280	1.214	-	-
Rock imports by sea	0.103	0.126	0.123	-	-
Rail depot sales (sand and gravel)	0.105	0.105	0.103	-	-
Rail depot sales (crushed rock)	0.641	0.620	0.618	-	-

Source: West Sussex County Council (2020)[144]

Note: *Million tonnes per annum.

** The sand and gravel landbanks of 9 years and 7.4 years are based on the 10-year average derived LAA rate of 0.080Mtpa (high growth scenario) and the 3-year average derived LAA rate of 0.099Mtpa respectively.

Table 8-6: The 10 year and 3 year total land won primary aggregate sales average (to 2019) for South East England

Aggregate	10 year average aggregate sales (Mtpa)	3 year average aggregate sales (Mtpa)	Annual sales, 2019 (Mt)	Existing permitted reserves at end of 2019 (Mt)	Landbank at end of 2019 (years)*
Sharp sand and gravel	4.25	4.42	4.26	45	10
Soft sand	1.68	1.85	1.98	21.56	12
Crushed rock	1.40	1.64	1.82	33.67	21

Source: South East England Aggregates Working Party (2021)[145]

Note: * Landbanks are derived from the current LAA Dashboards/LAAs calculated by dividing the south-east combined reserves (tonnage with planning permission) by the combined LAA Rates (thousand tonnes per annum).

A list of both active and inactive aggregate sites in West Sussex in 2019 is provided in Table 8-7: The aggregate sites available in West Sussex in 2019.

There were nine sand and gravel sites with planning permission within West Sussex in 2019, of which six were active sites. There were 18 sites with recycled and secondary aggregate production capacity in West Sussex in 2019, 14 of which were active.

Table 8-7: The aggregate sites available in West Sussex in 2019

Site name	Facility type	Operator name	Status
Chantry Lane Quarry, Sullington	Sharp sand and gravel quarry	Dudman Group Ltd	Inactive
Kingsham	Sharp sand and gravel quarry	Dudman Group Ltd	Active
Hampers Lane Sandpit, Sullington	Soft sand quarry	Britannia Crest Recycling Ltd.	Active
Rock Common Sandpit, Washington	Soft sand quarry	Dudman Group Ltd.	Active
Sandgate Park Quarry, Sullington	Soft sand quarry	CEMEX UK Ltd	Active
West Heath Quarry, West Harting	Soft sand quarry	CEMEX/RMC Agg. (Southern) Ltd	Active
Minstead Sandpit, Minstead	Soft sand quarry	Dudman Aggregates Ltd	Inactive
Heath End Quarry, Duncton	Soft sand quarry	Dudman Group of Companies	Active
Coates and pit, Coates, nr Fittleworth	Soft sand quarry	Birlington estate	Inactive
Halls Aggregate Wharf, Shoreham	Wharf	CEMEX UK Ltd.	Active
Turberville and Penneys Wharf, Southwick	Wharf	Dudman Group Ltd	Active
New Wharf, Shoreham	Wharf	Kendall Bros (Portsmouth) Ltd	Active
Solent /ARC Wharf, Portslade	Wharf	Tarmac and Hanson	Active
LDF Wharf, Shoreham	Wharf	Shoreham Port Authority	Inactive
Railway Wharf, Littlehampton	Wharf	Tarmac Ltd	Active

Site name	Facility type	Operator name	Status
Kingston Wharf, Shoreham	Wharf	Day Aggregates Ltd.	Inactive
Rombus Wharf	Wharf	N/A	Inactive
Tinsley Goods Yard, Crawley	Rail Depot	CEMEX UK ltd.	Inactive
Railway sidings, Chichester	Rail Depot	Dudman Group Ltd	Active
Crawley Rail Depot	Rail Depot	Day Aggregates	Active
Crawley Goods Yard, Crawley	Rail Depot	Aggregates Industries	Active
Ardingly Rail Depot, Ardingly	Rail Depot	Hanson Aggregates	Active
Bognor Road Distribution Centre	Recycled / Secondary aggregates	N/A	Inactive
Burleigh Oaks Farm, Turners Hill	Recycled / Secondary aggregates	Cox Skips	Active
Crawley Goods Yard, Crawley	Recycled / Secondary aggregates	Day Aggregates Ltd.	Active
Eastlands Farm	Recycled / Secondary aggregates	Mr D Nichols	Active
Elbridge, Chichester Road, Bersted	Recycled / Secondary aggregates	GR Ayling	Active
EWS Good Yard, Crawley	Recycled / Secondary aggregates	Aggregate Industries	Active
(Former) Hurstpierpoint WWTW	Recycled / Secondary aggregates	Edburton Contractors	Active
Ford Waste Management Facility, Ford	Recycled / Secondary aggregates	South Coast Skips	Active
Former Brickworks, Langhurstwood	Recycled / Secondary aggregates	Britaniacrest Recycling Ltd.	Inactive
Grinders Lane	Recycled / Secondary aggregates	Penfold Verrall	Inactive
Sussex Waste Recycling (Rabbit Skips)	Recycled / Secondary aggregates	Rabbit Skips	Active
Rowley Farm, Lowfield Heath, Crawley	Recycled / Secondary aggregates	Cook and Son LTd.	Active
Wyevale Garden Centre, Copthorne Road	Recycled / Secondary aggregates	TJS Services/AMV haulage	Active

Site name	Facility type	Operator name	Status
Shoreham Cement Works, Upper Beeding	Recycled / Secondary aggregates	Dudman Group Ltd	Active
Herberdens Farm, Finchdean	Recycled / Secondary aggregates	A Fisk	Active
Newtimber Chalk Works, Pyecombe	Recycled / Secondary aggregates	Robins of Herstmonceux	Active
Slindon Bottom Gravel Pit	Recycled / Secondary aggregates	Taylor Plant & Haulage Ltd	Inactive
Hobbs Barn, Climping	Recycled / Secondary aggregates	Arun Waste Services	Active

Source: South East England Aggregate Working Party (2021)[145]

West Sussex depends heavily on imports to its wharves and railheads for crushed rock and marine sand and gravel. Indeed, imports of marine-won sand and gravel to the county appear to have compensated for reduced land-won sharp sand and gravel extraction. Historically, demand for soft sand in West Sussex has largely been met from land-won sources though data suggests that marine-won sand could possibly provide a source of supply in future. The wharves and railheads in West Sussex have sufficient capacity to meet future demands for the importation of crushed rock and sand and gravel.

In addition to its resources of land won aggregates, secondary and recycled aggregates are also sourced within West Sussex. Secondary aggregates are by-products from industrial and mining operations and recycled aggregates are produced primarily from recycled construction waste such as crushed concrete, or planings from road surfacing.

In West Sussex, the by-products from chalk and sandstone have been used as secondary aggregates. Other sources of secondary aggregate extraction include bottom ash from thermal treatment facilities.

The 10-year average production of recycled aggregate in West Sussex is 444,414 tonnes. A total of 529,500tpa of capacity for recycled aggregates production was likely to be available within the county in 2018, which indicates that capacity within the county is underutilised. West Sussex County Council identifies the additional secondary aggregates production capacity in the county to be between 11,000tpa and 56,000tpa.

DMRB LA 110 identifies recycled aggregate contents targets of 26% for South East England, based on the UK Government's National and Regional guidelines for aggregates 2005-2020[148].

8.5.2 Generation and management of waste

The most recent information available relating to current waste generation and operational waste management infrastructure in West Sussex and the South East England region has been gathered to provide the baseline for this assessment. Information on the current waste arisings, and the waste management infrastructure have been determined through a desk-top study, using a number of readily available resources, in particular data from the Environment Agency, Defra and West Sussex County Council.

8.5.2.1 Waste generation in South East England region and England

The latest data from the Environment Agency indicates that England produced over 220 million tonnes of waste in 2020, which was managed by 6,026 permitted waste facilities. The permitted waste facilities in the South East England region received over 33.8 million tonnes of waste in 2020, and those in West Sussex received approximately 2.46 million tonnes (as shown in Table 8-8).

Table 8-8: Waste breakdown by site type in tonnes (2020)

Site Type	West Sussex	South East England	England
Landfill	382,184	8,036,284	40,034,198
Transfer	599,877	6,144,153	42,439,790
Treatment (excluding metal recycling)	1,189,676	11,610,905	86,817,098
Metal Recovery	88,701	879,485	14,318,173
Incineration	64,056	3,374,779	16,271,706
Use of Waste	0	651	147,921
Land Disposal	135,211	1,830,039	9,859,302
Total	**2,459,779**	**33,856,059**	**220,440,796**

Source: Environment Agency (2021)[149]

[148] Ministry of Housing, Communities & Local Government, UK (2009), National and regional guidelines for aggregates provision in England 2005-2020. ISBN 978-1-4098-1589-1. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7763/aggregatesprovision2020.pdf.

[149] Environment Agency (2022), Waste Data Interrogator 2020 – Wastes received – Version 4 [online] available at: https://environment.data.gov.uk/portalstg/home/item.html?id=f4adcd438cb144f8ad2b24529bbec78f (last accessed February 2022).

Note: Mobile plant, processing, combustion and storage of waste are included in the total waste tonnages

8.5.2.2 Construction and demolition waste

The Environment Agency's Waste Data Interrogator (WDI) recorded that 14,685,422 tonnes of inert construction and demolition (C&D) waste were received in permitted waste facilities in the South East England region in 2020, with 996,311 tonnes received in West Sussex[149]. The WDI states that 1,850,358 tonnes of inert C&D waste were removed from permitted waste facilities in the South East England region with 177,146 tonnes removed from West Sussex[150]. Of the 76.6 million tonnes of non-hazardous C&D waste received in permitted waste facilities in England in 2020, 14.7 million tonnes were removed.

Excavation and site clearance activities generate a significant quantity of waste arisings. The baseline target for recovery of C&D waste is 70% by weight, as set out in the EU Waste Framework Directive 2008/98/EC and the Waste Plan for England. Uncontaminated excavated soil and stones (List of Waste Code 17 05 04) are specifically excluded from this target. According to Defra[151], the recovery rate of non-hazardous C&D waste in 2018 was 92.3% and 93.8% in the UK and England respectively.

8.5.2.3 Hazardous waste

Table 8-6 summarises the quantities received and removed from permitted waste facilities in 2020 in England, the South East England region and West Sussex. According to the WDI[149], 22,431 tonnes of hazardous waste were received in permitted waste facilities in West Sussex, of which only 146 tonnes were specified as C&D waste (0.65% of all hazardous waste received). 36,869 tonnes of hazardous waste were removed from West Sussex, of which 146 tonnes were removed as C&D waste (0.4% of all hazardous waste removed).

Table 8-9: Hazardous waste received and removed in 2020 (tonnes)

Site Type	West Sussex	South East England	England
Received	22,431	602,988	6,992,926
Removed	36,869	433,891	5,873,434

Source: Environment Agency (2022)[149], [150]

[150] Environment Agency (2022), Waste Data Interrogator 2020 – Wastes removed – Version 4 [online] available at: https://environment.data.gov.uk/portalstg/home/item.html?id=1f2e26cd5897440495e184f46fe69cd5 (last accessed February 2022).
[151] Defra (2021), UK Statistics on Waste [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002246/UK_stats_on_waste_statistical_notice_July2021_accessible_FINAL.pdf (last accessed February 2022).

8.5.2.4 Potentially hazardous waste arisings

To identify potential sources of contamination, an initial review of authorised and historic landfill sites that are in close proximity to the scheme options was undertaken using the Environment Agency's 'Historic Landfill Sites' web map[152] and 'Permitted Waste Sites - Authorised Landfill Site Boundaries' web map[153] .

There is one historic landfill site within 500m of the scheme options. This historic landfill site, Hill barn Recreation Ground, is located approximately 495m north-east of the Grove Lodge Roundabout. There are no further historic landfills nor authorised landfill sites located within 500m of the scheme options.

Potential sources of contamination that are greater than 500m away from the scheme options have not been considered, as these are considered unlikely to affect any of the scheme options.

8.5.2.5 Waste management facilities

The Environment Agency reported that in 2020, 1,214 sites in the South East England region had environmental permits to accept waste. There were 69 active sites receiving waste in West Sussex in 2020.

Table 8-10 outlines the remaining landfill capacity within West Sussex, South East England, and England at the end of 2020. There are currently seven permitted landfills in West Sussex with only four landfills having remaining capacity at the end of 2020. West Sussex has four inert landfills, two non-hazardous landfills and one non-hazardous landfill with a Stable Non-Reactive Hazardous Wastes (SNRHW) cell. West Sussex does not have any landfills with remaining capacity that can accept hazardous waste.

Table 8-10: Remaining landfill capacity in cubic metres at the end of 2020

Landfill Type	West Sussex	South East England	England
Hazardous Merchant	-	146,325	15,571,171
Hazardous Restricted	-	117,042	809,640
Non-Hazardous with SNRHW* cell	-	22,196,097	66,969,897
Non-Hazardous	295,333	13,556,685	164,824,065
Non-Hazardous Restricted	-	-	-

[152] Environment Agency (2021), Historic Landfill Sites [online] available at: https://data.gov.uk/dataset/17edf94f-6de3-4034-b66b-004ebd0dd010/historic-landfill-sites (last accessed February 2022)
[153] Environment Agency (2021), Permitted Waste Sites - Authorised Landfill Site Boundaries [online] available at: https://data.gov.uk/dataset/ad695596-d71d-4cbb-8e32-99108371c0ee/permitted-waste-sites-authorised-landfill-site-boundaries (last accessed February 2022)

Landfill Type	West Sussex	South East England	England
Inert	260,268	27,174,453	140,191,731
Total	**555,601**	**63,190,602**	**388,366,504**

Source: Environment Agency (2022)[154]

Note: *Some non-hazardous sites can accept some SNRHW into a dedicated cell, but this is usually a small part of the overall capacity of the site.

The remaining capacity for West Sussex at the end of 2020 for inert landfill was 260,268m^3, and for non-hazardous landfill was 295,333m^3. There are four landfills with remaining capacity at the end of the 2020, three of which are inert landfills and one of which is a non-hazardous landfill. The inert landfills are outlined in Table 8.11.

Table 8-11: West Sussex permitted sites for inert landfill at the end of 2020

Facility Name	Operator name	Local Authority	Remaining capacity at the end of 2020 (cubic metres)
Boxgrove Landfill	Inert Waste Recycling Limited	Chichester	190,193
Golding Barn Quarry	Betaland Ltd	Horsham	65,175
Rudgwick Landfill Site	Restoration to Agriculture Ltd	Horsham	4,900

Source: Environment Agency (2021)[154]

A search on the public registers was undertaken for all permitted waste facilities within 10km of the three scheme options, based on three postcodes. These include:

- The westernmost point of the scheme (Offington Roundabout, measured from postcode BN13 2RU)
- The easternmost point of the scheme (Busticle Lane Junction, measured from postcode BN15 0DL)
- A central location along the scheme (Lyons Way Junction, measured from postcode BN14 9EY)

The search results were as follows:

[154] Environment Agency (2022), 2020 Remaining Landfill Capacity v2 [online] available at: https://environment.data.gov.uk/portalstg/home/item.html?id=7c316868000146ab8a5b2d07bff82368 (last accessed February 2022)

- Twenty waste facilities were identified within a 10km distance from the westernmost point of the scheme, 12 of which are able to treat or transfer C&D waste.
- Twenty-two waste facilities were identified within a 10km distance from the easternmost point of the scheme, 11 of which are able to treat or transfer C&D waste.
- Twenty waste facilities were identified within a 10km distance from Lyons Way Junction, 10 of which are able to treat or transfer C&D waste.

Table 8-12, Table 8-13 and Table 8-14 outline the available facilities for recycling and recovery which manage C&D waste, either through transfer, treatment, crushing and screening, and storage within 10km of Offington Roundabout, Busticle Lane Junction, and Lyons Way Junction respectively. Not all treatment facilities may be suitable for the waste generated by the scheme options during construction, but it demonstrates that sufficient treatment facilities are available for the waste that may be generated by the scheme options.

Reuse, recycling and recovery of wastes would be prioritised. However, if these options are not available or feasible the following alternative is to adopt the Proximity Principle. There are no permitted landfills within 10km of Lyons Way Junction. There are seven, however, within a 50km radius of this junction (shown in Table 8-15), only two of which have remaining capacity. The volumes of waste generated by the scheme would be assessed against the capacities of the relevant waste infrastructure to identify if there is sufficient capacity available.

Table 8-12: Permitted sites for waste recycling and recovery within 10km of Offington Roundabout

Site name	Operator	Treatment Facility Type	Postcode	Distance from Offington Roundabout (km)
North Barn Farm	Eurogreen Environmental Ltd	A22: Composting Facility	BN12 6NZ	3.3
Pountney Tyres Ltd	Pountney Tyres Limited	A16: Physical Treatment Facility	BN11 2RU	3.9
Meadow Road Depot	Worthing Borough Council	A09: Special Waste Transfer Station	BN11 2SA	4.2
Direct Services Unit	Adur District Council	A11: Household, Commercial & Industrial Waste T Station	BN15 8TA	4.3
Rabbit Waste Management Limited	Rabbit Waste Management Ltd	A11: Household, Commercial & Industrial Waste T Station	BN15 8TU	4.6

Site name	Operator	Treatment Facility Type	Postcode	Distance from Offington Roundabout (km)
Lancing Waste Transfer Station	Syracuse Waste Ltd	A09: Special Waste Transfer Station	BN15 8TX	4.6
Shoreham Recycling Centre	Dudman Waste And Environmental Limited	A16: Physical Treatment Facility	BN44 3TX	7.7
Washington Sandpit	Britaniacrest Recycling Limited	A25: Deposit of waste to land as a recovery operation	RH20 3EX	8.7
Inert Recycling (UK) Limited	Sandgate Park Quarry	A25: Deposit of waste to land as a recovery operation	RH20 4AS	9.1
Robinson DJ	Stubbs Copse Wood Yard	A22: Composting Facility	BN18 9PL	9.6
EMR	Cooper Barnes Metals Ltd	A20: Metal Recycling Site (mixed MRS's)	BN43 6RN	9.7

Source: Environment Agency (2022)[155]

Table 8-13: Permitted sites for waste recycling and recovery within 10km of Busticle Lane Junction

Site name	Operator	Treatment Facility Type	Postcode	Distance from Busticle Lane junction (km)
Direct Services Unit	Adur District Council	A11: Household, Commercial & Industrial Waste T Station	BN15 8TA	1.4
Lancing Waste Transfer Station	Syracuse Waste Ltd	A09: Special Waste Transfer Station	BN15 8TX	1.5
Rabbit Waste Management Limited	Rabbit Waste Management Ltd	A11: Household, Commercial & Industrial Waste T Station	BN15 8TU	1.5
Pountney Tyres Ltd	Pountney Tyres Limited	A16: Physical Treatment Facility	BN11 2RU	2.0
Meadow Road Depot	Worthing Borough Council	A09: Special Waste Transfer Station	BN11 2SA	2.1

[155] Environment Agency (2022), Environmental Permitting Regulations – Waste Operations [online] available at: https://environment.data.gov.uk/public-register/view/search-waste-operations (last accessed February 2022)

Site name	Operator	Treatment Facility Type	Postcode	Distance from Busticle Lane junction (km)
Shoreham Recycling Centre	Dudman Waste And Environmental Limited	A16: Physical Treatment Facility	BN44 3TX	4.4
EMR	Cooper Barnes Metals Ltd	A20: Metal Recycling Site (mixed MRS's)	BN43 6RN	5.6
North Barn Farm	Eurogreen Environmental Ltd	A22: Composting Facility	BN12 6NZ	7.2
Edburton Contractors Limited	Basin Road South	SR/12: Treatment of waste to produce soil <75,000 tpy	BN41 1WD	7.9
Stobart Energy Limited	Shoreham Docks	A15: Material Recycling Treatment Facility	BN41 1WF	8.5
Sweeptech Environmental Services Ltd	Sweeptech Recycling Park	A16: Physical Treatment Facility	BN5 9SE	9.9

Source: Environment Agency (2022)[155]

Table 8-14: Permitted sites for waste recycling and recovery within 10km of Lyons Way Junction

Site name	Operator	Treatment Facility Type	Postcode	Distance from Lyons Way junction (km)
Pountney Tyres Ltd	Pountney Tyres Limited	A16: Physical Treatment Facility	BN11 2RU	2.1
Direct Services Unit	Adur District Council	A11: Household, Commercial & Industrial Waste T Station	BN15 8TA	2.3
Meadow Road Depot	Worthing Borough Council	A09: Special Waste Transfer Station	BN11 2SA	2.3
Rabbit Waste Management Limited	Rabbit Waste Management Ltd	A11: Household, Commercial & Industrial Waste T Station	BN15 8TU	2.6
Lancing Waste Transfer Station	Syracuse Waste Ltd	A09: Special Waste Transfer Station	BN15 8TX	2.6
North Barn Farm	Eurogreen Environmental Ltd	A22: Composting Facility	BN12 6NZ	5.1
Shoreham Recycling Centre	Dudman Waste and Environmental Limited	A16: Physical Treatment Facility	BN44 3TX	6.3

Site name	Operator	Treatment Facility Type	Postcode	Distance from Lyons Way junction (km)
EMR	Cooper Barnes Metals Ltd	A20: Metal Recycling Site (mixed MRS's)	BN43 6RN	7.8
Washington Sandpit	Britaniacrest Recycling Limited	A25: Deposit of waste to land as a recovery operation	RH20 3EX	9.9
Basin Road South	Edburton Contractors Limited	SR/12: Treatment of waste to produce soil <75,000 tpy	BN41 1WD	10.0

Source: Environment Agency (2022)[155]

Table 8-15: Permitted landfill sites within 50km of Lyons Way Junction for C&D waste

Landfill facility name	Landfill type	Remaining capacity at the end of 2020 (cubic metres)	Distance from Lyons Way junction (km)
Golding Barn Quarry	L05 - Inert Landfill	65,175	8.7
Horton Landfill Site	L02 - Non-Hazardous Landfill with SNRHW cell	0	9.1
Lidsey Landfill Site	L04 - Non-Hazardous	0	21.9
Boxgrove Landfill	L05 - Inert Landfill	190,193	22.5
Brookhurstwood Landfill Site	L04 - Non-Hazardous	295,333	30.5
Rudgwick Landfill Site	L05 - Inert Landfill	4,900	29.3
Pendean Landfill	L05 - Inert Landfill	0	31.4

Source: Environment Agency (2022)[154]

In addition to permitted C&D waste management sites, inert material is also managed on sites that have an Environment Agency Environmental Permit exemption. These exempt sites generally comprise land restoration activities such as restoring mineral voids, engineering / landscaping schemes, and for agricultural improvements on farmland. These sites are an important part of the provision of the capacity for managing inert materials. Although small tonnages of waste from other waste streams, such as biodegradable waste may be managed at locations with an exemption, the largest tonnage of exempt activities is likely to involve C&D material.

A number of waste exempt sites are listed by the Environment Agency that lie within 10km of the selected postcodes. These are as follows:

- 281 waste exempt sites lie within 10km of the Offington Roundabout, of which 93 are ‘use of waste in construction’ (U1) exempt sites.
- 251 waste exempt sites lie within 10km of the Busticle Lane Junction, of which 88 are U1 exempt sites.
- 259 waste exempt sites lie within 10km of the Lyons Way Junction, of which 90 are U1 exempt sites.

These U1 exempt sites utilise waste for the purpose of construction, such as buildings or engineering work, and are often short-lived, and therefore should be identified upon commencement of construction.

8.5.2.6 Future baseline

The future waste baseline has been assessed on the basis of a desktop review of the waste forecasts presented in West Sussex County Council’s Monitoring Report 2019 - 20[156] for dealing with future waste arisings and is provided in Table 8-16.

Table 8-16: Forecast waste arisings in West Sussex to 2031

Waste stream	2019	2023	2027	2031
Commercial and Industrial waste	431,000	449,333	467,667	486,000
Construction, demolition and excavation waste	1,274,000	1,300,333	1,326,667	1,353,000
Municipal solid waste	423,000	431,667	440,333	449,000
Total tonnes	2,128,000	2,181,110	2,234,219	2,287,329

Source: West Sussex County Council (2021)[156]

Note: Waste arisings data for the years 2023 and 2027 were derived through calculation, based on the waste arisings data provided for 2019 and 2031 in the Monitoring Report 2019/20, and assuming a constant annual growth rate.

Any future changes to this permitted capacity and throughput of waste management facilities are uncertain.

8.6 Potential impacts

It is anticipated that all the scheme options would have similar potential impacts and have therefore been considered together. Potential impacts identified below as

[156] West Sussex County Council (2021), West Sussex Joint Minerals Local Plan and Waste Local Plan: Monitoring Report 2019/20. Available online at: https://www.westsussex.gov.uk/media/15975/monitoring_report_2019to2020.pdf. [Accessed 01/03/22]

a result of the construction of the scheme are those identified prior to the inclusion of mitigation.

8.6.1 Construction

This section provides an overview of potential impacts relating to material resource use and waste generation as a result of the scheme during its construction. The construction phase considers site preparation, demolition and construction.

8.6.1.1 Use of material resources

Material resources include raw materials such as aggregate and minerals from primary, secondary and recycled sources, and manufactured construction products. Manufactured construction products can include the materials required for the construction of the road surface, and pre-cast elements for the construction and/or modification of structures such as signage, pipework, barriers, lighting and fencing.

Road schemes generally require large quantities of both primary raw materials and manufactured construction products. Many material resources may originate off-site; purchased as construction products. However, some materials may arise on site, for example, excavated soils and sub-strata.

The likely materials required are listed below (although the list is not exhaustive):

- Steel
- Aggregate
- Cement
- Concrete
- Bitumen
- Wood
- Plastic

The receptors likely to be subject to impacts as a result of the requirement for material resources during the construction of the scheme options include quarries and other sources of minerals, and other finite raw material resources. The potential impacts associated with the use of material resources on these receptors include:

- The availability of material resources and the subsequent impact on the demand for materials. Materials would need to be imported to the site as it is assumed that the scheme would be unlikely to recover / reuse site won material
- The depletion of non-renewable resources. The majority of materials used on the scheme would comprise primary materials as the scheme is unlikely to be able to source all required materials from recycled / secondary materials

8.6.1.2 Generation and management of waste

In considering the generation and management of waste, it is important to define when, under current legislation and understanding, a material is considered to be a waste. The EU Waste Framework Directive 2008/98/EC defines waste as “any substance or object which the holder discards or intends or is required to discard”.

Waste generation during the construction phase may result in adverse impacts. These impacts include the temporary increased use of waste management facilities and permanent reduction in landfill capacity. Waste is likely to be generated primarily from site-won materials from excavations of natural and made ground but is also expected from the demolition of existing structures and from materials brought to site which are not used for their original purpose. Waste arisings likely to be generated during the construction phase include:

- Debris and litter lying on the ground
- Soil which may be contaminated or unsuitable for reuse without treatment
- Inert waste from site preparation and excavation
- Surplus excavated materials
- Green waste from vegetation clearance and small quantities of unsorted non-hazardous waste like timber
- Hazardous waste
- Surplus material from site preparation (including any remediation) and excavation works
- Damaged stock or cut-offs

The receptors likely to be subject to impacts as a result of waste generation and its management are landfills and other waste management infrastructure. The potential impacts relating to the generation and management of waste on these receptors include:

- Temporary occupation of waste management infrastructure capacity (from treatment of waste)
- Temporary occupation of land for the storage of waste awaiting transfer off-site
- Permanent reduction in landfill capacity (from disposal of waste)

8.7 Design, mitigation and enhancement measures

Measures would be implemented to reduce the effects of material resource use and waste generation by the scheme during the construction and operational phases. There is substantial overlap in the mitigation for both aspects (material resource use and waste generation), due to the synergy between the reuse of materials and the avoidance of waste generation.

A Design for Resource Efficiency (D4RE) online workshop was held on 8 December 2021 with the design team. The aim of the workshop was to identify opportunities to improve resource efficiency during the design of the scheme options. This ensures cost savings are maximised by considering waste minimisation initiatives and identifying opportunities to reduce, reuse or recycle waste materials and improve resource efficiency.

A Resource Management Opportunities Matrix was used during the D4RE workshop to identify suitable opportunities. The matrix utilises the D4RE Tool which assists designers, through the workshop format which is based on a stepped approach of identify, evaluate, capture and implement, to develop mitigation measures for resource use and waste management.

Changes in the scheme design, where possible, to enable resource efficiency and a reduction in waste, include:

- Using locally sourced materials, where available
- Building in resilience measures for future maintenance
- Investigating the use of sustainable materials (for example bamboo, graphene or others) and promoting longer life and low-emission materials to reduce maintenance interventions (for example weathering steel which eliminates need for painting)
- Using pre-cast concrete and bridge units, and prefabricated construction materials
- Considering low carbon cement/concrete/materials alternatives
- Reducing the need for long diversion routes at peak times, and designing for the shortest route, minimising new construction
- Employing a local workforce and involving local residents
- Reusing site-won material where possible (for example reusing site won topsoil to build environmental noise bunds)
- Maximising the use of existing substructures
- Reducing the breaking up of existing pavement
- Using technology to improve traffic flow (VMS, congestion monitoring, all-red vehicle detection on junctions, etc.)
- Investigating the use of widened soil embankments as opposed to steel sheet piles as retaining walls, if required
- Developing and implementing future maintenance provisions, traffic management provisions and signs / hard shoulder provisions
- Considering the installation of renewable energy infrastructure on-site to be used for the construction phase and then also to be transitioned to the operational stage

- Adhering to the waste hierarchy and sending waste to appropriate reuse/recovery facilities rather than landfill
- Reducing the number of structures (for example combining signage into single structures to reduce material / avoid multiple structures)
- Collaborating with other schemes in the area to use waste arisings from the scheme
- Investment in long-life pavement materials to reduce maintenance requirements
- Modular construction
- Narrowing the carriageway (departures in the cross section) to generate less excavated material
- Arranging fewer deliveries by maximising vehicle capacity and only arranging a delivery when it is needed
- Designing the scheme to connect low carbon transport modes (for example walking, bus)
- Segregating contaminated/hazardous wastes to prevent increased volume of materials needing to be moved off site
- Using felled trees / wood to create habitat areas
- Using autonomous plant
- Designing infrastructure for electric vehicles, where appropriate
- Use of BIM
- Investigating the use of piezoelectrics to generate electricity from road traffic
- Exploring the use of fungi 'infused' concrete which 'self heals' when cracks appear as fungi grows in response to exposure to calcium hydroxide from concrete reacting to water
- Reducing the amount of tie-in resurfacing
- Considering the use of 3D printing, where appropriate.

Value engineering of the design would continue through the detailed design stage and PCF Stage 3. This is expected to lead to further material savings.

Mitigation measures that would be implemented on-site to ensure efficient use of material resources and reduction of waste arisings, and to reduce the potential impacts identified in Section 8.6 are as follows:

- Materials would be delivered on an ‘as required’ basis to avoid damage or contamination and therefore limit the likelihood of waste
- Where site-won material is not available or suitable for reuse, secondary or recycled materials would be procured where available and practicable

- Suitable excavated material, where possible, would be reused in the construction of the scheme and in landscaping features to reduce the requirement to import materials for construction and reducing the need to remove surplus materials from site
- Where practicable, road planings would be incorporated into new pavements on or off-site
- Temporary stockpiling of fill materials prior to incorporation in the scheme would be avoided where possible, to ensure double handling and damage is minimised and therefore the avoidance of waste. However, where required, materials would be stockpiled in accordance with best practice and managed appropriately to limit the likelihood of damage or contamination
- Locally sourced materials and suppliers would be identified and used where practicable
- Pre-cast elements would be used where practicable to ensure efficient use of materials and avoid the generation of waste arisings from off-cuts
- The waste hierarchy would be implemented throughout the construction to minimise disposal and maximise reuse and recycling of waste arisings. Opportunities for reuse and recycling of waste include (but are not limited to):
  - Re-using excavated soils on site in the landscaping features of the scheme
  - Chipping green waste on site for use in the landscaping for the scheme
  - Composting of green waste
  - Recycling of inert material by crushing, blending and subsequent reuse, as an aggregate
  - Re-using waste on other nearby schemes
  - Re-using waste for uses with clear benefits to the environment, for example in the remodelling of agricultural land or in the restoration of nearby quarries or other excavation sites
  - Facilities would be provided on site to separate out waste to enable the recovery of material through recycling
- Where waste must be taken to a recycling or disposal site, the contractor would ensure that the sites have the appropriate permits. In addition, the suitable facility would be located as close to the works as possible to minimise the impacts of transportation, in particular the release of carbon emissions. The appointed contractor would identify the closest and most relevant treatment and disposal sites
- A non-exhaustive list of waste infrastructure sites within 10km of the scheme is provided in Table 8-12, Table 8-13 and Table 8-14. The ability for waste arisings to be deposited at these sites would be dependent on the conditions imposed on the sites by the relevant licence or permit. There may be other facilities in the vicinity of the scheme that may be used

- A non-exhaustive list of sites that could potentially receive inert waste for restorative purposes from the scheme is presented in Table 8-11
- The use of sites with Environment Agency Environmental Permit exemption to receive inert waste would be investigated

An Environmental Management Plan (EMP) would be produced and would incorporate the mitigation measures proposed above.

A Materials Management Plan (MMP) would be produced by the contractor and would form part of the second iteration EMP, if required. It would identify ways to reuse site-won or excavated materials within the construction of the scheme, provided they meet the requirements of the CL:AIRE Code of Practice

A SWMP would be developed by the contractor as part of the EMP. The aim of the SWMP is to ensure that waste is managed in accordance with the waste hierarchy and other relevant legislative requirements, and details information on the waste carriers and waste management facilities that could be used. The SWMP is a key part of the second iteration EMP and would be a live document based on construction operations as they occur. It is recommended that the SWMP is used to measure and monitor the types and quantities of waste removed off-site, to ensure that the waste hierarchy is being implemented, wherever possible.

As a requirement of the contract, waste audits would be undertaken by the contractor throughout the construction phase. The contractor would report on the types and quantities of waste taken off-site and performance against reuse and recycling targets throughout the construction phase and indicate where continual improvements to waste management and minimisation can be made. Information relating to these audits would be used to inform the revisions of the SWMP.

The MMP, SWMP and EMP would show how efficient use of material resources and reduction of waste arisings would be achieved, and how the potential impacts identified in this chapter would be reduced or mitigated.

Where waste must be taken to a recycling or disposal site, the contractor has a legal duty to ensure that the sites have the appropriate permits. The appointed contractor would identify the closest relevant treatment and disposal sites, to minimise the impacts of transportation.

8.8 Assessment of likely significant effects

This section provides details on the assessment of the likely significant effects and their significance on material resource use and waste generation as a result of the scheme, during construction.

8.8.1 Use of material resources

The estimated quantities of materials required for each of the scheme options are shown in Table 8-17, Table 8-18 and Table 8-19.

Table 8-17: Estimated material requirements for Option 1

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Grove Lodge Junction	Total material requirements
Demolition and site preparation	No material resources will be required for demolition and site preparation	Not applicable		
Earthworks	Excavation of acceptable material Class 5A Topsoil 150mm; excavate and set aside for reuse, <750m^3	398m^3	169m^3	567m^3
	Excavation of acceptable material Class 5A Topsoil 150mm	-	-	-
	Excavation of acceptable material, excluding hard or artificially hard material, excluding Class 5A; >2500m^3	4,779m^3	2,577m^3	7,356m^3
	Compaction of fill material	1m^3	4m^3	5m^3

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Grove Lodge Junction	Total material requirements
	Deposition of acceptable material; excluding Class 5A; normal material, excluding hard or artificially hard material, <2500m^3	1m^3	4m^3	5m^3
	Disposal of unacceptable material	119m^3	51m^3	170m^3
	Disposal of acceptable material excluding Class 5A	40m^3	17m^3	57m^3
	Completion of sub-formation on acceptable material	6,104m^2	4,074m^2	10,178m^2
Construction	Pavement (Foot/Cycleway):	3,299m^3	2,186m^3	5,485m^3
	• Surface course	1,185m^3	889m^3	2,074m^3
	• Binder course	132m^3	81m^3	213m^3

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Grove Lodge Junction	Total material requirements
	• Base course	220m^3	135m^3	355m^3
	• Subbase	661m^3	405m^3	1,066m^3
	• Capping course	1,101m^3	676m^3	1,777m^3

Table 8-18: Estimated material requirements for Option 2

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Lyons Way Sompting Junction	Total material requirements
Demolition and site preparation	No material resources will be required for demolition and site preparation	Not applicable		
Earthworks	Excavation of acceptable material Class 5A Topsoil 150mm; excavate and set aside for reuse, <750m^3	398m^3	69m^3	467m^3
	Excavation of acceptable material Class 5A Topsoil 150mm	-	-	-
	Excavation of acceptable material, excluding hard or artificially hard material, excluding Class 5A; >2500m^3	4,779m^3	2,175m^3	6,954m^3
	Compaction of fill material	1m^3	17m^3	18m^3

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Lyons Way Sompting Junction	Total material requirements
	Deposition of acceptable material; excluding Class 5A; normal material, excluding hard or artificially hard material, <2500m^3	1m^3	17m^3	18m^3
	Disposal of unacceptable material	119m^3	21m^3	140m^3
	Disposal of acceptable material excluding Class 5A	40m^3	7m^3	47m^3
	Completion of sub-formation on acceptable material	6,104m^3	3,229m^3	9,333m^3
Construction	Pavement (Foot/Cycleways):	3,299m^3	2,593m^3	5,891m^3
	• Surface course	1,185m^3	1,387m^3	2,572m^3
	• Binder course	132m^3	75m^3	207m^3
	• Base course	220m^3	126m^3	346m^3
	• Subbase	661m^3	377m^3	1,038m^3
	• Capping course	1,101m^3	628m^3	1,729m^3
	Concrete Retaining Wall (height <1.6m)	-	259m^3	259m^3

Table 8-19: Estimated material requirements for Option 3

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Busticle Lane Junction	Total material requirements
Demolition and site preparation	No material resources will be required for demolition and site preparation			
Earthworks	Excavation of acceptable material Class 5A Topsoil 150mm; excavate and set aside for reuse, <750m^3	398m^3	37m^3	435m^3
	Excavation of acceptable material Class 5A Topsoil 150mm	-	-	-
	Excavation of acceptable material, excluding hard or artificially hard material, excluding Class 5A; >2500m^3	4,779m^3	1,408m^3	6,187m^3
	Excavation of acceptable material excluding Class 5A	-	-	-
	Compaction of fill material	1m^3	86m^3	87m^3
	Deposition of acceptable material; excluding Class 5A; normal material, excluding hard or artificially hard material, <2500m^3	1m^3	86m^3	87m^3
	Disposal of unacceptable material	119m^3	11m^3	130m^3
	Disposal of acceptable material excluding Class 5A	40m^3	4m^3	44m^3

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Busticle Lane Junction	Total material requirements
	Completion of sub-formation on acceptable material	6,104m^3	3,052m^3	9,156m^3
Construction	Pavement (Foot/Cycleways):	3,299m^3	1,202m^3	4,501m^3
	• Surface course	1,185m^3	787m^3	1,972m^3
	• Binder course	132m^3	26m^3	158m^3
	• Base course	220m^3	43m^3	263m^3
	• Subbase	661m^3	130m^3	791m^3
	• Capping course	1,101m^3	217m^3	1,318m^3
	Concrete Retaining Wall (height <1.5m)	-	83m^3	83m^3

It can be seen from Table 8-17, Table 8-18 and Table 8-19 that the majority of the raw material required for the scheme is aggregate or aggregate based product.

Existing quarry locations for import of material resources have not been identified at this stage. If aggregates are to be imported, it is likely that the recycled content of these would be in the order of 20% given the nature of works. However, it is assumed that all aggregate material sourced either regionally or nationally would meet the regional target (26%) for the recycled and secondary aggregate where technically appropriate and economically feasible. The California Bearing Ratios (CBRs) for existing ground and associated pavement designs are not complete at this stage, however, use of recycled materials is common within lower unbound layers and ground improvement capping materials. It is assumed that all acceptable excavated topsoil would be reused in landscaping activities either within the scheme or in neighbouring projects.

No cut and fill balance has been undertaken to date. However, given the location of the site and its vicinity to the water's edge, the topography is generally very level. It is considered likely, therefore, that there would be a minor cut in balance resulting in spoil needing to be removed from site. No quarry locations or neighbouring schemes have been identified at this stage. Given the generally minor nature of the works, the amount of export would be likely to be small.

The quantities of acceptable material (as shown in Table 8-17 to Table 8-19) to be excavated, excluding hard or artificially hard material and Class 5A, are estimated to be approximately 7,356m^3 for Option 1, 6,954m^3 for Option 2 and 6,187m^3 for Option 3. It is estimated that approximately 57m^3, 47m^3 and 44m^3 of such material would require disposal for Options 1, 2 and 3, respectively. Unacceptable material requiring disposal is estimated to be approximately 170m^3 for Option 1, 140m^3 for Option 2 and 130m^3 for Option 3.

For Option 1, a total of 7,696m^3 of site-won material is expected to be reused on the scheme, consisting of 7,129m^3 of acceptable normal material, excluding hard or artificially hard material and Class 5A, and 567m^3 of Class 5A topsoil. This corresponds to 97.3% of the total excavated material arisings.

For Option 2, a total of 7,234m^3 of site-won material is expected to be reused on the scheme, consisting of 7,767m^3 of acceptable normal material, excluding hard or artificially hard material and Class 5A, and 467m^3 of Class 5A topsoil. This corresponds to 97.4% of the total excavated material arisings.

For Option 3, a total of 6,448m^3 of site-won material is expected to be reused on the scheme, consisting of 6,013m^3 of acceptable normal material, excluding hard or artificially hard material and Class 5A, and 435m^3 of Class 5A topsoil. This corresponds to 97.4% of the total excavated material arisings.

It is not anticipated that primary raw materials and manufactured products would be required for demolition activities. Therefore, it is not anticipated that there would

be any significant effects relating to material resource use of demolition activities on-site.

No sources of contamination have been identified to date. A survey would be undertaken during PCF Stage 3 to confirm the presence, or a lack thereof, of contaminated materials on-site.

Table 8-20 below sets out the likely significant effects associated with material resource use.

Table 8-20: Assessment of likely significant effects associated with material resource use

Receptor	Potential effects	Description of effects	Effect magnitude	Mitigation	Significance of effect (with mitigation)
Sources of secondary materials (recycled)	Impacts on the availability of material resources, and subsequent impacts on the demand for key construction materials.	The implementation of the mitigation measures as outlined in Section 8.7 would ensure the efficient use of material resources on-site. It is considered likely that there would be a minor cut in balance resulting in spoil needing to be removed from site. No import of fill is anticipated to be required, although materials would be required for the construction of the new pavement and retaining walls, which would need to be imported to site. The scheme is anticipated to achieve between 70-99% overall material recovery / recycling of non-hazardous C&D waste (to substitute use of primary materials, if used as fill material) for all three scheme options, and aggregates required to be imported to site are likely to comprise reused / recycled content in line with the relevant regional percentage target (26%) where technically appropriate and economically feasible. This is classed as a slight adverse effect based on Table 8-1.	Effects would be slight adverse, permanent and direct.	Measures set out in section 8.7	Not significant
Quarries / finite sources of virgin materials	Depletion of non-renewable resources.	The baseline has indicated an adequate supply of aggregates within the South East England region, therefore where further supplies of aggregates are required the majority of these can be procured within the region (Section 8.5). The scheme is anticipated to achieve between 70-99% overall material recovery / recycling of non-	Effects would be slight adverse, permanent and direct.	Measures set out in section 8.7	Not significant

Receptor	Potential effects	Description of effects	Effect magnitude	Mitigation	Significance of effect (with mitigation)
		hazardous C&D waste (to substitute use of primary materials, if used as fill material) for all three scheme options, it is assumed that 26% of all aggregates supply will consist of recycled and secondary aggregates, in line with the regional target where technically appropriate and economically feasible. This is classed as a slight adverse effect based on Table 8-1.			

8.8.2 Generation and management of waste

Table 8-21, Table 8-22 and Table 8-23 present the main waste streams that are likely to be generated by the construction of the scheme.

Table 8-21: Summary of anticipated waste arisings for Option 1

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Grove Lodge Junction	Estimated quantities of waste arisings
Site clearance	General clearance; debris and rubbish lying on the ground, manpower only	Area to be cleared: 850m^2	Area to be cleared: 790m^2	Area to be cleared: 1,640m^2
Earthworks and site construction	Excavated material:	5,177m^3	2,746m^3	7,923m^3
	• Excavation of acceptable material Class 5A Topsoil 150mm; excavate and set aside for reuse, <750m^3	398m^3	169m^3	567m^3
	• Excavation of acceptable material Class 5A Topsoil 150mm	-	-	606m^3
	• Excavation of acceptable material normal material, excluding hard or artificially hard material, excluding Class 5A; >2500m^3	4,779m^3	2,577m^3	7,356m^3
	• Excavation of acceptable material excluding Class 5A	-	-	2,135m^3
	• Disposal of unacceptable material	119m^3	51m^3	170m^3
	• Disposal of acceptable material excluding Class 5A	40m^3	17m^3	57m^3
	Waste from materials brought to site that are not used for their original purpose, for example damaged items, cut offs and surplus materials	Quantities unknown, as a worst-case scenario, likely to be 10% of construction materials.		

Table 8-22: Summary of anticipated waste arisings for Option 2

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Lyons Way Sompting Junction	Estimated quantities of waste arisings
Site clearance	General clearance; debris and rubbish lying on the ground, manpower only	Area to be cleared: 850m^2	Area to be cleared: 322m^2	Area to be cleared: 1,172m^2
Earthworks and site construction	Excavated material:	5,177m^3	2,244m^3	7,421m^3
	• Excavation of acceptable material Class 5A Topsoil 150mm; excavate and set aside for reuse, <750m^3	398m^3	69m^3	467m^3
	• Excavation of acceptable material Class 5A Topsoil 150mm	-	-	606m^3
	• Excavated normal material, excluding hard or artificially hard material, excluding Class 5A	4,779m^3	2,175m^3	6,954m^3
	• Excavation of acceptable material excluding Class 5A	-	-	-
	• Disposal of acceptable material excluding Class 5A	40m^3	7m^3	47m^3
	• Disposal of unacceptable material	119m^3	21m^3	140m^3
	Waste from materials brought to site that are not used for their original purpose, for example damaged items, cut offs and surplus materials	Quantities unknown, as a worst-case scenario, likely to be 10% of construction materials.		

Table 8-23: Summary of anticipated waste arisings for Option 3

Scheme activity	Material resources required for the scheme	Offington Corner Junction	Busticle Lane Junction	Estimated quantities of waste arisings
Site clearance	General clearance; debris and rubbish lying on the ground, manpower only	Area to be cleared: 850m^2	Area to be cleared: 312m^2	Area to be cleared: 1,162m^2
Earthworks and site construction	Excavated material:	5,177m^3	1,445m^3	6,622m^3
	• Excavated acceptable Class 5A Topsoil	398m^3	37m^3	435m^3
	• Excavated normal material, excluding hard or artificially hard material, excluding Class 5A	4,779m^3	1,408m^3	6,187m^3
	• Excavation of acceptable material excluding Class 5A	-	-	2,135m^3
	• Disposal of acceptable material excluding Class 5A	-	--	2,135m^3
	• Disposal of unacceptable material	119m^3	11m^3	130m^3
	Waste from materials brought to site that are not used for their original purpose, for example damaged items, cut offs and surplus materials			

The amount of waste that would arise during the construction phase of the scheme would be subject to change as the construction phase progresses and based on the efficiency achieved by the appointed Contractor. Forecasts have been made for this assessment on a reasonable worst-case scenario basis, informed by experience on similar projects.

No key structures or significant infrastructure have been identified for demolition as part of the scheme. However, limited pavement demolition to provide tie-in to areas of new-built pavement is anticipated.

Current guidance permits up to 10% of the bound pavement layers to be made up of site-won construction waste arisings and up to 25% of the lower foundation layers and/or ground improvement works if required. However, the nature of the construction waste material, the limited widening works, and existing site gradient provide limited scope for reuse of spoil.

The current design of the scheme options does not require fill material to be imported to the site. Where excavated material is unacceptable for reuse it would be managed in accordance with the waste hierarchy.

No sources of contamination have been identified to date. If hazardous material and contaminated excavated materials arise during construction, the SWMP procedures for handling and storing of this waste would be followed to ensure cross-contamination does not occur. In addition, ground investigation and soil testing would be undertaken to determine whether the soils can be reused directly on-site, would require treatment prior to reuse on site, or would require disposal off-site.

For Option 1, a total of 57m^3 of site-won material consisting of acceptable normal material, excluding hard or artificially hard material and Class 5A, and 170m^3 of unacceptable material would require disposal. This corresponds to 2.9% of the total excavated material arisings.

For Option 2, a total of 47m^3 of site-won material consisting of acceptable normal material, excluding hard or artificially hard material and Class 5A, and 140m^3 of unacceptable material would require disposal. This corresponds to 2.5% of the total excavated material arisings.

For Option 3, a total of 40m^3 of site-won material consisting of acceptable normal material, excluding hard or artificially hard material and Class 5A, and 130m^3 of unacceptable material would require disposal. This corresponds to 2.6% of the total excavated material arisings.

If it is assumed that all excavated non-hazardous waste identified for disposal is landfilled, it would occupy 0.08%, 0.06% and 0.06% of the non-hazardous landfill space in West Sussex (identified in Table 8-10) for Options 1, 2 and 3 respectively. On a regional level, this would correspond to 0.0017%, 0.0014% and 0.0013% of non-hazardous landfill space in South East England for Options 1 to 3 respectively.

The detailed assessment of effects of the generation and management of waste for all scheme options is outlined in Table 8-24.

Table 8-24: Assessment of likely significant effects associated with generation and management of waste for all scheme options

Sensitive receptor	Potential effects	Description of the effects	Effect magnitude	Mitigation	Significance of effect (with mitigation)
Waste management infrastructure	Production of non-hazardous waste resulting in the temporary occupation of waste management infrastructure capacity or permanent reduction in landfill capacity.	Non-hazardous waste would be primarily generated during the construction phase of the scheme through site earthworks and site clearance. Some non-hazardous waste would be generated by on-site staff. Minimal inert types of waste are considered to be present. Typically, the waste would comprise clean soil and/or cement bound materials from existing infrastructure. The presence of hazardous material (for example tar, etc) is still be determined. The implementation of measures outlined in section 8.7 would likely reduce the effects through the reuse and recycling of waste. However, the worst-case scenario would be that this waste requires disposal to landfill. The baseline has identified that the waste infrastructure in the South East England region has sufficient capacity to accommodate non-hazardous waste from the scheme without compromising the integrity of the receiving infrastructure within the region, if disposal to landfill is required. If it is assumed that all excavated non-hazardous waste identified for disposal is landfilled, it will occupy	Effects would be slight adverse, direct, and permanent.	Measures set out in section 8.7.	Not significant

Sensitive receptor	Potential effects	Description of the effects	Effect magnitude	Mitigation	Significance of effect (with mitigation)
		approximately 0.0064% of non-hazardous landfill space in South East England for all three options. Therefore, less than 1% reduction or alteration in the capacity of landfill within the South East England region is anticipated. This is classed as a slight adverse effect based on Table 8-1.			
	Production and treatment of hazardous waste resulting in the temporary occupation of waste management infrastructure capacity or permanent reduction in landfill capacity.	No sources of contamination have been identified to date. However, it is unlikely that significant volumes of hazardous waste would be generated. A survey would be undertaken during PCF Stage 3 to confirm the presence, or a lack thereof, of contaminated materials on-site. The baseline has identified that the hazardous waste infrastructure in the South East England region has sufficient capacity to accommodate hazardous waste from the scheme without compromising the integrity of the receiving infrastructure within the region, if disposal to landfill is required. The expected reduction or alteration in the regional capacity of hazardous waste landfill is of <1% based on current treatment and landfilling capacity in the South East England region. This is classed as a slight adverse effect based on Table 8-1.	Effects would be slight adverse, direct, and permanent.	Measures set out in section 8.7.	Not significant

Sensitive receptor	Potential effects	Description of the effects	Effect magnitude	Mitigation	Significance of effect (with mitigation)
	Production of inert waste resulting in the temporary occupation of waste management infrastructure capacity or permanent reduction in landfill capacity.	Most of the waste generated during the construction phase is likely to be non-hazardous waste, and any inert waste from the demolition of structures and from surplus materials or off-cut are likely to be minimal. Inert waste would be dealt with in accordance with the waste hierarchy, which would ensure that reuse on other sites and recycling are prioritised over disposal whenever feasible. The baseline has identified that the waste infrastructure in the South East England region has sufficient capacity to accommodate inert waste from the scheme without compromising the integrity of the receiving infrastructure within the region, if disposal to landfill is required. However, since very little to no inert waste is anticipated, it is very likely that this would result in less than 1% reduction or alteration in the capacity of inert landfill within the South East England region. This is classed as a slight adverse effect based on Table 8-1.	Effects would be slight adverse, direct, and permanent.	Measures set out in section 8.7.	Not significant

9 Noise and vibration

9.1 Legislative and policy framework

The following legislation, policy, standards, and guidelines are considered to be relevant to the assessment of noise and vibration:

- The National Planning Policy Framework (NPPF) 2021[157]
- The Noise Policy Statement for England (NPSE) 2010[158]
- Planning Practice Guidance (PPG) 2014[159]
- The Land Compensation Act 1973 Part 1[160]
- The Noise Insulation Regulations 1975 (amended 1988)[161]
- Sections 60 and 61 of The Control of Pollution Act 1974[162]
- The Environmental Noise (England) Regulations 2006 (amended 2018)[163]
- Design Manual for Roads and Bridges (DMRB) LA 111 Noise and vibration Revision 2, 2020[164]
- Calculation of Road Traffic Noise (CRTN) 1988[165]
- British Standard (BS) 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise'[166]
- British Standard (BS) 5228-2:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration'[167]
- World Health Organization (WHO) Guidelines for Community Noise, 1999[168]
- WHO Night Noise Guidelines for Europe, 2009[169]

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[157] Ministry of Housing, Communities and Local Government, National Planning Policy Framework (NPPF), 2021
[158] Department for Environment Food and Rural Affairs. The Noise Policy Statement for England, 2010
[159] Department for Communities and Local Government, Planning Practice Guidance, 2019
[160] His Majesty's Stationery Office, Land Compensation Act, 1973
[161] His Majesty's Stationery Office, Noise Insulation Regulations. Building and Buildings, 1975
[162] His Majesty's Stationery Office, The Control of Pollution Act, 1974
[163] His Majesty's Stationery Office, Environmental Noise Regulations, 2006 (Amended 2018)
[164] National Highways (2020) DMRB LA 111 - Noise and Vibration, Revision 2
[165] Department of Transport, Calculation of Road Traffic Noise, 1988
[166] British Standards Institution, BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise, 2014
[167] British Standards Institution, BS 5228-2:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration, 2014
[168] World Health Organization, Community Noise Guidelines, 1999
[169] World Health Organization, Night Noise Guidelines for Europe, 2009

- WHO Environmental Noise Guidelines for the European Region, 2018[170]

The above list is not exhaustive and further guidance will be referred to where necessary.

9.2 Assessment methodology

The DMRB LA 111 Revision 2 (2020) provides requirements and advice for the assessment of road projects within the UK.

9.2.1 Significance of effects

The assessment of construction noise and vibration and operational noise effects has been completed using the DMRB LA 111 to identify potential significant effects.

As the relevant national policy for the scheme, the NPPF provides a number of policies related to noise. The NPPF paragraph 174 states: *'Planning policies and decisions should contribute to and enhance the natural and local environment by preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of noise pollution.'*

The NPPF paragraph 185 states: *'Planning policies and decisions should ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life.'*

In order to comply with these policies, it is necessary to determine the Lowest Observed Adverse Effect Level (LOAEL) which is '*the level above which adverse effects on health and quality of life can be detected*', and the Significant Observed Adverse Effect Level (SOAEL) which is the level '*above which significant adverse effects on health and quality of life occur*' for noise effects. The mitigation strategy will therefore depend upon the magnitude of any impacts at sensitive receptors between LOAEL and SOAEL, in addition to exceedances of SOAEL.

The environmental assessment of significant effects on human health and determination of mitigation measures has been completed in accordance with the requirements of DMRB LA 111. DMRB LA 111 Annex E/1 summarises the national policy requirements of NPSE, NPPF and NPSNN for environmental assessment.

[170] World Health Organization, Environmental Noise Guidelines for the European Region, 2018

Table 9-1 summarises LOAEL and SOAEL values for noise and vibration at noise sensitive receptors as defined by DMRB LA 111.

Table 9-1: Summary of LOAEL and SOAEL values used to identify significant effects due to noise and vibration

Period	LOAEL	SOAEL
Construction Noise		
Day (07:00-19:00) weekday and Saturday morning (07:00-13:00)	Baseline noise levels $L_{Aeq,T}$	Threshold level determined as per BS 5228-1 Section E3.2 and BS 5228-1 Table E.1
Night (23:00-07:00)	Baseline noise levels $L_{Aeq,T}$	Threshold level determined as per BS 5228-1 Section E3.2 and BS 5228-1 Table E.1
Evening and weekends (periods not covered above)	Baseline noise levels $L_{Aeq,T}$	Threshold level determined as per BS 5228-1 Section E3.2 and BS 5228-1 Table E.1
Construction Vibration		
Anytime	0.3mm/s	1.0mm/s
Operational Noise		
Daytime (06:00 – 00:00)	55 dB $L_{A10,18hr}$ (facade)	68 dB $L_{A10,18hr}$ (facade)
Night-time (23:00 – 07:00)	40 dB $L_{night,outside}$ (free-field)	55 dB $L_{night,outside}$ (free-field)

Source: DMRB LA 111 Tables 3.12, 3.31 and 3.49.1.

9.2.2 Construction noise

DMRB LA 111 provides advice and guidance for the assessment of construction noise effects at sensitive receptors which utilises the BS5228–1:2009+A1:2014 'Example Method 1 – ABC Method' calculation methodology. DMRB LA 111 provides advice and guidance for the determination of the magnitude of impact and significance of effects due to construction noise including noise from additional construction activities such as construction traffic and diversion routes. The magnitude of impact is classified as negligible, minor, moderate, or major by comparison of construction noise levels with LOAEL and SOAEL values for all relevant receptor properties as per DMRB LA 111 Table 3.16 and as reproduced in Table 9-2. The LOAEL and SOAEL values for construction noise are defined in Table 9-1.

Table 9-2: Magnitude of impact and construction noise descriptions

Magnitude of impact	Construction noise level
Major	Above or equal to SOAEL +5 dB
Moderate	Above or equal to SOAEL and below SOAEL +5 dB

Magnitude of impact	Construction noise level
Minor	Above or equal to LOAEL and below SOAEL
Negligible	Below LOAEL

Source: DMRB LA 111 Table 3.16

The magnitude of impact from noise due to construction traffic and diversion routes is determined by changes in Basic Noise Level (BNL)[171] to be negligible, minor, moderate or major as per DMRB LA 111 Table 3.17 reproduced in Table 9-3.

Table 9-3 : **Magnitude of impact at receptors for construction traffic and diversion routes**

Magnitude of impact	Increase in BNL of closest public road used for construction traffic (dB)
Major	Greater than or equal to 5.0
Moderate	Greater than or equal to 3.0 and less than 5.0
Minor	Greater than or equal to 1.0 and less than 3.0
Negligible	Less than 1.0

Source: DMRB LA 111 Table 3.17

Construction noise and construction traffic noise is determined to be a significant effect where a moderate or major magnitude of impact will occur for a duration exceeding: 10 or more days or nights in any 15 consecutive days or nights; or a total number of days exceeding 40 in any six consecutive months as per DMRB LA 111 Section 3.19.

Details of construction methods, activities and programme are not available at Project Control Framework (PCF) Stages 1 and 2. A qualitative assessment has therefore been undertaken to identify potential significant effects due to construction noise and consider likely mitigation measures.

9.2.3 Construction vibration

The methodology within DMRB LA 111 will be adopted for the assessment of construction vibration effects at sensitive receptors which refers to BS 5228-2:2009+A1:2014.

The construction vibration magnitude of impact is determined to be negligible, minor, moderate or major by comparison of construction vibration levels with LOAEL and SOAEL values for all relevant receptor properties as per DMRB LA

[171] The Basic Noise Level (BNL) refers to the LA10,18hr noise level from road traffic at 10m from the nearside carriageway edge as defined within the Calculation of Road Traffic Noise (CRTN).

111 Table 3.33 and section 3.34 and reproduced in Table 9-4. The LOAEL and SOAEL for construction vibration are defined in Table 9-1.

Table 9-4: Construction vibration level – magnitude of impact

Magnitude of impact	Vibration level
Major	Above or equal to 10 mm/s PPV
Moderate	Above or equal to SOAEL and below 10 mm/s PPV
Minor	Above equal to LOAEL and below SOAEL
Negligible	Below LOAEL

Source: DMRB LA 111 Table 3.33

A likely significant effect due to construction vibration is identified where a moderate or major magnitude of impact is predicted to occur for a duration exceeding: 10 or more days or nights in any 15 consecutive days or nights; or a total number of days exceeding 40 in any six consecutive months as per DMRB LA 111 section 3.34

Information relating to the proposed construction method, activities and programme are not available at this stage. Therefore, a qualitative assessment has been completed to inform potential significant effects due to construction vibration and likely mitigation measures have been considered.

9.2.4 Operational noise

DMRB LA 111 provides methodology for the assessment of operational noise effects at sensitive receptors. Receptors which are potentially sensitive to noise include dwellings, hospitals, healthcare facilities, education facilities, community facilities, designated sites, public rights of way and cultural heritage assets.

DMRB LA 111 requires the level of road traffic noise to be predicted using the Calculation of Road Traffic Noise (CRTN) calculation method from forecast traffic data provided in terms of 18-hour Annual Average Weekday Traffic (AAWT) flow between the hours of 06:00 to 00:00, along with speed pivoted vehicle speed and percentage of heavy goods vehicles. Calculations determine road traffic noise levels using noise descriptors $L_{A10,18hr}$ and L_{night}. L_{night} values are derived using TRL Method 3 in accordance with DMRB LA 111.

Calculations of the road traffic noise level are carried out for four scenarios:

- Do-Minimum option in the opening year
- Do-Minimum option in the future assessment year
- Do-Something option in the opening year
- Do-Something option in the future assessment year

In the above scenarios, 'Do-Minimum' means traffic growth with committed development only. 'Do-Something' means committed growth with the scheme. The future assessment year is opening year +15 years. In accordance with the DMRB LA 111, the assessment of road traffic noise effects requires the following comparisons:

- Do-Minimum scenario in the opening year against Do-Something in the opening year (short-term change with the scheme)
- Do-Minimum scenario in the opening year against Do-Something in the future assessment year (long-term change with the scheme)
- Do-Minimum scenario in the opening year against Do-Minimum in the future assessment year (long-term change without the scheme)

DMRB LA 111 classifies the magnitude of noise level change as no change, negligible, minor, moderate or major and applies different criteria in the short-term and long-term. These changes may be beneficial (noise decrease) or adverse (noise increase). These classifications will be applied as per DMRB LA 111 Tables 3.54a and 3.54b and summarised below in Table 9-5.

Table 9-5 : **Short-term and long-term magnitude of change**

Magnitude of impact	Short-term noise change (dB $L_{A10,18hr}$ or L_{night})	Long-term noise change (dB $L_{A10,18hr}$ or L_{night})
Major	Greater than or equal to 5.0	Greater than or equal to 10.0
Moderate	3.0 to 4.9	5.0 to 9.9
Minor	1.0 to 2.9	3.0 to 4.9
Negligible	Less than 1.0	Less than 3.0

Source: DMRB LA 111 Table 3.54a and Table 3.54b

Initial assessment of operational noise significance is based on the short-term magnitude of change as per DMRB LA 111 Table 3.58 which is reproduced in Table 9-6. Initial assessment considers negligible and minor short-term change likely not to be significant and moderate and major short-term change to be significant.

Table 9-6 : **Initial assessment of operational noise significance**

Short-term magnitude of change	Significance
Major	Significant
Moderate	Significant
Minor	Not significant
Negligible	Not significant

Source: DMRB LA 111 Table 3.33

In all cases where the magnitude of noise level change in the short-term is classified as minor, moderate or major, additional factors described in DMRB LA

111 Table 3.60 are considered to determine the significance. The factors that influence this judgement include the magnitude of change with respect to minor and moderate boundaries, the magnitude of impact in the long-term and short-term, consideration of absolute noise levels with respect to the LOAEL and SOAEL, location of noise sensitive parts of the receptor, acoustic context, and perception of change.

9.3 Assessment assumptions and limitations

No noise measurements have been undertaken to date to determine baseline noise levels. Noise monitoring will be undertaken at PCF Stage 3 during representative ambient noise conditions (i.e. during typical traffic levels, not during school holidays, etc.) at locations representative of noise sensitive receptors within the study area.

There is currently no information relating to construction activities, diversion routes or construction and operational traffic. This information would be required to undertake a quantitative assessment of construction noise and vibration impacts at PCF Stages 3. As such, a qualitative assessment has been undertaken.

9.4 Study area

9.4.1 Construction phase

For construction noise, DMRB LA 111 states that the study area is defined to include all noise sensitive receptors:

“1) that are potentially affected by construction noise;

2) in areas where there is a reasonable stakeholder expectation that a construction noise assessment will be undertaken.”

The qualitative assessment of construction noise will consider a study area of 300m from the closest construction activity. This is considered sufficient to account for all relevant noise sensitive receptors for the purposes of assessment at this stage.

9.4.2 Operation phase

For operational noise, DMRB LA 111 states that the study area should include the following:

“1) noise sensitive receptors that are potentially affected by operational noise changes generated by the project, either on the route of the project or other roads not physically changed by the project;

2) noise sensitive receptors in areas where there is a reasonable stakeholder expectation that noise assessment is undertaken.”

DMRB LA 111 advises that assessment is undertaken for receptors within 600m of new road links or road links physically changed or bypassed by the project and 50m of roads which are likely to experience a short-term change of 1dB $L_{A10,18hr}$ as a result of the scheme. Consequently, the spatial extents of the assessment can extend beyond the physical works associated with the scheme.

In the interest of a uniform comparison each scheme option has used the same study area which has been defined by the area covered 600m from any development associated with the scheme. Furthermore, considering uncertainties associated with the early stage of assessment, any changes in traffic on the wider road network are considered negligible.

9.5 Baseline conditions

Baseline noise surveys have not been undertaken at this stage of the scheme development but are to be undertaken at PCF Stage 3 subject to project programme and any local constraints (i.e. suitable and secure access, representative noise conditions due to unrepresentative changes in traffic flow or construction works associated with other development projects). Sensitive receptors and existing baseline conditions have been reviewed through desktop study. Sources of information considered include national noise mapping[172] and Ordnance Survey (OS) mapping.

9.5.1 Baseline conditions

The baseline noise climate levels in the vicinity of the scheme options are dominated by road traffic noise associated with the A27 and A24.

Other noise sources also contribute to existing noise levels at surrounding receptors including:

- Local road traffic on minor routes
- Commercial activities (e.g. shops, supermarkets, car garages, etc.)
- Community and residential activities
- Environmental noise sources (e.g. birdsong, wind in trees)

9.5.2 Noise Important Areas

The Environmental Noise (England) Regulations 2006 stipulate the requirement of environmental noise mapping for the exposure of populated areas, identifying Noise Important Areas (NIAs) that are at risk of experiencing significant adverse impacts to health and quality of life as a result of their exposure to road traffic noise

[172] Defra (2019) Strategic noise mapping Round 3 (2017) [online] available at: https://www.gov.uk/government/publications/strategic-noise-mapping-2019 (last accessed March 2022).

and that the management of noise is required to promote wellbeing. This is set out in the Noise Action Plans which are developed and implemented by the authorities responsible for the sources of noise affecting the NIAs. Where road schemes have the potential to affect the exposure of populated areas within an NIA, this should be assessed and measures to avoid adverse changes as a result of the scheme or opportunities to create beneficial impacts should be considered.

Six NIAs are located within approximately 600m of the scheme options:

- ID 224 is located on the intersection between A24 and A27 adjacent to Worthing College
- ID 176 is located on A24 east of the roundabout adjoining A24, A27, and Offington Lane
- ID 222 is located on A24 north of the roundabout adjoining A24, A27, and Offington Lane
- ID 12476 is located on A2032 west of the intersection adjoining A2031, Poulters Lane, and Offington Lane
- ID 168 is located on A24 between the intersection with Queens Street and the intersection with the railway line
- ID 13815 is located on A27 from the intersection with Busticle Lane and spanning for 2km along the length of A27

9.6 Potential impacts

The sections below provide a summary of the potential construction and operational impacts anticipated at this stage of the scheme in relation to noise and vibration.

9.6.1 Construction

During construction, noise and vibration generated during the works has the potential to directly impact the baseline for sensitive receptors for a temporary period. Construction noise and vibration impacts have been defined in Sections 9.2.2 and 9.2.3. Factors which have the potential to affect construction phase noise and vibration impacts include:

- Construction plant inventory and utilisation
- Programme and the duration of activities with noise and vibration impacts exceeding relevant thresholds
- Hours of work
- Proximity of the works to receptors
- Frequency and routing of the movement of construction vehicles
- The location of compounds

- The routing of temporary diversions, the volumes of traffic using them and duration they are applied.

The affected receptors are expected to be those in the vicinity of the scheme extents, although could also extend along elements of the existing road network, subject to diversions, haul routes and construction-related traffic.

9.6.2 Operation

The scheme has the potential to result in changes in noise conditions at surrounding noise sensitive receptors. Operational noise and vibration impacts have been defined in Section 9.2.4. Impacts due to changes in noise may affect residential, environmental, and ecological receptors. Impacts can be beneficial or adverse. Factors which have the potential to affect road traffic noise include:

- Overall traffic volume
- Proportion of heavy vehicles
- Traffic speed
- Road alignment (vertical and horizontal alignment)
- Type of carriageway surfacing material
- Change to the noise character of the existing area or non-acoustic factors (e.g. vegetation removal)

9.7 Design, mitigation and enhancement measures

9.7.1 Construction

Mitigation measures to reduce and manage noise and vibration during construction will be included where required and may include measures such as:

- Implementation of Best Practicable Means (BPM) as defined by BS5228
- Control of the timing of works
- Restrictions on the noisiest of activities
- Use of acoustic screening or enclosures around noisy items of plant and machinery
- Careful siting of haul routes
- Early construction of mitigation or screening where required for operational purposes
- Careful site layout to minimise noise and vibration impacts (e.g. location of compounds and compound internal layout)
- Noise and vibration monitoring
- Noise insulation or temporary rehousing

Noise and vibration construction mitigation measures will be included within the Environmental Management Plan (EMP) in accordance with DMRB LA 120 – Environmental management plans, Revision 1[173].

9.7.2 Operation

Operational noise mitigation measures will be included in the scheme design where required and may include a combination of measures such as:

- Changes to the horizontal or vertical alignment (although the scope for this within the scheme corridor is likely to be too constrained to achieve significant benefits)
- Acoustic barriers and/or bunds
- Low noise road surfacing

Acoustics screening (including acoustic barriers or bunds) will be considered where necessary to prevent significant adverse effects. It is noted that the practicality of implementing additional bunds or barriers may be prohibitive in some circumstances due to space requirements and width of verges in some areas of the scheme.

The benefit of additional mitigation measures is not included within this assessment. The mitigation design will however be reviewed further with appropriate measures included during the PCF Stage 3 preliminary design.

9.8 Assessment of likely significant effects

9.8.1 Construction noise

There is currently no information relating to construction activities, diversion routes or construction traffic which is required to undertake a quantitative assessment of construction noise. However, the main activities common for all scheme options during the construction phase and which would generate noise and vibration are:

- Clearances, fencing and site setup
- Demolition of existing structures and carriageways
- Excavation, earthworks and compaction
- Construction of bridges, retaining structures, services, drainage and new carriageways
- Installation of noise barriers, signage and road markings

[173] National Highways (2020) DMRB LA 120 – Environmental Management Plans, Revision 1

- Vehicles accessing the site and compounds for delivery of materials and equipment and arrival/departure of the workforce
- Surfacing

It is anticipated that the limits for normal working hours and levels of noise at nearby properties will be incorporated into the EMP and agreed by the Contractor in advance of works with local Authority Environmental Health Officers.

The use of BPM would be applied for noise control at all times during construction. These should include the selection of the most appropriate method and plant for the job, adequate maintenance of plant, optimum siting of stationary plant, local screening and the education of the workforce. Restrictions may also be placed on early/late delivery times. Potentially affected residents should be kept informed in advance of the works and contact details be provided to request further information or to report disturbance.

Mitigation related to construction noise and vibration will be set out within the EMP. This will identify the series of measures to reduce the environmental effects during the construction period and covers environmental and safety aspects affecting the interests of residents, businesses, all road users and the general public in the vicinity of the works. These measures will include considerations such as period of works and different phases of construction.

The effects of potential noise and vibration on affected communities can be mitigated by effective communication between the promoter, Contractor and the public. Prior notification of construction works to any potential affected residents will be required. Following that, investigation and remediation of noise issues during construction may also be required.

Where potentially significant effects of construction noise and vibration are predicted, the Contractor will consult the Local Authority to determine potential additional mitigation measures for the scheme.

The greatest risk of potential significant effects due to construction noise and vibration would occur at the closest receptor locations for construction works over extended periods. This may occur during some of the construction works around the proposed new junctions, for works that include heavy ground or piling works (due to both noise and vibration), and during night works when sensitivity is greater.

Where night works are included within the construction programme, mitigation should be implemented such that night-time works do not exceed the SOAEL threshold value at any receptor location for a period of 10 nights or more in any 15 consecutive nights or 40 nights or more in any consecutive six months.

With strict adherence to mitigation measures, construction noise and vibration impacts are expected to be managed to be within appropriate levels and are therefore not anticipated to result in significant adverse effects. Further detailed

assessment and consideration of mitigation measures will be required at a later stage (PCF Stage 3) when construction information is known.

9.8.2 Construction traffic

Detailed information is currently unavailable relating to construction traffic movements or diversion routes. It is expected that the majority of construction traffic would make use of the A24 and A27. These routes have relatively high traffic volumes and therefore the addition of construction vehicles throughout the construction phase is unlikely to result in large changes in noise or significant effects. The risk of adverse or significant adverse effects due to construction traffic is much greater where minor routes are used or where construction traffic enters low traffic volume residential areas. Noise effects due to construction traffic will need to be reviewed during the next PCF stage to consider proposed routes and potential significant effects.

9.8.3 Construction vibration

Construction of the scheme is likely to require the use of vibration generating equipment which has the potential to result in adverse vibration effects. The specific activities which will be utilised are not known at this stage nor exactly where these activities would be required. However, temporary vibration could result from activities such as concrete breaking, compaction and piling during construction of structures.

There is a greater risk of significant adverse effects due to piling works should vibratory or driven piling be used. Where piling is undertaken near to sensitive receptors mitigation measures to avoid significant adverse effects should include selection of alternative piling techniques (i.e. CFA or bored piling) or controls to restrict the duration of works which have the potential to exceed SOAEL (i.e. to less than 10 days in 15 consecutive days or less than 40 days in a six month period).

9.8.4 Operation

9.8.4.1 Non-project noise impact

The information in Table 9-7 presents a comparison between the predicted noise levels in the short-term for the Do-Minimum scenario in the opening year against those for the Do-Minimum scenario in the future assessment year.

Table 9-7 : **Non-project noise change: Do-Minimum future assessment year compared against the Do-Minimum Opening Year**

	Daytime		Night-time	
Change in noise level	**Number of dwellings**	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**

		Daytime		Night-time	
Increase in noise level, $L_{A10,18h}$	0.1-0.9	7498	233	7503	233
	1.0-2.9	28	0	24	0
	3.0-4.9	1	0	0	0
	5.0+	0	0	0	0
No change	0	211	0	211	0
Decrease in noise level, $L_{A10,18h}$	0.1-0.9	350	8	350	8
	1.0-2.9	0	0	0	0
	3.0-4.9	0	0	0	0
	5.0+	0	0	0	0
Total		8088	241	8088	241

9.8.4.2 Option 1

The information in Table 9-8 presents a comparison between the predicted noise levels in the short-term for the Do-Minimum scenario in the opening year against those for the Do-Something scenario in the opening year.

Table 9-8 : Short-term road traffic noise impacts for Option 1

		Daytime		Night-time	
Change in noise level		**Number of dwellings**	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level, $L_{A10,18h}$	0.1-0.9	3826	74	3839	74
	1.0-2.9	18	1	5	1
	3.0-4.9	0	0	0	0
	5.0+	0	0	0	0
No change	0	2747	86	2747	86
Decrease in noise level, $L_{A10,18h}$	0.1-0.9	1264	66	1296	67
	1.0-2.9	162	14	134	13
	3.0-4.9	9	0	6	0
	5.0+	62	0	61	0
Total		8088	241	8088	241

All short-term minor adverse impacts occur outside of NIAs. There are no short-term moderate or major adverse impacts anticipated associated with the scheme.

The information in Table 9-9 presents a comparison between the predicted noise levels in the long-term for the Do-Minimum scenario in the opening year against those for the Do-Something scenario in the future assessment year.

Table 9-9 : Long-term road traffic noise impacts for Option 1

		Daytime		Night-time	
Change in noise level		**Number of dwellings**	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level, $L_{A10,18h}$	0.1-2.9	7442	227	7442	227
	3.0-4.9	0	0	0	0
	5.0-9.9	0	0	0	0
	10.0+	0	0	0	0
No change	0	95	0	95	0
Decrease in noise level, $L_{A10,18h}$	0.1-2.9	484	14	486	14
	3.0-4.9	6	0	5	0
	5.0-9.9	30	0	37	0
	10.0+	31	0	23	0
Total		8088	241	8088	241

The are no long-term adverse impacts anticipated associated with the scheme.

9.8.4.3 Option 2

The information in Table 9-10 presents a comparison between the predicted noise levels in the short-term for the Do-Minimum scenario in the opening year against those for the Do-Something scenario in the opening year.

Table 9-10 : Short-term road traffic noise impacts for Option 2

		Daytime		Night-time	
Change in noise level		**Number of dwellings**	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level, $L_{A10,18h}$	0.1-0.9	4526	102	4572	103
	1.0-2.9	95	2	49	1
	3.0-4.9	0	0	0	0
	5.0+	0	0	0	0
No change	0	1485	25	1485	25

		Daytime		Night-time	
Decrease in noise level, $L_{A10,18h}$	0.1-0.9	1545	93	1611	97
	1.0-2.9	292	15	240	11
	3.0-4.9	50	3	42	3
	5.0+	95	1	89	1
Total		8088	241	8088	241

All short-term minor adverse impacts occur outside of NIAs. There are no short-term moderate or major adverse impacts anticipated associated with the scheme.

The information in Table 9-11 presents a comparison between the predicted noise levels in the long-term for the Do-Minimum scenario in the opening year against those for the Do-Something scenario in the future assessment year.

Table 9-11 : Long-term road traffic noise impacts for Option 2

		Daytime		Night-time	
Change in noise level		**Number of dwellings**	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level, $L_{A10,18h}$	0.1-2.9	5915	192	822	76
	3.0-4.9	912	24	211	6
	5.0-9.9	0	0	0	0
	10.0+	0	0	0	0
No change	0	192	2	10	2
Decrease in noise level, $L_{A10,18h}$	0.1-2.9	772	13	143	12
	3.0-4.9	174	7	7	0
	5.0-9.9	61	2	0	0
	10.0+	62	1	0	0
Total		8088	241	1193	96

The are no long-term adverse impacts anticipated associated with the scheme.

9.8.4.4 Option 3

The information in Table 9-12 presents a comparison between the predicted noise levels in the short-term for the Do-Minimum scenario in the opening year against those for the Do-Something scenario in the opening year.

Table 9-12 : Short-term road traffic noise impacts for Option 3

Change in noise level		Daytime		Night-time	
		Number of dwellings	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level, $L_{A10,18h}$	0.1-0.9	3992	97	4028	97
	1.0-2.9	73	1	37	1
	3.0-4.9	0	0	0	0
	5.0+	0	0	0	0
No change	0	1820	51	1820	51
Decrease in noise level, $L_{A10,18h}$	0.1-0.9	1781	73	1842	78
	1.0-2.9	286	15	235	10
	3.0-4.9	46	3	62	3
	5.0+	90	1	64	1
Total		8088	241	8088	241

All short-term minor adverse impacts occur outside of NIAs. There are no short-term moderate or major adverse impacts anticipated associated with the scheme.

The information in Table 9-13 presents a comparison between the predicted noise levels in the long-term for the Do-Minimum scenario in the opening year against those for the Do-Something scenario in the future assessment year.

Table 9-13 : Long-term road traffic noise impacts for Option 3

Change in noise level		Daytime		Night-time	
		Number of dwellings	**Number of other sensitive receptors**	**Number of dwellings**	**Number of other sensitive receptors**
Increase in noise level, $L_{A10,18h}$	0.1-2.9	7045	208	7045	208
	3.0-4.9	0	0	0	0
	5.0-9.9	0	0	0	0
	10.0+	0	0	0	0
No change	0	123	7	123	7
Decrease in noise level, $L_{A10,18h}$	0.1-2.9	805	24	818	24
	3.0-4.9	54	1	41	2
	5.0-9.9	30	1	38	0

		Daytime		Night-time	
	10.0+	31	0	23	0
Total		8088	241	8088	241

The are no long-term adverse impacts anticipated associated with the scheme.

9.8.4.5 Summary

The assessment results indicate there would likely be adverse and beneficial operational noise effects at a number of receptors due to implementation of any of the scheme options.

Potential noise impacts set out in Table 9-7 to Table 9-13 have been reviewed within the context of the noise levels at each receptor in relation to SOAEL and LOAEL in order to determine the potential for significant adverse operational noise effects. This review is presented in Table 9-14. At this stage of the project, no likely significant effects are anticipated as a result of Option 1.

Table 9-14 : **Assessment of likely significant effects for Options 2 and 3**

Receptor	Options	Cause of potential significance of effect	Mitigation	Significance of effect (with mitigation)
Dwellings on Offington Lane (A2031)	Options 2 and 3	Residual noise level is above SOAEL and magnitude of impact is minor adverse which according to Table 3.60 in LA 111 may result in an adverse significant effect.	N/A – mitigation is not possible with the effect occurring within an urban context where, for example, it would not be possible to install noise barriers or low noise road surfacing.	Not significant – impact is marginally above the minor threshold and long-term impacts are negligible

Further assessment at PCF Stage 3 is required to support design of any mitigation measures required to reduce noise impacts. While it will not be possible to mitigate or enhance in all locations due to scheme constraints and the urban context, acoustic mitigation or enhancement measures such as the horizontal and vertical alignment of roads, low noise surfacing, provision of acoustic bunds or barriers should be considered to minimise potential adverse noise impacts.

Considering the current design it is expected that residual noise impacts would not result in significant adverse effects from any of the three scheme options. In accordance with the NPPF, optimisation of the design and provision of additional measures should be included to minimise noise emissions and, where possible, reduce noise transmission. Removal of significant adverse effects would comply with the aims of NPPF and NPSE. Provision of mitigation to reduce noise effects would also assist in meeting the aims of the NPPF and NPSE.

10 Population and human health

10.1 Legislative and policy framework

The following legislation, planning policies and guidance relevant to the assessment of the effects of the scheme on the population and human health receptors are provided below.

10.1.1 Countryside and Rights of Way Act 2000

The main legal framework governing public footpaths, bridleways, traffic and restricted byways is provided by the Countryside and Rights of Way Act 2000. The first two parts of the Act are relevant to this assessment:

- Part 1 Access: this section of the Act recognises the right of access to mountain, moor, heath, down and registered common land. It also recognises the needs of landowners and managers.
- Part 2 Rights of Way: this section of the Act requires local authorities to review and publish plans for improving rights of way in their areas, taking into account the needs of the public, including disabled people. This section of the Act also outlines the mechanism to temporarily and permanently divert public rights of way (PRoW).

10.1.2 The Equality Act 2010

The Equality Act 2010 requires decision making to have due regard to the need to remove discrimination and support equality of opportunity for a range of 'protected characteristic' groups, including disabled people, children, women and older people. This is further considered within the Equality Impact Assessment (HE608509-MMD-GEN-OP00-RP-ZM-0010) for the scheme.

10.1.3 National Planning Policy Framework

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and the requirements for the planning system. It provides a framework within which local authorities and residents can produce local and neighbourhood plans reflecting the needs and priorities of communities.

Section 8 sets out core planning principles of the NPPF to achieve healthy, inclusive and safe places by promoting social interaction, ensuring safety and accessibility of public areas, and support healthy lifestyles. This also includes addressing identified local health and wellbeing needs through the provision of safe and accessible green infrastructure.

The same section presents core principles to support access to a network of high quality open spaces and opportunities for sport and physical activity. Planning

policies and decisions should protect and enhance PRoW and National Trails to support population health.

Section 9 encourages development that provides opportunities for sustainable transport, particularly by giving priority to pedestrian and cycle movements, and providing access to high quality public transport facilities.

10.1.4 Local Policy

The local planning framework comprises a number of documents that form the statutory development plan for West Sussex County Council (WSCC) and Adur and Worthing Councils. The scheme, which goes from Worthing to Lancing, covers both local areas and hence development plans of both West Sussex and Adur and Worthing Councils are considered. Table 10-1 below outlines local planning policies and consideration of these policies within this Environmental Assessment Report (EAR) chapter.

Table 10-1: Summary of Local Planning Policy

Local Planning Policy	Consideration within the EAR
West Sussex County Council Plan 2021-2025[174]	
Policy 2 – A sustainable and prosperous economy – Focusing on resetting the local economy, achieving social value and the delivery of sustainable infrastructure.	The EAR considers the impact of the scheme on employment and economy.
Policy 3 – Helping people and communities to fulfil their potential – Focusing on promoting independence, improving access to education and achieving connected communities.	The EAR considers the impact of the scheme on accessibility, amenity and health of communities to fulfil their potential.
Policy 4 – Making the best use of resources - Focusing on good governance and making best use of financial, human and natural resources to deliver collective ambitions.	The EAR considers the impact of the scheme on the requirement for land, green spaces, recreational areas and development land to make the best use of resources and minimise disruption.
Arun Local Plan 2011 to 2031[175]	
Policy SD SP1- Taking a positive approach that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework.	The EAR considers NPPF policies and aligns the baseline and impact assessment to evaluate the impact on population and human health.
Policy SD SP2 - Designing all major development to protect and enhance existing Green Infrastructure assets and connections between them.	Sections 10.5.1.5 and 10.5.2.2.2 provide an outline of green spaces and walkers, cyclers and horse riders (WCH) routes in Arun and assess the impact on these in sections 10.6.1 and 10.6.2.

[174] West Council County Council (2021): 'Our Council Plan 2021-2025:
[175] Arun District Council (2018): 'Adoption Arun local Plan 2011-2031'

Local Planning Policy	Consideration within the EAR
Policy HWB SP1 – Designing all development to maximise the impact it can make to promoting healthy communities and reducing health inequalities.	The EAR considers the health-related resources and impact of the scheme on hospitals and open spaces.
Policy OSR DM1 – Protecting open space, outdoor and indoor sport, community, arts and cultural facilities.	Sections 10.5.1.2, 10.5.1.5 and 10.5.2.2 of the EAR identify the community resources and open spaces within the study area.
Policy T SP1 – Ensuring that development provides safe access on to the highway network, contributes to highway improvements and promotes sustainable transport.	The EAR considers accessibility and road safety, making sure that potential impacts are analysed and mitigated in both construction and operation.
Policy T DM1 – New development ensuring ease of movement, prioritising safe pedestrian and cycle access to the green infrastructure network and access to public transport and community transport services.	Section 10.5.1.5 identifies key PRoW and cycle routes within the Local Impact Area (LIA).
Policy QE SP1 – New development contributing positively to the quality of the environment and ensuring that development does not have a significantly negative impact upon residential amenity, the natural environment, leisure and recreational activities enjoyed by residents and visitors.	The EAR identifies residential properties, recreational areas and community resources in Arun and other communities, and evaluates the potential impact on these, and provides mitigation measures to make sure impacts are managed.
Worthing Submission Draft Local Plan (2020-2036)[176]	
Policy SP3 Healthy Communities – New development must be designed to achieve healthy, inclusive and safe places, enabling and supporting healthy lifestyles and addressing health and well-being needs in Worthing.	The EAR identifies and assesses the impact on resources used for health purposes. The assessment also aims to improve walking and cycling facilities, and considers the overall impact on health and wellbeing.
Policy SS1 Spatial Strategy – Providing for the needs of local communities and balancing the impact of growth through the protection and enhancement of local services and the safeguarding of employment sites, leisure sites, community facilities and open spaces.	The EAR considers accessibility of services and resources, to ensure impacts are effectively identified and managed.
Policy DM8 Planning for sustainable communities – Supporting the improvements to health, education, social, community and cultural facilities to ensure they meet the needs of local communities.	The EAR identifies health, community assets and recreational resources in Worthing.
Policy DM9 Delivering Infrastructure – Development should take into account existing infrastructure and contribute to the provision of facilities, infrastructure and services.	The EAR identifies facilities and resources used by the local community in Worthing, making sure impacts are identified and mitigated.

[176] Worthing Borough Council (2021) 'Worthing Submission Draft Local plan 2020-2036'

10.2 Assessment methodology

The following policy, standards and guidelines are considered to be relevant to the assessment of population and human health effects due to the scheme:

- Design Manual for Roads and Bridges (DMRB) – LA 112 Population and Human Health Revision 1
- Institution of Environmental Management and Assessment (IEMA) Health in Environmental Impact Assessment: A primer for proportionate approach
- National Highways Cycling Strategy
- National Highways Accessibility Strategy

10.2.1 List of data sources used

The following provides a list of data sources used to undertake the Population and Human Health assessment:

- Arun District Council (2018): ‘Adoption Arun local Plan 2011-2031’
- Worthing Borough Council (2021) ’Worthing Submission Draft Local plan 2020-2036’
- DMRB LA 112 Population and human health revision 1
- Office for National Statistics (2021): ‘Business Register and Employment Survey’
- ONS mid-year population estimates for 2019 and Annual Population Survey 2020
- Ministry of Housing, Communities and Local Government (2019) 'English Indices of Deprivation'
- Public Health England (2019): National health indicators

10.2.2 Land-use and accessibility

The assessment will focus on those impacts that are likely to have significant effects on population and human health conditions and will be completed in accordance with the standard on population and human health impact assessment included in DMRB LA 112. Topic areas include the following, which focus on impacts associated with the requirement for land and impacts on accessibility:

- Private property and housing
- Community land and assets
- Development land and businesses
- Agricultural land holdings
- Walking, Cycling and Horse-riding (WCH)

Significance of effects is determined by considering the sensitivity of the receptor, as well as the magnitude of the impact on those receptors.

10.2.2.1 Sensitivity of receptors

Table 10-2 sets out criteria that will be used to describe and assess the sensitivity of population and human health receptors relevant to the land-use and accessibility, as outlined in the DMRB LA 112.

Table 10-2: Sensitivity of receptors

Sensitivity	Sensitivity criteria
Very high	Private property and housing: • Existing private property or land allocated for housing located in a local authority area where the number of households are expected to increase by >25% by 2041 (Office for National Statistics (ONS) data). • Existing housing and land allocated for housing (e.g. strategic housing sites) covering >5ha and/or >150 houses. Community land and assets where there is a combination of the following: • Complete severance between communities and their land/assets, with little/no accessibility provision • Alternatives are only available outside the local planning authority area. • The level of use is very frequent (daily). • The land and assets are used by the majority (>=50%) of the community. Development land and businesses: • Existing employment sites (excluding agriculture) and land allocated for employment (for example strategic employment sites) covering >5ha. Agricultural land holdings: • Areas of land in which the enterprise is wholly reliant on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on a frequent basis (daily). WCH: • National trails and routes likely to be used for both commuting and recreation that record frequent (daily) use. Such routes connect communities with employment land uses and other services with a direct and convenient WCH route. Little / no potential for substitution. • Routes regularly used by vulnerable travellers such as the elderly, school children and people with disabilities, who could be disproportionately affected by small changes in the baseline due to potentially different needs.

Sensitivity	Sensitivity criteria
	• Rights of way for WCH crossing roads at-grade with >16,000 vehicles per day.
High	Private property and housing: • Private property or land allocated for housing located in a local planning authority area where the number of households are expected to increase by 16-25% by 2041 (ONS data). • Existing housing and land allocated for housing (e.g. strategic housing sites) covering >1-5ha and / or >30-150 houses. • Community land and assets where there is a combination of the following: • There is substantial severance between community and assets, with limited accessibility provision. • Alternative facilities are only available in the wider local planning authority area. • The level of use is frequent (weekly). • The land and assets are used by the majority (>=50%) of the community. • Development land and businesses: • Existing employment sites (excluding agriculture) and land allocated for employment (for example strategic employment sites) covering >1 – 5ha. • Agricultural land holdings: • Areas of land in which the enterprise is dependent on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on a frequent basis (weekly). • WCH: • Regional trails and routes (for example promoted circular walks) likely to be used for recreation and to a lesser extent commuting, that record frequent (daily) use. Limited potential for substitution. Rights of way for WCH crossing roads at-grade with >8,000 – 16,000 vehicles per day.
Medium	Private property and housing: • Houses or land allocated for housing located in a local authority area where the number of households are expected to increase by >6-15% by 2041 (ONS data). • Existing housing and land allocated for housing (e.g. strategic housing sites) covering <1ha and / or <30 houses. Community land and assets where there is a combination of the following: • There is severance between communities and their land/assets but with existing accessibility provision. • Limited alternative facilities are available at a local level within adjacent communities. • The level of use is reasonably frequent (monthly). • The land and assets are used by the majority (>=50%) of the community. Development land and businesses:

Sensitivity	Sensitivity criteria
	• Existing employment sites (excluding agriculture) and land allocated for employment (for example strategic employment sites) covering <1ha. Agricultural land holdings: • Areas of land in which the enterprise is partially dependent on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on a reasonably frequent basis (monthly). WCH: • Public Rights of Way and other routes close to communities which are used for recreational purposes (for example dog walking), but for which alternative routes can be taken. These routes are likely to link to a wider network of routes to provide options for longer, recreational journeys. • Rights of way for WCH crossing roads at-grade with >4,000 – 8,000 vehicles per day.
Low	Private property and housing: • Proposed development on unallocated sites providing housing with planning permission/in the planning process. Community land and assets where there is a combination of the following: • Limited existing severance between community and assets, with existing Equality Act 2010 compliant accessibility provision. • Alternative facilities are available at a local level within the wider community • The level of use is infrequent (monthly or less frequent). • The land and assets are used by the minority (>=50%) of the community. Development land and businesses: • Proposed development on unallocated sites providing employment with planning permission / in the planning process. Agricultural land holdings: • Areas of land which the enterprise is not dependent on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on an infrequent basis (monthly or less frequent). WCH: • Routes which have fallen into disuse through past severance, or which are scarcely used because they do not currently offer a meaningful route for either utility or recreational purposes. • Rights of way for WCH crossing roads at-grade with <4,000 vehicles per day.
Negligible	Private property and housing: • N/A Community land and assets where there is a combination of the following: • No or limited severance or accessibility issues • Alternative facilities are available within the same community. • The level of use is very infrequent (a few occasions yearly). • The land and assets are used by the minority (>=50%) of the community. Development land and businesses:

Sensitivity	Sensitivity criteria
	• N/A Agricultural land holdings: • Areas of land which are infrequently used on a non-commercial basis WCH: • N/A

Source: DMRB LA 112 Population and human health, Revision 1, Table 11 Environmental value (sensitivity) and descriptions.

10.2.2.2 Magnitude of impacts

Table 10-3 sets out criteria that will be used to describe and assess the magnitude of impact on populations and human health receptors, as outlined in DMRB LA 112.

Table 10-3: Impact magnitude criteria for receptors

Magnitude	Criteria
Major	Private property and housing, community land and assets, development land and businesses and agricultural land holdings: • Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements. for example direct acquisition and demolition of buildings and direct development of land to accommodate highway assets. • Introduction (adverse) or removal (beneficial) of complete severance with no/full accessibility provision. WCH: • >500m increase (adverse) / decrease (beneficial) in WCH journey length.
Moderate	Private property and housing, community land and assets, development land and businesses and agricultural land holdings: • Partial loss of / damage to key characteristics, features or elements, for example partial removal or substantial amendment to access or acquisition of land compromising viability of property, businesses, community assets or agricultural holdings. • Introduction (adverse) or removal (beneficial) of severe severance with limited / moderate accessibility provision. WCH: • >250m - 500m increase (adverse) or decrease (beneficial) in WCH journey length.
Minor	Private property and housing, community land and assets, development land and businesses and agricultural land holdings: • A discernible change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements, for example amendment to access or acquisition of land resulting in changes to operating conditions that do not compromise overall viability of property, businesses, community assets or agricultural holdings. • Introduction (adverse) or removal (beneficial) of severance with adequate accessibility provision. WCH:

Magnitude	Criteria
	• >50m – 250m increase (adverse) or decrease (beneficial) in WCH journey length
Negligible	Private property and housing, community land and assets, development land and businesses and agricultural land holdings: • Very minor loss or detrimental alteration to one or more characteristics, features or elements. e.g. acquisition of non-operational land or buildings not directly affecting the viability of property, businesses, community assets or agricultural holdings. • Very minor introduction (adverse) or removal (beneficial) of severance with ample accessibility provision. WCH: • <50m increase (adverse) or decrease (beneficial) in WCH journey length.
No change	• No loss or alteration of characteristics, features, elements or accessibility; no observable impact in either direction.

Source: DMRB LA 112 Population and human health, Revision 1

10.2.2.3 Significance of effects

Once the appropriate sensitivity of the receptor and magnitude of impact have been identified using the sensitivity and magnitude criteria above, along with professional judgement to consider site specific factors that may be of relevance, the likely significance category and overall significance of effects were assessed by using the matrix provided within the Table 4-5 in Chapter 4.

Effects can be adverse or beneficial, and temporary or permanent. Only effects that are moderate or large are considered significant.

10.2.3 Human health

A qualitative assessment of human health has been undertaken in accordance with DMRB LA 112, with evidence provided to support conclusions. The geographical extent of the impacts considered within the qualitative assessment are dependent upon the nature and characteristics of a project and sensitivity of receptors.

The chapter considers effects on health determinants, which are the personal, social, economic and environmental factors that influence health status. The DMRB specifies the indicative types of health determinants, which include:

- The location and type of community, recreational and education facilities and severance/separation of communities from such facilities
- The location of green/open space and severance/separation from such facilities
- The location of healthcare facilities and severance/separation from such facilities

- Outline spatial characteristics of the transport network and usage in the area[177]
- Air quality management areas and ambient air quality
- Noise sensitive areas
- Sources and pathways of potential pollution
- Landscape amenity
- Safety information associated with the existing road[178]
- Information from stakeholder consultation[179]

Once the health profile of communities has been established, the sensitivity of a community/population to change is identified (supported with evidence).

The sensitivity of a community/population from a health point of view is reported as:

1. Low
2. Medium
3. High

The likely health outcome(s) have been identified in line with the categories in Table 10-4 below.

Table 10-4: Human health outcome categories

Health outcome category	Health outcome description
Positive	A beneficial health impact is identified
Neutral	No discernible health impact is identified
Negative	An adverse health impact is identified
Uncertain	Where uncertainty exists as to the overall health impact

Source: DMRB LA 112 Revision 1, Table 3.32 Human health outcome categories

Although the assessment of human health effects will describe the likely qualitative health outcomes, it is not possible to quantify the severity or extent of the effects which give rise to these outcomes. The potential health outcomes during construction and operation are based on broad categories for the qualitative impacts identified in accordance with Table 10-4 above. Significance is not assigned in the health assessment.

[177] Usage details are not available at this stage
[178] Safety information is not available at this early stage.
[179] Consultation information is not available at this stage.

10.2.4 Temporal scope of the scheme

The start of construction works associated with the scheme is currently anticipated to be March 2025. The exact construction duration remains unknown at present as the preferred route announcement is yet to be made, although the current programme estimates a construction period of approximately 18 months. The scheme is currently expected to be operational and open to traffic in 2026.

10.3 Assessment assumptions and limitations

Several assumptions and limitations have been identified as part of the assessment, which are summarised below:

- The assessment of the potential for significant effects has been carried out against a benchmark of current baseline conditions within the study area described in the section below. As with any dataset, these may be subject to change over time, which may influence the findings of the assessment and could lead to the assessment being subject to statistical time lag.
- The assessment of effects on users of community facilities is based on desktop study, and no topic-specific formal consultation has been undertaken to date to verify user levels.
- It is assumed that the construction process would not render local properties unusable and there would be no displacement of local residents.
- It is assumed that the construction compounds would require temporary land take, but the land would be reinstated ready for future uses.
- At this early stage of design agricultural land holding information is not yet available so it is not possible to determine the number of agricultural land holdings within the study area. In addition, questionnaires and interviews have not been undertaken with agricultural land holders at this early stage of design so further information on type, husbandry, frequency of use, and existing severance / accessibility issues, for example, is not yet known. Therefore, this assessment has only identified broad agricultural land within the area and land take, and not considered impacts at the land holding scale.
- WCH surveys have not been undertaken at this early stage of design. If WCH amenities (for example PRoW) are to be affected, then surveys will need to be completed in subsequent design stages to inform WCH provision for the scheme.
- There will be no traffic modelling data available for construction at this stage of assessment, but only for operation to feed into the noise and air quality assessments. Therefore, safety has not yet been assessed.

10.4 Study area

The population and human health assessment for both the construction and operational phases has been conducted at both Land Use and Accessibility Impact Area (LUAIA) level and Human Health Impact Area (HHIA) level, dependent on the type of impact being assessed.

The LUAIA and HHIA are created based on the DMRB LA 112 standard and professional judgement, and are defined as follows:

- LUAIA – The areas located within 500m of the scheme extent of the junctions is referred to as the LUAIA. The LUAIA covers several interventions and junctions along the Worthing to Lancing scheme extent. Effects considered within the LIA are more localised environmental, transport and health effects on the population.
- HHIA – The area covering the local authorities of WSCC and Adur and Worthing Council is referred to as the HHIA. This includes settlements such as Durrington Hill, Offington, Worthing, Lancing and parts of West Sussex. The WIA includes the extent of the area that may be affected by the operation of the scheme and is used for the consideration of population and human health effects in a broader area, as one of the objectives of the scheme is to support economic growth aspirations of the County and the region. Effects considered within the HHIA are largely on the local economy and public health.

Appendix F.1 and F.2 show maps of the LUAIA and HHIA respectively.

10.5 Baseline conditions

A range of publicly accessible data sources have been used to determine the population and human health baseline, covering all three options. These include statistics on demographics and employment from the ONS, health statistics from Public Health England, and local authority data on land use and resources.

These baseline conditions are presented below in accordance with DMRB LA 112 assessment requirements.

10.5.1 Land use and accessibility

10.5.1.1 Private property and housing

There are approximately 6,771 residential properties within the LUAIA. The majority of the residential properties within the LUAIA are located in the settlements of High Salvington, Offington, Broadwater, and North Lancing. Appendix F.4 shows residential properties within the LUAIA.

The total number of households is projected to increase by 21.7% by 2041 in Adur, and 26.6% in Worthing.

10.5.1.2 Community land and assets

There are a total of 80 community resources located within the LUAIA, including children's' nurseries, churches and religious meeting places, hospitals, primary schools, playgrounds, and several other resources. Appendix F.4 shows the locations and categories of community resources within the LUAIA.

Community resources closest to the scheme include:

- Worthing College, Worthing, approximately 180m north of the scheme
- First Steps Childcare Group, Worthing, approximately 260m north of the scheme
- Bramber Primary School, Worthing, approximately 115m south of the scheme
- Sompting Abbotts Preparatory School, Sompting, approximately 250m north of the scheme
- Church of St Mary the Blessed Virgin, Sompting, approximately 250m north of the scheme
- Christadelphians Church, Sompting, approximately 220m south-east of the scheme
- Sompting United Reformed Church, Sompting, approximately 220m south-east of the scheme
- Durrington Cemetery, Worthing, immediately adjacent to the scheme

10.5.1.3 Development land and businesses

According to the Worthing Local Plan, there are several allocated developments within the LUAIA, which include:

- A1 – Beeches Avenue: a residential development comprising of 90 residential units on Beeches Avenue, approximately 300m north of the scheme
- A15 – Upper Brighton Road: residential units on a greenfield site located on the north-eastern edge of Worthing. This development would be adjacent to the scheme.

According to the Adur Local Plan[180], there are several allocated developments within the LUAIA, which include:

- Policy 6: Land at West Sompting allocated for residential development comprising minimum of 480 dwellings at West Sompting. This allocated development land is adjacent to the scheme.

[180] Adur Local Plan (2017). 'Adur Local Plan 2017'. Available at: https://www.adur-worthing.gov.uk/media/media,147015,smxx.pdf#page=15

- Policy 5: Land at New Monks Farm allocated for residential development comprising a minimum of 800 dwellings, community resources and employment-generating floorspace. This allocated development is adjacent to the scheme. Suitable access from the A27 is also included.

There are 223 businesses within the LUAIA. The majority of businesses are concentrated around the Offington Corner Junction, Grove Lodge Junction, and Upper Brighton Road. Businesses include golf clubs, car repair shops, cafes and restaurants. Appendix F.5 shows businesses within the LUAIA.

Amongst the businesses closest to the scheme are:

- The Coach & Horses, Worthing– a bed and breakfast on Arundel Road, approximately 20m south of the scheme.
- Grove Lodge Vets, Worthing – a veterinarian clinic on the Upper Brighton Road, approximately 20m south of the scheme.
- The Charmandean Centre, Worthing, an events centre 10m south of the scheme.
- Toby Carvery, Worthing, a chain restaurant 15m north of the scheme.
- Red Square Retail Park, Worthing, with several well-known outlets and shops, immediately north of the scheme.

10.5.1.3.1 Employment and economic activity

Table 10-5 shows the economic activity rate, employment rate and unemployment rate for the working age population (16-64) for the study area. Data at LUAIA level is available only for the proportion of working age population.

Table 10-5: Economic activity baseline data

Area	Working age population (16-64)	Employment Rate (% of working age population)	Unemployment rate (% of working age population)
LUAIA	59%	n/a	n/a
HHIA	59%	82%	n/a
South East	61%	78%	3%
England	62%	75%	4%

Source: ONS mid-year population estimates, 2019 and Annual Population Survey 2020

The proportion of the population of working age in the LUAIA (59%) is in line with the HHIA proportion (59%) and slightly lower than the South East (61%) and England (62%) proportions. The proportion of employed working age population within the HHIA (82%) is higher than the South East (78%) and England (75%) proportions.

The Business Register and Employment Survey (BRES)[181] provides data on employment estimates by industry. The largest industries of employment in the LUAIA are manufacturing (32%), retail (12%), education (13%), health (9%), professional services (6%) and construction (8%).

10.5.1.4 Agricultural land holdings

There are several agricultural land holdings within the LUAIA. Much of the land appears to be used for arable production, predominantly to the north of the scheme. For instance, pockets of land on both sides of the Upper Brighton Road and West Street are used for agricultural purposes, with direct access from the A27. There are no agricultural land holdings within the footprint of the scheme. This means agricultural land would not be affected by the scheme, as no land take would be required.

10.5.1.5 Walkers, cyclists and horse-riders

According to WSCC, the following PRoW are located within the LUAIA:

- WSCC 2071: Footpath which intersects the scheme at Sompting Bypass between Dankton Lane and Thornbury House
- WSCC 2072: Footpath to the north of the scheme between Church Lane and Sompting Bypass
- WSCC 2073: Footpath which intersects the scheme at Sompting Bypass between West Street and bridleway 2076
- WSCC 2074: Footpath to the north of the scheme between Church Lane and Lambleys Lane
- WSCC 2075: Bridleway to the north of the scheme along Dankton lane
- WSCC 2081: Bridleway to the north of the scheme which intersects at Warren Road
- WSCC 2097: Bridleway to the north of the scheme between Foxley Lane and long Furlong
- WSCC 3134: Footpath to the north of the scheme which intersects the scheme at Upper Brighton Road
- WSCC 3135: Footpath to the south of the scheme between Upper Brighton Road and Bramper Road

The majority of footpaths and bridleways are to the north of the scheme.

[181] Office for National Statistics (2021): 'Business Register and Employment Survey' Available at: Business Register and Employment Survey - Office for National Statistics (ons.gov.uk)

Analysis of the Adur and Worthing Council's Local Cycling and Walking Infrastructure Plan (LCWIP)[182] has identified several cycle routes off the A27, which fall within the LUAIA, such as:

- Cycle Route 212: located near Offington Corner Junction
- Cycle Route 310: located between the Offington Corner Junction and Grove Lodge Junction
- Cycle Route 210: located parallel to the A27 between Worthing and Lancing

There are no national cycle network paths or national trails in the LUAIA.

There are further WCH amenities in the study area such as footways, PRoWs and road crossings which are identified in the section 10.4.1.5 above. The level of use, frequency of use and type of user of different WCH routes are not known, please see Section 10.3 for more detail.

10.5.2 Human health

10.5.2.1 Health profiles of affected communities

10.5.2.1.1 Population

There are approximately 24,883 people living in the LUAIA. The main settlements along the scheme are West Durrington, High Salvington, Offington, Broadwater and North Lancing.

Table 10-6 below shows the population and age structure of the LUAIA, HHIA, South East, and England.

Table 10-6: Population and age structure

Location	Total population	Children (Under 16)	Young people (16-24)	Older people (65+)
LUAIA	15,710	18%	9%	23%
HHIA	174,914	18%	8%	23%
South East	9,217,265	19%	10%	20%
England	56,286,961	19%	11%	19%

Source: 2019 mid-year population estimates, ONS and 2019 English Indices of Deprivation, MHCLG

The age structure of the population living within the LUAIA is broadly in line with the population living in the HHIA, South East, and England. However, the proportion of older people within the LUAIA (23%) is higher than the England

[182] Adur & Worthing Councils (2020): 'Local Cycling& Walking Infrastructure Plan' Available at: Adur & Worthing Local Walking & Cycling Infrastructure Plan (adur-worthing.gov.uk)

(19%) and South East (20%) proportions, despite being in line with the HHIA proportions (23%).

10.5.2.1.2 Deprivation

The English Indices of Deprivation (IoD) use a collection of indicators to provide a relative estimate of deprivation levels (poverty) within England. Table 10-7 shows the deprivation quintiles across the LUAIA, HHIA, South East, and England.

Table 10-7: Population by deprivation quintiles

Area	Most deprived	Second most deprived	Third most deprived	Fourth most deprived	Least deprived
LUAIA	0%	14%	14%	45%	27%
HHIA	6%	21%	30%	25%	18%
South East	8%	15%	20%	24%	33%
England	20%	20%	20%	20%	20%

Source: 2019 mid-year population estimates, ONS and 2019 English Indices of Deprivation, MHCLG

The proportion of the LUAIA population living in the most deprived areas is considerably lower than the HHIA (6%), South East (8%) and England (20%) proportions. The majority of population within the LUAIA live in areas that fall within either the least deprived or fourth most deprived quintile.

10.5.2.1.3 Health indicators

Table 10-8 presents key health indicators within the LUAIA, HHIA, South East and England. Data is only available for 'bad or very bad health' and 'long-term health problem or disability' (LTHD) at the LUAIA level.

Table 10-8: Public health baseline data

Measure	LUAIA	HHIA	South East	England
Bad or very bad health (2011)	5%	5%	4%	5%
Long-term health problem or disability (2011)	18%	20%	16%	18%
Life expectancy at birth (male 2016-18) (years)	n/a	80.1	80.7	79.6
Life expectancy at birth (female 2016-18) (years)	n/a	83.4	84.1	83.2
Percentage of physically inactive adults	n/a	18%	20%	23%
Under-75 mortality rate, cardiovascular diseases (per 100,000, 2019)	n/a	63	57.1	70.4
Under-75 mortality rate, all respiratory diseases (per 100,000, 2019)	n/a	27.3	28.1	34.2

Source: Public Health England 2018/2019, ONS Census 2011, ONS Life expectancy, UK, 2016 to 2018, Public Health England Mortality Profile 2017-2019

The proportion of population within the LUAIA (5%) with bad or very bad health is broadly in line with the HHIA (5%), South East (4%), and England (5%) proportions. In addition, the proportion of population with a long-term health problem or disability within the LUAIA (18%%) is also in line with the HHIA (20%), South East (16%) and England (18%) proportions. In addition, the proportion of physically inactive people within the HHIA (18%) is in line with South East's (20%), but lower than England (23%) proportions.

10.5.2.1.4 Community, recreational and educational facilities

The community, recreational and educational facilities within the LUAIA are listed in Section 10.5.1.2. The communities which these facilities serve do not experience existing severance or separation.

10.5.2.1.5 Green/open space

There are several green and open spaces within the LUAIA, the majority of which are unnamed. Green and open spaces located within the LUAIA include:

- South Downs National Park, a national park and designated green space, approximately 100m north of the scheme
- Hill Barn Kids Playground, Worthing, approximately 315m north-east of the scheme
- Charmandean Recreation Ground, Worthing, approximately 450m north-east of the scheme
- Sompting Recreation Ground, Sompting, approximately 450m east of the scheme
- Lancing Manor, Lancing, approximately 20m north of the scheme
- Manor Park Gardens, Lancing, approximately 20m south of the scheme

Appendix F.6 shows the green and open spaces (along with WCH routes) within the LIA.

10.5.2.1.6 Healthcare facilities

There are several healthcare facilities and hospitals within the LUAIA, amongst which are:

- Offington Park Residential Care Home, Worthing – a care home for older people, approximately 200m south-east of the scheme.
- Ball Tree Surgery, Sompting – an NHS GP surgery approximately 480m south of the scheme.
- Ball Tree Dental Practice, Sompting– a dental clinic approximately 170m south of the scheme.

The communities which these facilities serve do not experience existing severance or separation.

10.5.2.1.7 Transport network

The A27 is the main road providing connectivity between communities within the LUAIA. Several roads cross the A27, such as, A24 Findon Road, A2031 Offington Road, A24 Broadwater Street West and Busticle Lane, and also link to different communities and amenities in the LUAIA and HHIA.

There are several bus routes and stops within the LUAIA, which include bus routes 69 (Alfold to Worthing), 7 (Lancing to Salvington) and 23 (Worthing to Crawley).

10.5.2.1.8 Air quality management areas and ambient air quality

All scheme options are within the Worthing Air Quality Management Area (AQMA) and two additional AQMAs (the Shoreham AQMA and Southwick AQMA) are located within 10km of the scheme options, as indicated in the air quality chapter (Chapter 6). Existing pollutant concentrations are within the air quality objectives for PM_{10} and $PM_{2.5}$ within the study area. NO_2 concentrations are also within the air quality objective for the majority of locations, except a small number of locations within the Worthing AQMA, near the Grove Lodge Roundabout, and Busticle Lane junction.

10.5.2.1.9 Noise

The noise chapter (Chapter 12) identifies four Noise Important Areas (NIA) within the population and human health LIA for the scheme, amongst which are:

- ID 215 on a short section of the A27 Arundel Road
- ID 176 on a short section of the A24 Warren Road close to the roundabout
- ID 224 along the A24/A27 Warren Road from Hillside Avenue through the Grove Lodge Roundabout along the A27 Upper Brighton Road to Gainsborough Avenue
- ID 13815 along the A27 Upper Brighton Road from Busticle Lane to the east

10.5.2.1.10 Land quality

The land and soil conditions are summarised in the baseline of the Stages 1 and 2 Environmental Scoping Report (H608509-MMD-ENG-OP00-RP-LE-0003) chapter for geology and soils (Chapter 10). The scheme is situated in an area characterised as urban, with the historical land uses and fuel stations nearby posing contamination risk.

10.5.2.1.11 Landscape amenity

The scheme falls within the National Character Area (NCA) 125 South Downs (NE432) to the north and NCA 126 South Coast Plain (NE525) to the south, which is detailed further in the landscape and visual effects chapter (Chapter 8).

10.6 Potential impacts

All options under consideration have been assessed together, on the basis that they are likely to have similar potential impacts. Wherever option-specific effects are identified, this has been clarified within the assessment text.

10.6.1 Construction

10.6.1.1 Land use and accessibility

10.6.1.1.1 Private property and housing

Requirement for land

There would be no land requirement from any of the private properties and houses within the LUAIA.

Access

Increases in traffic from construction activities due to highway improvement works and junction interventions could affect access to several residential properties in the LUAIA. These impacts would be temporary and access would be maintained to affected properties, however the residents are likely to experience delays and inconveniences in accessing their properties.

10.6.1.1.2 Community land and assets

Requirement for land

There will be temporary 1m land take at different interventions along the A27 and this will not result in any impact on community land and assets.

Access

Increases in heavy goods vehicle (HGV) traffic from construction activities could impact a number of community resources in the LIA for Options 1, 2 and 3. Community resources to which access may be affected include several healthcare facilities in the LUAIA, including the Salvington Lodge, Meadowfield Hospital and Selden Hospital.

In Options 2 and 3, there is also likely to be a temporary effect on access to community resources on Upper Brighton Road and Goodwood Road, due to changes in the pedestrian and cycling environment while road signage and markings are being installed. This may affect access to resources including Bramber Primary School, Sompting Abbotts Preparatory School, Church of St Mary the Blessed Virgin and Christadelphians Church.

10.6.1.1.3 Agricultural land holdings

Requirement for land

All options may result in temporary land take, which will be 1m at each intervention and will not result in any impact on agricultural land holdings.

Access

None of the options are likely to affect access to agricultural land.

10.6.1.1.4 Development land and businesses

Requirement for land

All options may result in temporary land take, which will be 1m at each intervention and will not result in any impact on development land and businesses.

Access

Temporary changes to access, such as diversions, as well as increases in traffic from construction activities may impact access to a number of businesses within the LUAIA. Access to businesses on Upper Brighton Road may be temporarily disrupted in Options 2 and 3, including the Grove Lodge Vets close to the scheme. This is due to the conversion of Upper Brighton Road from a two-way to a one-way road, with no alternative routes.

In Options 2 and 3, access to businesses on Goodwood Road may be impacted due to the permanent loss of access from the A27. Offington Lane is an alternative route for Goodwood Road.

Option 3 is likely to permanently impact access to businesses on Hillbarn Parade during construction due to loss of access from the A27 eastbound. Halewick Lane runs adjacent to Hillbarn Parade and can be an alternative route for reaching the resources on Hillbarn Parade.

10.6.1.1.5 Walkers, cyclists and horse-riders

All options are likely to adversely impact WCH facilities for a temporary period, resulting in journey length and time increases, and increased severance to routes used by local people for accessing community facilities, including nearby schools such as Worthing College, Bramber Primary School and Sompting Abbotts Preparatory School.

10.6.1.2 Human health

10.6.1.2.1 Access to services, health and social care

None of the options are likely to affect access to services, health and social care within the LUAIA.

10.6.1.2.2 Employment and income

There are anticipated positive impacts on the local economy and employment during the construction of the scheme. This is because the scheme would include

development of local supply and value chains. This would generate construction-related jobs.

10.6.2 Operation

10.6.2.1 Land use and accessibility

10.6.2.1.1 Private property and housing

Requirement for land

There would be no further requirement for land associated with the operational phase for all scheme options. Therefore, there are no impacts anticipated on private property or housing associated with the requirement for land take in the operational stage.

Access

No additional disturbances in access are expected for any of the scheme options during the operational phase. The scheme is proposed to decrease congestion on the A27, which has the potential to improve access to settlements surrounding the scheme, including Offington, Broadwater and North Lancing. The scheme is also expected to reduce severance for road users and non-motorised users to residential areas in operation, resulting in further potential improvements to access.

10.6.2.1.2 Community land and assets

Requirement for land

There is no requirement for further land take from community assets expected for all options during the operational phase. Therefore, there are no impacts anticipated on community land and assets associated with the requirement for land take.

Access

The operation of the scheme has the potential to reduce severance for road users and non-motorised users for all scheme options, which means access to community land and assets is likely to improve. The extent of benefits would depend on each intervention, although reduction in road traffic along the A27 would benefit community assets around all interventions in High Salvington, Offington, Broadwater and North Lancing.

10.6.2.1.3 Agricultural land holdings

Requirement for land

There would be no requirement for further land take from agricultural land during the operational phase. Therefore, no agricultural land would be affected during the operational phase of all options.

Access

No additional disturbances in access are expected for any of the scheme options during the operational phase.

10.6.2.1.4 Development land and businesses

Requirement for land

There would be no requirement for land take for any of the scheme options during the operational phase. Therefore, there are no impacts anticipated on businesses or development land associated with the requirement for land take during operation.

Access

All scheme options have the potential to decrease congestion on the A27 in operation, which has the potential to improve access to businesses and development land in the vicinity of the scheme, including Salvington, Offington, Broadwater and North Lancing.

Walkers, cyclists and horse riders

All three scheme options have the potential to deliver improvements to pedestrian and cycle crossings at several junctions along the A27. This is likely to result in benefits in terms of accessibility and safety of WCHs within the LUAIA and WIA.

10.6.2.2 Human health

Access to green space, recreation and physical activity

None of the scheme options are expected to provide or remove opportunities for physical activity and keeping active. No change is expected to the current green spaces and recreational areas within the LUAIA. Improvements to infrastructure that encourages active travel modes has the potential for delivering public health benefits, although it is unlikely to cause a major change in the health of the population within the LUAIA.

Safety

All scheme options are proposed to reduce the number of accidents. All options are expected to result in the reduction of accidents and increased road safety along the A27 and in the vicinity.

Safety impacts have not been assessed at this stage but will be addressed at future PCF stages of the scheme.

Access to services, health and social care

The operation of the scheme is expected to reduce congestion and improve access to health and social care facilities within the LUAIA, such as Offington Park Residential Care Home. This is due to capacity improvements at nearby interventions and junctions along the A27. As there are several care homes throughout the scheme, these capacity improvements are likely to benefit access to these health and social care resources.

10.7 Design, mitigation and enhancement measures

10.7.1 Construction

Potential design, mitigation and enhancement measures in construction include:

- Use of appropriate mitigation measures through the Environmental Management Plan (EMP), which captures environmental mitigation and provides steps to mitigate traffic, landscape and visual effects.
- Liaison with stakeholders prior to the commencement of construction works such as hospitals, emergency services, South Downs National Park and local businesses and residents.
- Working with local businesses along the scheme to mitigate potential adverse construction effects through engaging them to understand their operational requirements and ensure scheme updates are communicated in a timely manner.
- Appropriate signage would be provided for temporary WCH diversions
- Liaise with bus companies in advance of works to enable them to plan service changes as necessary and advise passengers accordingly.

10.7.2 Operation

Potential design, mitigation and enhancement measures in operation include:

- New or diverted WCH routes would be embedded into the scheme design.
- Maintain access to all affected residential properties, businesses and community resources.

10.8 Assessment of likely significant effects

This section provides an overview of the likely significant effects in construction (Table 10.9) and operation (Table 10.10). All scheme options have been considered together, as they are considered to give rise to the same likely significant effects. Health effects are not included, as we do not assess significance in the same way.

10.8.1 Construction

Table 10-9: Assessment of likely significant effects

Receptor	Impact summary	Sensitivity/value	Impact magnitude	Mitigation	Significance of effect (with mitigation)
Construction – Land use and accessibility					
Residential properties within the LUAIA	Temporary reduction in access to and between residential properties due to increased construction vehicle traffic and delays to road users.	High	Negligible	Access to the properties would be maintained throughout construction.	Slight adverse
Community land and assets – within the LUAIA	Temporary reduction in access to community land and assets due to increased HGV and construction traffic.	Medium	Negligible	Use of appropriate good practice measures through the implementation of EMP and traffic management plans	Slight adverse
Businesses within the LUAIA	Temporary reduction in access to the businesses from construction activity and road works at interventions	Medium	Minor	No land would be required from businesses and access would be maintained throughout the construction.	Slight adverse
Walkers and cyclists in the LUAIA	Temporary reduction in the quality and enjoyment of the pedestrian and cycling environment within the LUAIA due to construction works and traffic.	Medium	Negligible (Option 1) Minor (Options 2 and 3)	Traffic and construction management measures will be in place and an access would be maintained throughout construction.	Neutral (Option 1) Slight adverse (Options 2 and 3)
Construction – Local Economy					
Local economy (HHIA)	Temporary beneficial effects on the local economy and employment in	Medium	Minor	Mitigation not applicable – beneficial impact	Slight beneficial

Receptor	Impact summary	Sensitivity/value	Impact magnitude	Mitigation	Significance of effect (with mitigation)
	relation to job creation, the supply chain and employment opportunities during construction.				

10.8.2 Operation

Table 10-10: Assessment of likely significant effects

Receptor	Impact summary	Sensitivity/value	Impact magnitude	Mitigation	Significance of effect (with mitigation)
Operation – Local Economy					
Local economy (HHIA)	The operation of the scheme is anticipated to permanently reduce congestion and journey times, supporting the future economic growth of the region.	Low	Minor	Mitigation not applicable – beneficial impact	Slight beneficial
Operation - Land use and accessibility					
Residential properties	The operation of the scheme is anticipated to improve access to and between residential properties due to reduction in road traffic and junction improvements.	High	Negligible	Not applicable – beneficial impact	Slight beneficial
Community land and assets – within the LUAIA	The operation of the scheme is likely to improve accessibility of community land and assets, including schools, churches and	Medium	Negligible	Not applicable – beneficial impact	Slight beneficial

Receptor	Impact summary	Sensitivity/value	Impact magnitude	Mitigation	Significance of effect (with mitigation)
	hospitals within the LUAIA.				

11 Road drainage and the water environment

11.1 Legislative and policy framework

The following legislation, planning policies and guidance relevant to the assessment of the effects of the scheme on the road drainage and water environment are provided below.

11.1.1 European legislation

Although the UK has left the EU, the following European legislation has been captured and integrated into UK law and is therefore still relevant to the scheme:

- EC Directive 2007/60/EC: The Floods Directive[183]
- EC Directive 2006/118/EC: Groundwater Daughter Directive[184]
- EC Directive 2004/35/EC: The 'Environment Liability Directive'[185]
- EC Directive 2000/60/EC: The Water Framework Directive[186]

11.1.2 National legislation

The national legislation relevant to the assessment of effects of the scheme on the road drainage and water environment is as follows:

- The Water Act (2014)[187]
- The Flood and Water Management Act (2010)[188]
- The Land Drainage Act (1991) (as amended)[189]

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[183] Available at: Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance) (legislation.gov.uk) [accessed March 2022].
[184] Available at: Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (legislation.gov.uk) [accessed March 2022].
[185] Available at: Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (legislation.gov.uk) [accessed March 2022].
[186] Available at: Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (legislation.gov.uk) [accessed March 2022].
[187] Available at:: Water Act 2014 (legislation.gov.uk) [accessed March 2022].
[188] Available at: Flood and Water Management Act 2010 (legislation.gov.uk) [accessed March 2022].
[189] Available at: Land Drainage Act 1991 (legislation.gov.uk) [accessed March 2022].

- The Water Resources Act (1991) (as amended)[190]
- The Salmon and Freshwater Fisheries Act 1975 as amended[191]
- The Environmental Permitting (England and Wales) Regulations 2016[192]
- The Environmental Damage (Prevention and Remediation) Regulations 2015[193]
- The Groundwater (England and Wales) Regulations 2009[194]
- The Water Environment (Water Framework Directive (WFD)) (England and Wales) Regulations 2017[195]
- The Control of Pollution (Oil Storage) (England) Regulations 2001[196]
- The Highways Act 1980 (Section 100)[197]
- The Flood Risk Regulations 2009[198]

11.1.3 Policies, standards and guidance documents

The national and local policy relevant to the assessment of effects of the scheme on the road drainage and water environment is as follows:

- National Planning Policy Framework (NPPF) 2019[199]
- Design Manual for Roads and Bridges (DMRB), LA 113 – Road drainage and the water environment[200]
- Future Water (2011) – Water strategy for England[201]

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[190] Available at: Water Resources Act 1991 (legislation.gov.uk) [accessed March 2022].
[191] Available at: Salmon and Freshwater Fisheries Act 1975 (legislation.gov.uk) [accessed March 2022].
[192] Available at: The Environmental Permitting (England and Wales) Regulations 2016 (legislation.gov.uk) [accessed March 2022].
[193] Available at: The Environmental Damage (Prevention and Remediation) (England) Regulations 2015 (legislation.gov.uk) [accessed March 2022].
[194] Available at: The Groundwater (England and Wales) Regulations 2009 (legislation.gov.uk) [accessed March 2022].
[195] Available at: The Groundwater (England and Wales) Regulations 2009 (legislation.gov.uk) [accessed March 2022].
[196] Available at: The Control of Pollution (Oil Storage) (England) Regulations 2001 (legislation.gov.uk) [accessed March 2022]
[197] Available at: Highways Act 1980 (legislation.gov.uk) [accessed March 2022].
[198] Available at: The Flood Risk Regulations 2009 (legislation.gov.uk) [accessed March 2022].
[199] Available at: National Planning Policy Framework (publishing.service.gov.uk) [accessed March 2022].
[200] Available at: d6388f5f-2694-4986-ac46-b17b62c21727 (standardsforhighways.co.uk) [accessed March 2022].
[201] Available at: Future water: The government's water strategy for England - GOV.UK (www.gov.uk) [accessed March 2022].

- Sustainable Drainage Systems Guidance[202]
- Local Policy – Adur Local Plan 2017158: Policy 35, and Policy 36
- Local Policy – Core Policies South Downs Local Plan 159: Policy SD17
- Local Policy – Draft Worthing Local Plan 2020: Policy DM20, Policy DM21, and Policy DM22.

11.2 Assessment methodology

The assessment will be undertaken in accordance with the methodology provided in DMRB LA 113 and LA 104, for assessing the significance of effects of the scheme on the road drainage and water environment, as outlined below.

11.2.1 Sensitivity and magnitude

Table 11-1 sets out the criteria that will be used to estimate the importance of the receptors and Table 11-2 sets out the criteria used to estimate the magnitude of an impact on the receptor, as outlined in DMRB LA 113.

Table 11-1: Estimating the importance of water environment

Importance	Typical criteria	Typical examples	
Very high	Nationally significant attribute of high importance	Surface water	• Watercourse having a WFD classification shown in a River Basin Management Plans (RBMP) and Q_{95} >1. 0m^3/s. • Site protected/designated under EC or UK legislation (Special Area of Conservation (SAC), Special Protection Area (SPA), Sites of Special Scientific Interest (SSSI), Ramsar site, salmonid water)/ Species protected by EC legislation LA 108 [Ref 1.N]
		Groundwater	• Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation LA 108 [Ref 1.N]. • Groundwater locally supports Ground Water Dependent Terrestrial Ecosystems (GDWTE) • Source Protection Zones 1 (SPZ)
		Flood risk	• Essential infrastructure or highly vulnerable development

[202] Available at: Sustainable drainage systems: non-statutory technical standards - GOV.UK (www.gov.uk) [accessed March 2022].

Importance	Typical criteria	Typical examples	
High	Locally significant attribute of high importance	Surface water	• Watercourse having a WFD classification shown in a RBMP and Q_{95} <1. 0m^3/s. • Species protected under EC or UK legislation LA 108 [Ref 1.N]
		Groundwater	• Principal aquifer providing a locally important resource or supporting river ecosystem. • Groundwater locally supports GWDTE • SPZ2
		Flood risk	• More vulnerable development
Medium	Of moderate quality and rarity	Surface water	• Watercourses not having a WFD classification shown in a RBMP and Q_{95} >0.001m^3/s.
		Groundwater	• Aquifer providing water for agricultural or industrial use with limited connection to surface water. • SPZ3.
		Flood risk	• Less vulnerable development.
Low	Lower quality	Surface water	• Watercourses not having a WFD classification shown in a RBMP and Q_{95} <0.001m^3/s.
		Groundwater	• Unproductive strata
		Flood risk	• Water compatible development.

Source: DMRB LA 113 – Road drainage and the water environment Revision 1. Table 3.70

Table 11-2: Estimating the magnitude of an impact on an attribute

Magnitude	Criteria	Typical examples	
Moderate adverse	Results in loss of attribute and/or quality and integrity of the attribute	Surface water	• Failure of both acute-soluble and chronic sediment related pollutants in Highways ENGLAND Water Risk Assessment Tool (HEWRAT) and compliance failure with Environmental Quality Standards (EQS) values. Calculated risk of pollution from a spillage >2% annually (spillage assessment). • Loss or extensive change to a fishery • Loss of regionally important public water supply • Loss or extensive change to a designated nature conservation site • Reduction in water body WFD classification
		Groundwater	• Loss of, or extensive change to an aquifer. • Loss of regionally important water supply.

Magnitude	Criteria	Typical examples	
			• Potential high risk of pollution to groundwater from routine run-off – risk score >250 (Groundwater quality and run-off assessment). • Calculated risk of pollution from spillages >2% annually (Spillage assessment). • Loss of, or extensive change to the GWDTE or baseflow contribution to protected surface water bodies. • Reduction in water body WFD classification. • Loss or significant damage to major structures through subsidence or similar effects.
		Flood risk	• Increase in peak flood level (> 100mm).
Moderate adverse	Results in some measurable change in attributes, quality or vulnerability	Surface water	• Failure of either acute-soluble and chronic sediment related pollutants in HEWRAT Calculated risk of pollution from a spillage >1% annually <2% annually (spillage assessment). • Partial loss in productivity of a fishery. • Degradation of regionally important public water supply or loss of major commercial / industrial / agricultural supplies. • Contribution to reduction in water body WFD classification.
		Groundwater	• Partial loss or change to an aquifer. • Degradation of regionally important public water supply or loss of significant commercial / industrial / agricultural supplies. • Potential medium risk of pollution from spillages >1% annually <2% annually (spillage assessment). • Partial loss of the integrity of GWDTE. • Contribution to reduction in water body WFD classification. • Damage to major structure through subsidence or similar effects or loss of minor structures.
		Flood risk	• Increase in peak flood level (> 50mm).
Minor adverse	Results in some measurable change in attributes, quality or vulnerability	Surface water	• Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. • Calculated risk of pollution from spillages >0.5% annually and <1% annually. • Minor effects on water supplies.
		Groundwater	• Potential low risk of pollution to groundwater from routine run-off – risk score <150.

Magnitude	Criteria	Typical examples	
			• Calculated risk of pollution from >0.5% annually and <1% annually. • Minor effects on an aquifer, GWDTEs, abstractions and structures.
		Flood risk	• Increase in peak flood level (> 10mm).
Negligible	Results in some measurable change in attributes but of insufficient magnitude to affect the use or integrity	The proposed project is unlikely to affect the integrity of the water environment.	
		Surface water	• No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). • Risk of pollution from spillages <0.5%.
		Groundwater	• No measurable impact upon an aquifer and/or groundwater receptors and risk of pollution from spillages <0.5%.
		Flood risk	• Negligible change to peak flood level (<+/-10mm).
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Surface water	• HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually).
		Groundwater	• Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk is <1% annually). • Reduction of groundwater hazards to existing structures. • Reductions in waterlogging and groundwater flooding.
		Flood risk	• Creation of flood storage and decrease in peak flood level (>10mm).
Moderate beneficial	Results in moderate improvement of attribute quality	Surface water	• HEWRAT assessment of either acute soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. • Calculated reduction in existing spillage by 50% or more (when existing spillage >1% annually). • Contribution to improvement in water body WFD classification.
		Groundwater	• Calculated reduction in existing spillage by 50% or more (when existing spillage >1% annually). • Contribution to improvement in water body WFD classification.

Magnitude	Criteria	Typical examples	
			• Improvement in water body catchment abstraction management strategy (or equivalent) classification. • Support to significant improvements in damaged GWDTE.
		Flood risk	• Creation of flood storage and decrease in peak flood level (>50mm).
Major beneficial	Results in major improvement of attribute quality	Surface water	• Removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to a watercourse. • Improvement in water body WFD classification.
		Groundwater	• Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. • Recharge of an aquifer. • Improvement in water body WFD classification.
		Flood risk	• Creation of flood storage and decrease in peak flood level (>100mm).
No change			No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Source: DMRB LA 113 Road drainage and the water environment Revision 1. Table 3.71

Following on from identifying an appropriate receptor sensitivity and magnitude of impact using Table 11-1 and Table 11-2, the likely significance category and overall significance of effects would be assessed by using the matrix provided within Table 4-5 within Section 4.4.

In accordance with DMRB LA 113, the principal types of impacts considered within the scoping assessment and subsequent EAR include:

- Impacts on surface water:
  - Water quality (routine run-off and spillage)
  - Hydromorphology
- Impacts on groundwater:
  - Water quality (routine run-off and spillage)
  - Groundwater levels and flows
  - Groundwater dependent terrestrial ecosystems
- Flood impacts

No Water Framework Directive (WFD) assessment or Flood Risk Assessment (FRA) has been completed at this stage. These will be completed in PCF Stage 3 if required.

11.3 Assessment assumptions and limitations

The assessment in this chapter has been prepared using publicly available information only and is based on a desk-based study. No flood modelling has been carried out for this report. No water or sediment quality sampling was carried out for this report. It has also been assumed that the available information on surface water and groundwater quality and flood risk is representative of the general conditions and there are therefore no limitations on the assessment.

Discharges of trade effluent or water to a surface waterbody may require an environmental permit to be acquired from the Environment Agency. As no main rivers have been identified within 100m of the scheme interventions, it is not anticipated for works to require an environmental permit.

11.4 Study area

The study area for the assessment of potential effects on road drainage and the water environment covers a 1km radius around the scheme, based on professional judgement to ensure potential effects on surface and groundwater are sufficiently identified. The 1km study area has been extended where there are sensitive features (protected areas) that may be affected by contaminants transported downstream of the works via surface water bodies, these features are included in the assessment where appropriate. This approach ensures that any potential effects of the scheme are sufficiently identified.

11.5 Baseline conditions

Information to assist with defining the existing baseline conditions has been obtained from the following sources:

- Environment Agency's Catchment Data Explorer[203]
- Environment Agency Flood Map for Planning[204]
- South East River Basin Management Plan (RBMP)[205]
- Department for Environment Food Rural Affairs (Defra) 'Magic' (Multi-agency geographic information for the countryside) interactive map[206]

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[203] Environment Agency (2021) Environment Agency Data Catchment Explorer [online] Available at: https://environment.data.gov.uk/catchment-planning/ (Last accessed March 2022).
[204] Environment Agency (2021) Environment Agency Flood Map for Planning [online] available at: https://flood-map-for-planning.service.gov.uk/ (Last accessed March 2022).
[205] Environment Agency (2015) South East River Basin Management Plan [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718337/South_East_RBD_Part_1_river_basin_management_plan.pdf (Last accessed March 2022).
[206] DEFRA Magic Map. Available at: https://magic.defra.gov.uk/MagicMap.aspx (Last accessed March 2022).

- Environment Agency's published data[207]
- British Geological Society: Geology of Britain[208]
- United Kingdom Soil Observatory (UKSO) information[209]
- Design Manual for Roads and Bridges (DMRB) LA 104 – Environmental assessment and monitoring, Revision 1[210]
- DMRB LA 113 – Road drainage and the water environment, Revision 1[211]
- DMRB LA 104 – Environmental assessment and monitoring, Revision 1[212]

The baseline considers the range and interactions of processes which will influence surface and groundwater, meeting the WFD objectives, and flood risk and drainage.

11.5.1 WFD identified waterbodies

Table 11-3 identifies the WFD receptors within the study area below.

Table 11-3: WFD identified waterbodies

WFD name	WFD category	Scheme option	Approximate distance from intervention
Teville Stream (GB107041011940)	River	Lyons Way Sompting Junction	645m east
		Upper Brighton Road	210m south
Worthing Chalk (GB40701G505300)	Groundwater	All	Underlying

Source: Environment Agency's Catchment Data Explorer

[207] Environment Agency's published data. Available at: Public registers (data.gov.uk) (Last accessed March 2022).
[208] British Geological Survey, Geology of Britain. Available at: Geology of Britain viewer | British Geological Survey (BGS) (Last accessed March 2022).
[209] UKSO. Available at: UK Soil Observatory (bgs.ac.uk) (Last accessed March 2022).
[210] National Highways (2020) DMRB LA 104 – Environmental assessment and monitoring Revision 1 [online] available at: 0f6e0b6a-d08e-4673-8691-cab564d4a60a (standardsforhighways.co.uk) (Last accessed March 2022).
[211] National Highways (2020) DMRB LA 113 – Road drainage and the water environment Revision 1 [online] available at: d6388f5f-2694-4986-ac46-b17b62c21727 (standardsforhighways.co.uk) (Last accessed March 2022).
[212] National Highways (2020) DMRB LA 104 – Environmental assessment and monitoring Revision 1 [online] available at: 0f6e0b6a-d08e-4673-8691-cab564d4a60a (standardsforhighways.co.uk) (Last accessed March 2022).

11.5.1.1 WFD quality

Teville Stream is classified as a heavily modified waterbody (HMWB) with a status (RBMP Cycle 2 (2019)) of 'bad' for ecological quality and 'moderate' for physico-chemical quality elements.

Worthing Chalk groundwater body has an overall waterbody status of RBMP Cycle 2 (2019) 'Poor', with the objective of achieving overall 'Poor' by 2015.

11.5.2 Surface water

Table 11-4 identifies the surface waterbodies and flood risk within the study area relevant to the individual intervention locations. This has been done to allow the locations to be split into the different options for the assessment.

Table 11-4: Surface waterbodies and flood risk identification at assets

Intervention	Topic		Summary of existing baseline
Offington Corner Roundabout	Surface waterbodies		No streams or ponds identified from Ordance Survey (OS) maps within 1km.
	Flood risk	Surface water	This roundabout and the surrounding road network are identified as varying in risk of surface water flooding from low to high. Offington Lane (A2031), Findon Road (A24) and Goodwood Road are highlighted as having a high risk of surface water flooding.
		Rivers / sea	No risk of flooding from the river/sea identified.
		Artificial sources	No risk of flooding from reservoirs or canals identified
Grove Lodge Junction	Surface waterbodies		No streams or ponds identified from OS maps within 1km.
	Flood risk	Surface water	The majority of the roundabout is identified as having a low to very low risk of flooding from surface water, with a minor section of high risk identified along Warren Road (A27) and close to the exit for Broadwater Street West (A24). Parallel to the A27 and A24, there is a series of high – low risk areas within the housing developments adjacent and to the west of the junction.
		Rivers / sea	No risk of flooding from the river / sea identified.
		Artificial sources	No risk of flooding from reservoirs or canals identified.
	Surface waterbodies		There are a series of drains (possibly agricultural drains) approximately 520m

Intervention	Topic		Summary of existing baseline
Lyons Way Sompting Junction			south-east of the junction which appear to drain into the Teville Stream. There are two ponds adjacent to the A27, approximately 845m east of the junction within a residential property.
	Flood risk	Surface water	The majority of the junction is considered to be at very low risk of surface water flooding, with surrounding roads to the south of the A27 are at a low risk of surface water flooding.
		Rivers / sea	The immediate area surrounding the Teville Stream and the associated drainage network has areas of medium to high risk of river and surface water flooding.
		Artificial sources	No risk of flooding from reservoirs or canals identified.
Upper Brighton Road	Surface waterbodies		There are a series of drains (possibly agricultural drains) approximately 70m south of the road which are assumed for the purpose of this assessment to drain into the Teville Stream. There are two ponds adjacent to the A27, approximately 220m north of the road within a residential property.
	Flood risk	Surface water	The road is considered to be at a very low risk of surface water flooding.
		Rivers / sea	The immediate area surrounding the Teville Stream and the associated drainage network is considered to have areas of medium to high risk of river and surface water flooding.
		Artificial sources	No risk of flooding from reservoirs or canals identified.
Busticle Lane Junction	Surface waterbodies		There is a drain approximately 980m south of the junction, which is assumed for the purpose of this assessment to drain into the Teville Stream WFD waterbody. There is a small, covered water storage pond at a pumping station approximately 880m north-west of the junction.
	Flood risk	Surface water	The junction is considered to have a medium to low risk of surface water flooding. In the field bordering the northern section of the junction, it is considered for the corner to have a high risk of flooding from surface water.
		Rivers / sea	There is no risk of flooding from rivers / sea within 1km of the junction.

Intervention	Topic		Summary of existing baseline
		Artificial sources	No risk of flooding from reservoirs or canals identified.

11.5.3 Discharge consents

Table 11-5 identifies the consented discharges within the study area. If the scheme intervention is not listed below, no discharge consents were identified.

Table 11-5: Discharge consents within study area

Intervention	Owner	Location	Grid reference	Distance from asset (km)	Nature of discharge
Grove Lodge Junction (BN14 9DL)	Mr J King	P00643, Building No.2, North of Beeches Avenue, Worthing, West Sussex	TQ1494005390	0.9	Miscellaneous
Lyons Way Sompting Junction (BN14 9JL)	Mr J King	P00643, Building No.2, North of Beeches Avenue, Worthing, West Sussex	TQ1494005390	0.4	Miscellaneous
	Sompting Estate Trustees	N03195, 3 Bungalows Upton Park, Sompting Estate, Lambley's Lane, Sompting Lancing, Sussex	TQ1557005320	0.4	Sewage – not water company
	M.Tristram ESQ, & Mrs. R.Macmahon	P00752, 1 & 2 Lambleys Lane, Sompting, West Sussex	TQ1558005330	0.4	Sewage – not water company
	Southern Waters Services Ltd.	A00962, Sompting Road, CSO opposite No.22, Worthing, West Sussex, BN14 9EP	TQ1511004491	0.6	Sewage – water company
	Southern Waters Services Ltd.	A00962, Sompting Road, CSO opposite No.22, Worthing, West Sussex, BN14 9EP	TQ1511004491	0.6	Sewage – water company
	Southern Waters Services Ltd.	A00962, Sompting Road, CSO opposite No.22, Worthing, West Sussex, BN14 9EP	TQ1511004491	0.6	Sewage – water company
	Smithkline Beecham Pharm. PLC	P01305, Clarenden Road, Worthing, West Sussex	TQ1560004600	0.6	Trade
	Smithkline Beecham Pharm. PLC	P01305, Clarenden Road, Worthing, West Sussex	TQ1560004600	0.6	Trade
	Smithkline Beecham PLC	P07126, Smithkline Beecham Pharmaceutica, Clarenden Road, Worthing, West Sussex	TQ1518004430	0.6	Trade
	Smithkline Beecham PLC	S01633, Clarenden Road, Worthing, West Sussex	TQ1571004711	0.6	Miscellaneous

Intervention	Owner	Location	Grid reference	Distance from asset (km)	Nature of discharge
	Smithkline Beecham PLC	AU0392, Clarenden Road, Worthing, West Sussex	TQ1571004710	0.6	Trade
	Smithkline Beecham Pharm. PLC	S01889, Clarenden Road, Worthing, West Sussex	TQ1570004540	0.7	Miscellaneous
	Smithkline Beecham Pharm. PLC	N01418, Clarenden Road, Worthing, West Sussex	TQ1569004530	0.7	Miscellaneous
	PFC Asset Management Ltd.	S02186, Hazelwood Nursery Site, Dominion Way, Worthing, West Sussex	TQ1590004500	0.9	Miscellaneous
	Timberlaine Properties PLC	S01864, Site of park nursery, Southdownview Road, Worthing, West Sussex	TQ1583004420	0.9	Miscellaneous
Upper Brighton Road (BN14 9JS)	Sompting Estate Trustees	N03195, 3 Bungalows Upton Park, Sompting Estate, Lambley's Lane, Sompting Lancing, Sussex	TQ1557005320	0.3	Sewage – not water company
	M.Tristram ESQ, & Mrs. R.Macmahon	P00752, 1 & 2 Lambleys Lane, Sompting, West Sussex	TQ1558005330	0.3	Sewage – not water company
	Smithkline Beecham PLC	S01633, Clarenden Road, Worthing, West Sussex	TQ1571004711	0.5	Miscellaneous
	Smithkline Beecham PLC	AU0392, Clarenden Road, Worthing, West Sussex	TQ1571004710	0.5	Trade
	Smithkline Beecham Pharm. PLC	P01305, Clarenden Road, Worthing, West Sussex	TQ1560004600	0.5	Trade
	Mr J King	P00643, Building No.2, North of Beeches Avenue, Worthing, West Sussex	TQ1494005390	0.5	Miscellaneous
	Smithkline Beecham Pharm. PLC	S01889, Clarenden Road, Worthing, West Sussex	TQ1570004540	0.6	Miscellaneous

Intervention	Owner	Location	Grid reference	Distance from asset (km)	Nature of discharge
	Smithkline Beecham Pharm. PLC	N01418, Clarenden Road, Worthing, West Sussex	TQ1569004530	0.6	Miscellaneous
	Southern Waters Services Ltd.	A00962, Sompting Road, CSO opposite No.22, Worthing, West Sussex, BN14 9EP	TQ1511004491	0.7	Sewage – water company
	Smithkline Beecham PLC	P07126, Smithkline Beecham Pharmaceutica, Clarenden Road, Worthing, West Sussex	TQ1518004430	0.7	Trade
	PFC Asset Management Ltd.	S02186, Hazelwood Nursery Site, Dominion Way, Worthing, West Sussex	TQ1590004500	0.8	Miscellaneous
	Timberlaine Properties PLC	S01864, Site of park nursery, Southdownview Road, Worthing, West Sussex	TQ1583004420	0.9	Miscellaneous
	Geoffrey A. Javis Industrials	N02048, Land east of Ziebart Ltd., Dominion Way	TQ1592004420	0.8	Miscellaneous
	Nursing & Hygiene Supplies	P07216, Nursing & Hygiene Supplies, Riverside House	TQ1588004370	0.8	Sewage – not water company
	Johnson & Wayne Ltd.	S01942, Plot 6 E. WTHG Trading Est, Worthing	TQ1592004390	0.8	Miscellaneous
	R.M.C. Properties Ltd.	S01946, Plots 1 & 2, E. Worthing Trading Est.	TQ1579004280	0.9	Miscellaneous
	Imry Management Ltd.	N01503, Hazelwood Estate, Hazelwood Close	TQ1575004250	0.9	Miscellaneous

Source: Department for Environment Food & Rural Affairs. Available online at: Environmental Permitting Regulations – Discharges to water and groundwater (data.gov.uk)

11.5.4 Groundwater

This section summarises the existing groundwater, geology and soils within the study area.

The geology across the study area has been classified as a Principal (bedrock) Aquifer, which is defined as being '*strategically important due to high permeability and water storage capacity*'. There are small areas across the scheme extent classified as Secondary (undifferentiated) Aquifers (permeable layers capable of supporting water supplies at a local rather than strategic scale).

The underlying bedrock within the scheme extent comprises of Tarrant Chalk Member, Newhaven Chalk Formation, and Spetisbury Chalk Member with overlying superficial deposits comprising of clay, silt, sand and gravel.

Upper Brighton Road and Busticle Lane Junction are located within the Sussex Chalk Nitrate Vulnerable Zone (NVZ), whilst the Grove Lodge Junction, and Lyons Way Sompting Junction are located adjacent to the NVZ. Offington Corner Roundabout, Grove Lodge Junction, Lyons Way Sompting Junction, and Upper Brighton Road are located within Source Protection Zones (SPZs); more information is provided in Section 11.5.5.

There are two historical landfills registered within the study area:

- The northern corner of Hill Barn Recreation Ground is registered as a historic landfill and this is approximately 495m north-east, 815m north, and 960m north-east of Grove Lodge Junction, Lyons Way Sompting Junction, and Upper Brighton Road respectively.
- Halewick Lane Tip is approximately 930m north of Busticle Lane Junction.

11.5.5 Protected areas

Table 11-6 identifies the protected areas within the study area.

Table 11-6: Identified protected areas within study area

Intervention	Summary of existing baseline	
Offington Corner Roundabout	Biodiversity	No designations identified within study area of this asset.
	Water environment	This asset is located within a SPZ I (Inner Protection Zone). This asset is located above a Principal Aquifer (bedrock) and Secondary (undifferentiated) Aquifer (superficial).
	Contaminated land	There are no authorised or historic landfills within the study area.
	Biodiversity	No designations identified within study area of this asset.

Intervention	Summary of existing baseline	
Grove Lodge Junction	Water environment	This asset is located within a SPZ I (Inner Protection Zone). This asset is located above a Principal Aquifer (bedrock) and Secondary (undifferentiated) Aquifer (superficial).
	Contaminated land	The northern corner of Hill Barn Recreation Ground approximately 495m north-east of the asset is registered as a historical landfill site. There are no authorised landfills within the study area.
Lyons Way Sompting Junction	Biodiversity	No designations identified within study area of this asset.
	Water environment	This asset is located within a SPZ I (Inner Protection Zone). This asset is located above a Principal Aquifer (bedrock) and Secondary (undifferentiated) Aquifer (superficial).
	Contaminated land	The northern corner of Hill Barn Recreation Ground approximately 815m north of the asset is registered as a historical landfill site. There are no authorised landfills within the study area.
Upper Brighton Road	Biodiversity	No designations identified within study area of this asset.
	Water environment	This asset spans across SPZ I (Inner Protection Zone) and SPZ II (Outer Protection Zone). This asset located above a Principal Aquifer (bedrock) and Secondary (undifferentiated) Aquifer (superficial).
	Contaminated land	The northern corner of Hill barn Recreation Ground approximately 960m north-east of the asset is registered as a historical landfill site. There are no authorised landfills within the study area.
Busticle Lane Junction	Biodiversity	Lancing Ring Local Nature Reserve (LNR) is located approximately 350m north-east from this junction. This LNR is important for its chalk grassland and is an Urban Fringe LNR, however it is not hydrologically connected to the intervention.
	Water environment	This asset is not within a SPZ. This asset is located above a Principal Aquifer (bedrock) and Secondary (undifferentiated) Aquifer (superficial).
	Contaminated land	Halewick Lane Tip is approximately 930m north of the asset and is registered as a historical landfill site. There are no authorised landfills within the study area.

11.5.6 Water attribute importance (value) of receptors

The following sensitive receptors (Table 11-7) have been identified within the study area of each option, following the methodology set out in Table 11-1.

Table 11-7: Importance of sensitive receptors

Option	Receptor	Importance	Justification
Option 1	Worthing Chalk (GB40701G505300) WFD groundwater body	Very high	Principal aquifer considered to be highly productive. Areas of SPZ1 identified.
Option 2	Teville Stream (GB107041011940) WFD river waterbody	High	This river waterbody has a WFD classification shown in a RBMP. It is not known what Q_{95} value this waterbody has, therefore it is assumed to be <1.0m^3/s.
	Worthing Chalk (GB40701G505300) WFD groundwater body	Very high	Principal aquifer considered to be highly productive. Areas of SPZ1 identified.
Option 3	Teville Stream (GB107041011940) WFD river waterbody	High	This river waterbody has a WFD classification shown in a RBMP. It is not known what Q_{95} value this waterbody has, therefore it is assumed to be <1.0m^3/s.
	Worthing Chalk (GB40701G505300) WFD groundwater body	Very high	Principal aquifer considered to be highly productive. Areas of SPZ1 identified.

11.6 Potential impacts

11.6.1 Construction

The potential construction impacts in Table 11-8 were identified for all scheme options.

Table 11-8: Summary of potential construction impacts

Potential construction impact	
Changes to groundwater flow	Earthworks may cause disruptions to the groundwater flow regime and flood flow pathway. This may lead to interruptions of flow, leading to either a reduction or loss of water supply to abstractions, and springs/streams. This may also impact properties or roads within flood zones.
Pollution of groundwater	Contamination of groundwater may occur due to accidental spillages or direct contact with construction materials, or piling operations which would create pathways and mobilise contaminated soil (if present).
	Aquifer pollution may affect indirect groundwater receptors such as springs, streams and/or abstractions.

Potential construction impact	
Surface water quality	Contaminants likely to impact water quality during the construction phase are suspended soils, fuel, oil, concrete liquors and hydrocarbons from road surface construction.
	Disturbance and release of excess fine sediment and suspended solids can contaminate run-off and could reduce water quality.
Construction within areas with risk of flooding	Construction within or adjacent to areas with a risk of flooding could temporarily alter the flow paths or increase run-off, therefore there is a potential increase in risk of flooding occurring.

11.6.2 Operation

The potential operational impacts in Table 11-9 were identified for all scheme options.

Table 11-9: Summary of potential operational impacts

Potential operational impact	
Changes to groundwater flow	Piling or other permanent below-ground surface alterations may cause a change in the existing groundwater flow regime, resulting in an interruption to flow. This may also lead to the loss of water supply to springs and streams.
	New drainage systems have the potential to interrupt flow by reducing recharge to the underlying principal aquifer.
Pollution of surface water	Discharge of routine run-off may lead to long-term degradation of water quality.
	Discharge of run-off during accidental spills or collisions, or potential mobilisation of de-icing salt from routine highway maintenance could impact water quality.
	Vehicle fuel spills could lead to a reduction in water quality.
Risk of flooding	Changes in surface water flow pathways (changes in drainage layout) may increase the risk of flooding.
	More intense rainfall has the potential to overwhelm the drainage system and result in surface water flooding.

11.7 Design, mitigation and enhancement measures

To avoid impacts on the water environment as far as practically possible the following section provides details of mitigation measures and best practice techniques to be implemented for all scheme options.

11.7.1 Construction

During construction, best practice mitigation measures would be in place for all options to manage implications of the scheme on water resources and to ensure the scheme will comply with current policies/regulations that aim to protect water resources, including the Construction Industry Research and Information Association (CIRIA) guidance. These best practice measures would be

incorporated within the Environmental Management Plan (EMP) and may include measures such as designated wheel and plant wash, designated re-fuelling stations and concrete and cement mix areas, and inclusion of secondary containment and bunds and onsite security and storage.

To reduce the risk of contaminated surface water run-off, it is advised that monitoring of the watercourses at risk of pollution be carried out during the construction phase, this is relevant for works occurring at Lyons Way Sompting Junction, Upper Brighton Road and Busticle Lane Junction as surface water receptors were identified within the study area. Types of assessment include visual assessments for oil and silt, sampling points located upstream and downstream of the works. Monitoring requirements should be discussed and agreed with the Environment Agency prior to construction.

Any piling works required for the scheme would be subject to appropriate risk assessments. Method statements detailing piling operations would cover the potential to cause pollution to the underlying principal aquifer and potential mobilisation of contaminated soil.

11.7.2 Operation

Alterations to the road network will provide adequate drainage to accommodate potential changes in surface run-off, including an allowance for climate change in accordance with DMRB CG 501 - Design of highway drainage systems, and through consultation with the Environment Agency and the Lead Local Flood Authority (West Sussex County Council). There are small areas of land outside of the highway boundary to be taken, however the majority of the works are to be undertaken within the highway boundary, and relate to improvement works (for example reconfiguration of lanes or existing structures, enlargement of roundabouts within the highway footprint, and installation of signals). Therefore, any increase in impermeable surface would be mitigated for with suitable drainage to be incorporated within the design to account for the potential for additional surface water run-off and the appropriate permit/licence acquired.

During operation, there is a potential for surface water run-off to be contaminated by accidental spills/collisions/vehicle fuel spills and/or mobilisation of de-icing salt. It is anticipated that the appropriate road drainage will be incorporated into the design to mitigate for this. The proposed drainage design for all options would be designed and constructed in compliance with the DMRB CG501 – Design of highway drainage systems, and through consultation with the Environment Agency and the Lead Local Flood Authority. It will also be ensured that regular maintenance (for instance inspection of drainage systems to ensure no blockages, emptying of gulley pots) is undertaken throughout the operational phase.

11.8 Assessment of likely significant effects

11.8.1 Construction

Table 11-10 identifies the likely significant effects during construction, assuming the mitigation in Section 11.7.1 is adhered to. All options have been assessed together due to the similar nature of the works and as they would all result in similar effects.

Table 11-10: Assessment of likely significant effects (construction)

Receptor	Importance	Potential effect	Mitigation	Impact magnitude	Significance of effect (with mitigation)
Groundwater receptors					
Worthing Chalk (GB40701G505300) WFD groundwater body	Very high	Ground and earthworks may cause disruptions to the groundwater flow regime and flood flow pathway. This may lead to interruptions of flow, leading to either a reduction or loss of water supply to abstractions, and springs/streams. This may also impact properties or roads within flood zones.	Design development to minimise interaction with groundwater and drains during construction. Implementation of standard best practice measures to reduce the risk of adverse effects.	Negligible	Slight adverse
		Contamination of groundwater may occur due to accidental spillages or direct contact with construction materials, or piling operations which would create pathways and mobilise contaminated soil (if present).	No discharges of any contaminated water permitted to groundwater. Works at risk of spill to be undertaken on hardstanding (non-permeable surface) where feasible. EMP to include standard best practice measures including (but not limited to): designated wheel and plant wash, designated re-fuelling stations and concrete and cement mix areas. Inclusion of secondary containment and bunds and onsite security and storage. Staff to be trained and spill kits visible onsite.	Negligible	Slight adverse
		Aquifer pollution may affect indirect groundwater receptors such as springs, streams and/or abstractions.		Negligible	Slight adverse

Receptor	Importance	Potential effect	Mitigation	Impact magnitude	Significance of effect (with mitigation)
Surface water receptors					
Teville Stream waterbody catchment	Medium	Contaminants likely to affect water quality during the construction phase are suspended soils, fuel, oil, concrete liquors and hydrocarbons from road surface construction.	No discharges of any contaminated water permitted to surface water. EMP to include measures such as designated wheel and plant wash, designated re-fuelling stations and concrete and cement mix areas. Inclusion of secondary containment and bunds and onsite security and storage. Staff to be trained and spill kits visible onsite.	Negligible	Neutral*
		Disturbance and release of excess fine sediment and suspended solids can contaminate run-off and could reduce water quality.		Negligible	Neutral*
		Construction within or adjacent to a flood zone could temporarily alter the flow paths or increase run-off, therefore there is a potential increase in risk of flooding occurring.		Negligible	Neutral*
Teville Stream (GB107041011940) WFD river waterbody	Medium	Contaminants likely to affect water quality during the construction phase are suspended soils, fuel, oil, concrete liquors and hydrocarbons from road surface construction.	No discharges of any contaminated water permitted to surface water. EMP to include measures such as designated wheel and plant wash, designated re-fuelling stations and concrete and cement mix areas. Inclusion of secondary containment and bunds and onsite security and storage.	Negligible	Neutral*
		Disturbance and release of excess fine sediment and suspended solids can contaminate run-off and could reduce water quality.		Negligible	Neutral*
		Construction within or adjacent to a flood zone could temporarily alter the flow paths or		Negligible	Neutral*

Receptor	Importance	Potential effect	Mitigation	Impact magnitude	Significance of effect (with mitigation)
		increase run-off, therefore there is a potential increase in risk of flooding occurring.	Staff to be trained and spill kits visible onsite.		
Ferring Rife waterbody catchment	Medium	Contaminants likely to affect water quality during the construction phase are suspended soils, fuel, oil, concrete liquors and hydrocarbons from road surface construction.	No discharges of any contaminated water permitted to surface water. EMP to include measures such as designated wheel and plant wash, designated re-fuelling stations and concrete and cement mix areas. Inclusion of secondary containment and bunds and onsite security and storage. Staff to be trained and spill kits visible onsite.	Negligible	Neutral*
		Disturbance and release of excess fine sediment and suspended solids can contaminate run-off and could reduce water quality.		Negligible	Neutral*
		Construction within or adjacent to a flood zone could temporarily alter the flow paths or increase run-off, therefore there is a potential increase in risk of flooding occurring.		Negligible	Neutral*

* This is considered 'Neutral or Slight Adverse' following assessment methodology, however according to DMRB LA 104: 'Where the significance matrix includes two significance categories, evidence should be provided to support the reporting of a single significance category'. Mitigation measures (best practice measures and those outlined in the table) will be incorporated to reduce the risk of contaminants in surface water run-off, and/or increase in surface water. Therefore, it is expected the significance of effect to be 'Neutral'.

11.8.2 Operation

The assessment of likely significant effects as a result of the operation of the scheme are shown in the Table 11-11 below.

Table 11-11: Assessment of likely significant effects (operation)

Receptor	Importance	Potential effect	Mitigation	Impact magnitude	Significance of effect (with mitigation)
Groundwater receptors					
Worthing Chalk (GB40701G505300) WFD groundwater body	Very high	Piling or other permanent below-ground surface alterations may cause a change in the existing groundwater flow regime, resulting in an interruption to flow. This may also lead to the loss of water supply to springs and streams.	Minimise below ground structures where possible. Appropriate mitigation measures to be reviewed during design to minimise the impact of any below ground structures on groundwater.	Negligible	Slight adverse
		New drainage systems have the potential to interrupt flow by reducing recharge to the underlying Principal aquifer.	All potential drainage as a result of the scheme would require an appropriate permit/licence and would be designed in line with specification to avoid interrupting groundwater flows. Regular maintenance of drainage.	Negligible	Slight adverse
Surface water receptors					
Teville Stream waterbody catchment	Medium	Discharge of routine run-off may lead to long-term degradation of water quality.	Incorporation of appropriate and standard best practice road drainage with the design to minimise adverse risks.	Negligible	Neutral*
		Discharge of run-off during accidental spills or collisions, or potential mobilisation of de-icing salt from routine highway maintenance could affect water quality.		Negligible	Neutral*
		Vehicle fuel spills could lead to a reduction in water quality.		Negligible	Neutral*

Receptor	Importance	Potential effect	Mitigation	Impact magnitude	Significance of effect (with mitigation)
		Changes in surface water flow pathways (changes in drainage layout) may increase the risk of flooding.	Run-off is anticipated to be managed via suitable drainage incorporated within the design.	Negligible	Slight adverse
		More intense rainfall has the potential to overwhelm the drainage system and result in surface water flooding.		Negligible	Slight adverse
Teville Stream (GB107041011940) WFD river waterbody	Medium	Discharge of routine run-off may lead to long-term degradation of water quality.	Incorporation of appropriate and standard best practice road drainage within the design to minimise adverse risks.	Negligible	Neutral*
		Discharge of run-off during accidental spills or collisions, or potential mobilisation of de-icing salt from routine highway maintenance could affect water quality.		Negligible	Neutral*
		Vehicle fuel spills could lead to a reduction in water quality.		Negligible	Neutral*
		Changes in surface water flow pathways (changes in drainage layout) may increase the risk of flooding.	Run-off is anticipated to be managed via suitable drainage incorporated within the design.	Negligible	Slight adverse
		More intense rainfall has the potential to overwhelm the drainage system and result in surface water flooding.		Negligible	Slight adverse
Ferring Rife waterbody catchment	Medium	Discharge of routine run-off may lead to long-term degradation of water quality.	Incorporation of appropriate and standard best practice road drainage within the design to minimise adverse risks.	Negligible	Neutral*
		Discharge of run-off during accidental spills or collisions, or potential mobilisation of de-icing salt from routine highway maintenance could affect water quality.		Negligible	Neutral*

Receptor	Importance	Potential effect	Mitigation	Impact magnitude	Significance of effect (with mitigation)
		Vehicle fuel spills could lead to a reduction in water quality.		Negligible	Neutral*
		Changes in surface water flow pathways (changes in drainage layout) may increase the risk of flooding.	Run-off is anticipated to be managed via suitable drainage incorporated within the design.	Negligible	Neutral*
		More intense rainfall has the potential to overwhelm the drainage system and result in surface water flooding.		Negligible	Neutral*
					Neutral*

*This is considered 'Neutral or Slight Adverse' following assessment methodology, however according to DMRB LA 104: 'Where the significance matrix includes two significance categories, evidence should be provided to support the reporting of a single significance category'. Mitigation measures (best practice measures and those outlined in the table) will be incorporated to reduce the risk of contaminants in surface water run-off, and/or increase in surface water. Therefore, it is expected the significance of effect to be 'Neutral'.

12 Climate

12.1 Legislative and policy framework

12.1.1 National Legislation

12.1.1.1 Climate Change Act 2008

The Climate Change Act 2008[213] forms part of the United Kingdom (UK) government's plan to reduce greenhouse gases (GHG)[214] emissions. In 2019 the UK government amended the Act to commit to net zero GHG emissions by 2050, supporting the Paris Agreement which provides a framework to keep global warming well below 2°C, pursuing efforts to limit the temperature increase to 1.5°C. The Climate Change Act creates a new approach to managing and responding to climate change in the UK, by:

- Setting ambitious, legally binding emission reduction targets
- Taking powers to help meet those targets
- Strengthening the institutional framework
- Enhancing the UK's ability to adapt to the impact of climate change
- Establishing clear and regular accountability to the UK Parliament and to the devolved legislatures

Key provisions of the Act in respect of climate change mitigation include the requirement for the government to set legally binding carbon budgets capping the amount of GHG emitted in the UK over five-year periods, as set out in Table 12-1.

Table 12-1 : UK Carbon Reduction Targets

Carbon Budget	Carbon Budget Level	Reduction Below 1990 Levels
Fourth Carbon Budget (2023 – 2027)	1,959 $MtCO_2e$[215]	51% by 2025
Fifth Carbon Budget (2028 – 2032)	1,725 $MtCO_2e$	57% by 2030

[213] UK Government (2008). *Climate Change Act 2008* [online] available at: https://www.legislation.gov.uk/ukpga/2008/27/contents (last accessed June 2022).
[214] A greenhouse gas is a gas that absorbs and emits radiant energy within the thermal infrared range. Greenhouse gases cause the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride, and nitrogen trifluoride.
[215] Carbon dioxide equivalent is a standard unit of measurement in which greenhouse gases are converted to equivalent amounts of carbon dioxide, in other words the amount of carbon dioxide that would give the same radiative forcing.

Carbon Budget	Carbon Budget Level	Reduction Below 1990 Levels
Sixth Carbon Budget (2033 – 2037)	965 $MtCO_2e$	78% by 2035[216]

Source: Department for Business, Energy & Industrial Strategy

Key provisions of the Act in respect of climate change adaptation include:

- A requirement for the government to report, at least every six years, on the risks to the UK of climate change, and to publish a programme setting out how these will be addressed. This Act also introduces powers for government to require public bodies and statutory undertakers to carry out their own risk assessment and make plans to address those risks.
- The Adaptation Sub-Committee of the Committee on Climate Change will provide advice to, and scrutiny of, the government's adaptation work.

12.1.2 National Policy

12.1.2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and the requirements for the planning system. Section 14 Meeting the challenge of climate change, flooding and coastal change within the NPPF includes details on how projects should build resilience to climate change and reduce carbon emissions. Notably paragraph 154 is pertinent to this scheme:

"New development should be planned for in ways that:

(a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and

(b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the government's policy for national technical standards."

[216] UK Government (2021). *UK enshrines new target in law to slash emissions by 78% by 2035* [online] available at: https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035 (last accessed June 2022).

12.1.3 Local Policy

12.1.3.1 Adur Local Plan

The Adur Local Plan[217] was adopted in 2017. Three key issues are identified within the plan with regards to climate:

- Issue 7 – The need to address road congestion and related pollution – air and noise - whilst improving the existing transport network and facilitating the development of sustainable transport measures
- Issue 8 – The need to address climate change and flood risk
- Issue 9 – The need to work towards achieving sustainability

Within the plan relevant policies include; Policy 1: Sustainable Development will take a favourable view on developments that favour sustainable development as identified within the NPPF and Policy 30: Green Infrastructure requires developments to incorporate elements of green infrastructure into their overall design.

12.1.3.2 Worthing Local Plan

The 2020 – 2036 Draft Local Plan was submitted in January 2021[218]. Three policies are identified with regards to climate change:

- SP1 – Presumption in favour of sustainable development will take a favourable view on developments that favour sustainable development as identified within the NPPF
- SP2 – Climate change outlines measures to reduce carbon emissions, as well outlining the need to adapt and mitigate the effects of climate change, as well as improving the resilience of communities
- DM20 – Flood risk and sustainable drainage identifies the local authority's aim that development should be directed away from areas of highest risk of flooding and opportunities should be taken to reduce flooding through sustainable drainage systems and natural flood management to deliver multi-functional benefits for people and wildlife

[217] Adur District Council (2017) *Adur Local Plan* [online] available at: https://www.adur-worthing.gov.uk/adur-local-plan/ (last accessed June 2022).
[218] Worthing Borough Council (2021) *Submission Draft Local Plan 2020 – 2036* [online] available at: https://www.adur-worthing.gov.uk/worthing-local-plan/submission-examination/ (last accessed June 2022).

12.1.3.3 Sustainable Adur & Worthing Framework

The Sustainable Adur & Worthing Framework ('SustainableAW') was published in July 2021[219]. The Councils declared a climate emergency in 2019 and have set a target to be carbon neutral by 2030. The framework also outlines actions for the councils to deliver offsetting projects to address residual carbon emissions and to explore nature-based solutions for Blue Carbon and climate resilience.

12.1.3.4 West Sussex Council Plan

'Our Council Plan 2021 – 2025' outlines targets for West Sussex County Council to reduce carbon emissions from their activities[220]. A target to reduce carbon emissions by 24% by 2024/25 has been set (relative to the 2019/20 baseline).

12.1.4 Guidance, strategies and plans

12.1.4.1 Infrastructure Carbon Review (2013)

The UK government published the Infrastructure Carbon Review[221] to set out carbon reduction actions to be taken across the infrastructure sector at all stages of the supply chain. It is aimed at the leaders of organisations involved in designing, constructing, operating and maintaining economic infrastructure assets across all the sectors defined in the government's Strategy for National Infrastructure: Communications, Energy, Transport, Waste and Water. In terms of this scheme, this means that emission reduction actions should be taken into account when developing scheme-specific mitigation measures, where relevant.

12.1.4.2 Publicly Available Specification 2080: 2016 Carbon Management in Infrastructure

Publicly Available Specification (PAS) 2080[222] sets out a common approach to whole life carbon management in the provision of economic infrastructure as a result of the Infrastructure Carbon Review. It promotes reduced carbon, reduced cost infrastructure delivery, more collaborative ways of working, and a culture of challenge in the infrastructure value chain.

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[219] Adur & Worthing Councils (2021) *Sustainable AW* [online] available at: https://www.adur-worthing.gov.uk/sustainable-aw/ (last accessed June 2022).
[220] West Sussex County Council (2022) *Our Council Plan* [online] available at: https://www.westsussex.gov.uk/about-the-council/policies-and-reports/corporate-policy-and-reports/our-council-plan/ (last accessed June 2022).
[221] HM Treasury (2013) *Infrastructure Carbon Review* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/260710/infrastructure_carbon_review_251113.pdf (Last accessed June 2022).
[222] British Standards Institute (2016) *PAS 2080: Carbon management in infrastructure* [online] available at: https://shop.bsigroup.com/ProductDetail?pid=000000000030323493 (last accessed June 2022).

12.1.4.3 Institute for Environmental Management and Assessment EIA Guide to: Climate Change and Adaptation (2020)

The Institute of Environmental Management and Assessment (IEMA) publication[223] is an essential reference point and guidance by providing a framework to consider climate change vulnerability and adaptation in the EIA process.

12.1.4.4 Institute for Environmental Management and Assessment Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance (2nd Edition, 2022)

This IEMA publication[224] provides guidance to assist professionals with GHG emissions assessment, mitigation, and reporting in statutory and non-statutory EIA. The guidance recommends the use of iterative design, and the application of the mitigation hierarchy. It also presents guidance for evaluating the significance of any changes in GHG emissions which has been used for context in this assessment but not as the methodology.

12.1.4.5 Decarbonising Transport: A Better, Greener Britain 2021

The Department for Transport (DfT) published the Transport Decarbonisation Plan[225] on 14 July 2021 which outlines the UK government's commitments and the identified actions to decarbonise the UK transport system. This plan includes commitments to support improving traffic flow, reduce emissions and drive the transition to alternative fuel types, such as battery electric vehicles.

12.1.4.6 UK Government Net Zero Strategy: Build Back Better

The UK government's plan for net zero, published in autumn 2021, outlines the government's position on roads and transport including to ensure consistent action to reduce emissions across the transport sector. The press release for the Sixth Carbon Budget in April 2021[226] included the following statement: "The government will look to meet this reduction target through investing and capitalising on new green technologies and innovation, whilst maintaining people's freedom of choice".

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[223] Institute of Environmental Management and Assessment (2020) *IEMA EIA Guide to: Climate Change Resilience and Adaptation* [online] available at: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020 (last accessed June 2022).

[224] Institute of Environmental Management and Assessment (2021) *Institute of Environmental Management & Assessment Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance* [online] available at: https://www.iema.net/resources/blog/2022/02/28/launch-of-the-updated-eia-guidance-on-assessing-ghg-emissions (last accessed June 2022).

[225] Department for Transport (2021) *Decarbonising Transport: A Better, Greener Britain [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009448/decarbonising-transport-a-better-greener-britain.pdf (last accessed June 2022).*

[226] UK Government (2021) *UK enshrines new target in law to slash emissions by 78% by 2035* [online] available at: https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035 (last accessed June 2022).

This highlights the intention to focus on innovation to achieve net zero and not restrictions.

12.1.4.7 The Carbon Plan 2011

The Carbon Plan 2011[227] was presented to UK parliament pursuant to Sections 12 and 14 of the Climate Change Act 2008. The plan sets out how the UK will achieve decarbonisation within the framework of the energy policy. UK local authorities and regional level authorities must report on their carbon dioxide (CO_2) emissions.

12.1.4.8 UK Climate Change Risk Assessment 2022

The UK Climate Change Risk Assessment 2022[228] replaces the second UK Climate Change Risk Assessment published in 2017 and fulfils the requirement of the Climate Change Act for the government to report on the climate change risks to the UK every five years. Risks due to climate hazards are regarded as 'very high' for infrastructure networks such as transport, resulting in cascading failures across sectors such as water, energy and Information and Communication Technology.

12.1.4.9 National Highways Net Zero Roadmap

National Highways published their net zero roadmap in 2021[229]. The net zero roadmap is aligned with the UK's commitment to be a net zero economy by 2050. The roadmap outlines three commitments:

- Net zero by 2030 for corporate emissions
- Net zero by 2040 for maintenance and construction emissions
- Net zero by 2050 for road user emissions

12.2 Assessment methodology

12.2.1 Effects on climate

Aspects included in this assessment were defined at the Scoping stage. All aspects noted in Table 15.4 of the Environmental Scoping Report (HE608509-MMD-EGN-OP00-RP-LE-0003) have been considered to determine the carbon footprint of the scheme options despite some aspects being likely to form a relatively small proportion of the total emissions. However, it may be determined at

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[227] UK Government (2011) *The Carbon Plan: Delivering our low carbon future* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf (last accessed June 2022).
[228] UK Government (2022) *The Third UK Climate Change Risk Assessment (UKCCRA3)* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf (last accessed June 2022).
[229] National Highways (2021) *Net zero highways: our 2030 / 2040 / 2050 plan* [online] available at: https://nationalhighways.co.uk/netzerohighways/ (last accessed June 2022).

a later Project Control Framework (PCF) stage that some of the lifecycle stages can be scoped out or assessed qualitatively due to either lack of data availability or if the emissions are likely to be negligible in comparison to other lifecycle stages.

The assessment methodology is in line with the Design Manual for Roads and Bridges (DMRB) LA 114 Climate[230].

12.2.1.1 Construction

The assessment of the construction effects on climate includes:

- Assessment of the carbon emitted during construction using recognised methodologies and tools
  - The Mott MacDonald Carbon Portal, which is PAS 2080 certified and used models produced from traceable sources (Inventory of Carbon and Energy v3.0) relating to materials and plant used on highways engineering projects.
  - The Royal Institution of Chartered Surveyors (RICS) guidance[231] and assumptions on the transport of materials to site.
- This includes the following lifecycle stages detailed within PAS 2080:
  - A1-3 Materials
  - A4 Transport of materials
  - A5 Construction plant

12.2.1.1 Operation

The assessment of the operational effects on climate includes:

- Assessment of carbon emitted during the user's utilisation of the scheme over a 60-year assessment period, for the scheme opening year and forecast year (known as the Do-Something (DS)), compared to a without scheme scenario (known as the Do-Minimum (DM)), to derive the change in emissions, in accordance with DMRB LA 114. The Transport Analysis Guidance (TAG)[232] Databook also provides additional information on future trends that can be used in the assessment of future years.

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[230] National Highways (2021) *LA 114 Climate* [online] available at: https://www.standardsforhighways.co.uk/prod/attachments/d1ec82f3-834b-4d5f-89c6-d7d7d299dce0?inline=true (last accessed June 2022).
[231] Royal Institution of Charted Surveyors (2017) *Whole life carbon assessment for the built environment, RICS professional statement* [online] available at: https://www.rics.org/globalassets/rics-website/media/news/whole-life-carbon-assessment-for-the--built-environment-november-2017.pdf (last accessed June 2022).
[232] Department for Transport (2022) *TAG data book* [online] available at: https://www.gov.uk/government/publications/tag-data-book (last accessed June 2022).

12.2.1.2 Significance of effect

For the purpose of determining any change in emissions due to the scheme, the assessment of significance has followed DMRB LA 114 Climate.

DMRB LA 114 states that “projects shall only report significant effects where increases in GHG emissions will have a material impact on the ability of Government to meet its carbon reduction targets”. It also notes that the National Policy Statement for National Networks states: *“It is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets" and that in this context “it is considered unlikely that projects will in isolation conclude significant effects on climate”.*

It is of note for context and narrative that the guidance on evaluating significance of carbon emissions published by the IEMA presents a different approach. The 2022 IEMA guidance states that *“GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit; as such any GHG emissions or reductions from a project might be considered to be significant”*. The 2022 IEMA guidance states that: *“When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project’s emissions should therefore be based on its net impact over its life time, which may be positive, negative or negligible. Where GHG emissions cannot be avoided, the goal of the EIA process should be to reduce the project’s residual emissions at all stages”.* The 2022 IEMA guidance suggests that the carbon footprint of a project should be contextualised with relevant budgets consistent with net zero and be mitigated as much as possible and that the level of significance should be determined based on the relevant context. Both the DMRB LA 114 and IEMA guidance advise contextualising the carbon footprint of the scheme by comparing to carbon budgets and policy, as well as a focus on carbon reduction. The assessment will follow the DMRB LA 114 approach and not the IEMA approach.

The IEMA guidance and DMRB LA 114 reinforces the importance of delivering and subsequently demonstrating carbon reduction through the entire scheme. The procedure noted in Section 5 and within the Carbon Management Plan (CMP) (HE608509-MMD-EGN-OP00-RP-LE-0002) will seek to ensure this is considered throughout.

12.2.2 Vulnerability of the scheme to climate change

Assessing the vulnerability of the scheme to climate change is fundamentally different to the rest of the assessment, as it assesses the impact of an external event (climate change) on the scheme, where the receptors are the elements of the scheme and its users during its operational lifetime.

A qualitative methodology for assessing the vulnerability of the scheme assets to climate change has been produced in line with DMRB LA 114 considering the life

span of the project, climate trends and environmental baseline under future projected climate conditions. This assessment begins by identifying climate change induced hazards for the scheme design receptors due to the projected climate change. Then, the likelihood of these impacts occurring (Table 12-2) and the measure of consequence of the impact (Table 12-3) is determined. Professional judgement through collaboration between the climate change specialist and the design team is used to determine these factors.

Table 12-2 : Criteria for determining the likelihood of impacts occurring

Likelihood category	Description (probability and frequency of occurrence)
Very high	The event occurs multiple times during the lifetime of the project (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the project (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g. approximately once every 15 years, typically four events.
Low	The event occurs during the lifetime of the project (60 years) e.g. once in 60 years.
Very low	The event can occur once during the lifetime of the project (60 years).

Source: Table 3.39a DMRB LA 114

Table 12-3 : Criteria for determining measure of consequence

Consequence category	Description (probability and frequency of occurrence)
Very large adverse	Operation - national level (or greater) disruption to strategic route(s) lasting more than one week.
Large adverse	Operation - national level disruption to strategic route(s) lasting more than one day but less than one week or regional level disruption to strategic route(s) lasting more than one week.
Moderate adverse	Operation - regional level disruption to strategic route(s) lasting more than one day but less than one week.
Minor adverse	Operation - regional level disruption to strategic route(s) lasting less than one day.
Negligible	Operation - disruption to an isolated section of a strategic route lasting less than one day.

Source: Table 3.39b DMRB LA 114

12.2.2.1 Significance of effect

The criteria for determining the significance of effect for the vulnerability of the scheme to climate change is detailed in Table 12-4. The likelihood and consequence of the impact is combined to determine the significance of the impact on a receptor.

Table 12-4 : Significance of vulnerability of scheme to climate change

Measure of consequence	Magnitude of likelihood				
	Very Low	**Low**	**Medium**	**High**	**Very High**
Very Large	NS	S	S	S	S
Large	NS	NS	S	S	S
Moderate	NS	NS	S	S	S
Minor	NS	NS	NS	NS	NS
Negligible	NS	NS	NS	NS	NS

Source: DMRB Volume 11, LA 114, Table 3.41

Notes: NS = Not Significant, S = Significant

12.3 Assessment assumptions and limitations

12.3.1 Effects on climate

The construction assessment has been based on the design of the scheme at this PCF Stage 1 and 2. Assumptions have been necessary to ensure the aspects can be assessed, this has included selection of the closest available emission factors, assumptions on dimensions and material type, and use of benchmark data.

- For new road pavement construction, pavement areas thicknesses of 100mm surface course, 60mm binder course, 100mm base, 300mm subbase, and 50mm capping layer have been assumed

The following items have been omitted at this stage due to lack of information, they will be included within the PCF Stage 3 assessment:

- Upper Brighton Road – works are likely to consist of updating road lining and signage to convert to a one-way street
- Grove Lodge Roundabout – works are likely to consist of refining the existing traffic signals phasing and widening of a crossing

The assessment excludes the following lifecycle aspects, based on both the expected small scale of these impacts and the availability of data at this PCF stage:

- Land use change
- Operational lighting
- Maintenance activities

Where possible the maintenance activities will be estimated during PCF Stage 3.

The operational assessment has been based upon the traffic data produced from a traffic model for the scheme. In addition, the WebTAG assessment used the future

projections of vehicle fuel efficiency and split of vehicles by fuel type detailed in the TAG Databook.

12.3.2 Vulnerability of the scheme to climate change

Information on the climate baseline and future projections are based on freely available information from third-parties, including the historical meteorological variables recorded by the Met Office and the UK Climate Projections (UKCP18) developed by the Met Office.

Climate projections are not predictions or forecasts but simulations of potential scenarios of future climate, under a range of hypothetical emissions scenarios and assumptions. Therefore, the results from running the climate models cannot be treated as exact or factual, but projection options. They represent internally consistent representations of how the climate may evolve in response to a range of potential forcing scenarios, and their reliability varies between climate variables. Scenarios exclude outlying surprise or disaster scenarios in the literature, and any scenario necessarily includes subjective elements and is open to various interpretations. Generally global projections are more certain than regional, and temperature projections are more certain than those for precipitation. Furthermore, the degree of uncertainty associated with all climate change projections increases for projections further into the future.

Accordingly, any further research, analysis or decision-making should take account of the nature of the data sources and climate projections and should consider the range of literature, additional observational data, evidence and research available, and any recent developments in these.

12.4 Study area

12.4.1 Effects on climate

The assessment of the effects on climate does not have a physical study area *per se* as the receptor (climate change) for GHG emissions is not spatially defined. The study area is defined using standards from the DMRB LA 114[30], where the study area for construction is established as the GHG emissions associated with project construction activities and the materials required, as well as their associated transport to site.

The operational study area includes the GHG emissions associated with the operational road user emissions consistent with the traffic model affected road network. The road links included within the assessment follow the criteria set out within DMRB LA 114[30].

12.4.2 Vulnerability of the scheme to climate change

The vulnerability of the scheme to climate change relates to the effects that climate change may have on the scheme based on the relative risk of changes in climatic variables. The study area will be based on the construction footprint and scheme boundary (including compounds and temporary land take), as well as end-users.

12.5 Baseline conditions

12.5.1 Effects on climate

The data sources for the effects on the climate baseline are as follows:

- Department for Business, Energy & Industrial Strategy (BEIS), 2021 UK Provisional Greenhouse Gas Emissions[233]
- BEIS, 2005 to 2019 UK local and regional CO_2 emissions – data tables[234]
- Climate Change Committee (CCC), The Sixth Carbon Budget – The UK's path to Net-Zero[235]

In 2021, the UK net emissions were estimated at 424.5 $MtCO_2e$ demonstrating a 5% reduction on 2019 levels. During 2021, the transport sector accounted for 31% of UK carbon emissions[33] reducing 11% since 2019.

The scheme falls within Worthing local authority area where the emissions total for 2019 was 315$ktCO_2e$, of which 12% (39$ktCO_2e$) is attributable to transport on A roads[234].

For the Do-Minimum option (without the scheme) the emissions for the opening year and the design year have been calculated (using the traffic model) as shown in Table 12-5 below.

Table 12-5 : Baseline operational road user emissions

Option	Open year (2027) ($ktCO_2e$)	Design year (2042) ($ktCO_2e$)
1	20.2	18.9

[233] Department for Business, Energy & Industrial Strategy (2022) *Provisional UK greenhouse gas emissions national statistics 2021* [online] available at: https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2021 (last accessed June 2022).
[234] Department for Business, Energy & Industrial Strategy (2021) *UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2019* [online] available at: https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019 (last accessed June 2022).
[235] Climate Change Committee (2020) *The Sixth Carbon Budget – The UK's path to Net-Zero* [online] available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/ (last accessed June 2022).

Option	Open year (2027) ($ktCO_2e$)	Design year (2042) ($ktCO_2e$)
2	28	22.2
3	28.1	26.1

Through 2019, carbon emissions from manufacturing and construction in the UK were estimated at 66$MtCO_2e$[236], an increase of 39% on the estimated 1990 emissions. Although data accounts for manufacturing in addition to construction, this gives the best indication of the proportion of UK emissions associated with construction. Data is not available for the UK construction sector alone, but the World Green Building Council has found that building materials and construction were responsible for around 11% of global energy-related GHG emissions in 2018[237].

The projections from BEIS show a decline in total emissions to 2040 (emissions are projected to fall by 24% from 2019 levels). In 2018, 97% of transport's final energy consumption was from oil-based fossil fuels but by 2040 this is projected to fall to 89% due to an increase in electric vehicles and increasing biofuels use[238]. In 2021, the UK government pledged to end the sale of new petrol and diesel vehicles by 2030 and that all new cars and vans will be required to be fully zero emission at the tailpipe by 2035[239]. Furthermore, the UK government consulted to phase out all new, non-zero emission road vehicles and heavy goods vehicles by 2040 at the latest[26]. Because of these changes, the BEIS projections are likely to be updated to meet these new policy goals.

As discussed in Section 12.2 the UK government, as part of the Climate Change Act[18], has set legally binding carbon budgets capping the amount of carbon that can be emitted in the UK over a five year period, as shown in Table 12-1.

The BEIS projections show that the Third Carbon Budget is very likely to be achieved with a headroom of around 26$MtCO_2e$. However, the projections show shortfalls for the Fourth Carbon Budget and Fifth Carbon Budget of 188$MtCO_2e$

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[236] Department for Business, Energy & Industrial Strategy (2021) *Annex 2: 2019 UK Greenhouse Gas Emissions, final figures by Standard Industrial Classification* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/995865/annex-2-1990-2019-uk-ghg-emissions-final-figures-by-sic.pdf (last accessed June 2022).
[237] Climate Change Committee (2020) *The Sixth Carbon Budget Manufacturing and construction* [online] available at: https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Manufacturing-and-construction.pdf (last accessed June 2022).
[238] Department for Business, Energy & Industrial Strategy (2020) *Updated energy and emissions projections 2019* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931323/updated-energy-and-emissions-projections-2019.pdf (last accessed June 2022).
[239] Department for Transport (2021) *Transitioning to zero emission cars and vans: 2035 delivery plan* [online] available at: https://www.gov.uk/government/publications/transitioning-to-zero-emission-cars-and-vans-2035-delivery-plan (last accessed June 2022).

and 253MtCO_2e respectively. Meanwhile, the CCC have stated that emissions will need to fall more rapidly than these targets[35]. As such, an ambitious Sixth Carbon Budget was proposed by the CCC and accepted by the UK Government and transcribed into law to allow the UK to meet net-zero carbon by 2050, with a commitment to a reduction of almost 80% by 2035 compared to 1990 levels.

The CCC have also determined a balanced net-zero pathway for construction and manufacturing that includes a reduction of 43% by 2030, 75% by 2035 and 90% by 2040 to achieve the 97% reduction by 2050. This pathway considers a proportion of the reduction will come from improved resource efficiency in production and material substitution. Therefore, significant effort is required to ensure that all contributing emissions are reduced as far as possible through the design, construction, and operation of all projects.

12.5.2 Vulnerability of the scheme to climate change

The data sources for the vulnerability of the scheme to climate change baseline are as follows:

- Met Office, Southern England: climate[240]
- Met Office, UKCP18 Climate Projections[241]

The vulnerability of the scheme to climate change has an existing baseline and a future baseline. The existing baseline is the current climatic conditions whereas the future baseline is the projected changes in climatic conditions over the assessment period. This section details both the existing baseline and future baseline.

The existing baseline is obtained from the Met Office historical regional climate information, in which the scheme falls within the Southern England region[42]. High-level climate observations for Southern England over a 30-year averaging period between 1981–2010 are presented in Table 12-6 below. In addition, a web search has been used to identify any historic extreme weather events in the vicinity of the scheme. This search has identified numerous cases of flooding in recent years along the A27, particularly near Shoreham and Lewes, however none along the section of the A27 where the scheme is situated.

[240] Met Office (2016) *Southern England: climate* [online] available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/southern-england_-climate---met-office.pdf (last accessed June 2022).
[241] Met Office (2018) *UKCP18 Climate Projections: Key Results* [online] available at: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Key-results.xlsx (last accessed June 2022).

Table 12-6 : Existing climatic conditions for Southern England (30 year average 1981-2010)

Climatic conditions	Climate observations
Temperature	Mean daily minimum temperatures ranged from 0°C on higher ground to 3°C in London and on the coast in winter, whilst summer daily maximum temperatures were in the region of 21°C along to the coast to 23.5°C in London.
Rainfall	Rainfall averages 950 mm per year around the scheme. Rainfall is generally well-distributed throughout the year but with an autumn/early winter maximum that is more pronounced in counties bordering the English Channel.
Wind	Southern England is one of the more sheltered parts of the UK. The strongest winds are associated with the passage of deep areas of low pressure close to or across the UK. The frequency and strength of these depressions is greatest in the winter half of the year, especially from December to February, and this is when mean speeds and gusts (short duration peak values) are strongest.
Sunshine	Southern England includes the sunniest places in mainland UK, these being the coastal resorts of Sussex and Hampshire. On the coast average annual sunshine durations can exceed 1800 hours, but 1550-1600 hours is typical of most of the region.
Air frost	The average number of days with air frost varies from 30 days per year on the coast to 50 days per year on higher ground.

Source: Met Office[40]

The future baseline is obtained from the UK Climate Change Projections developed by the Met Office Hadley Centre which include regional climate projection data, for which the scheme is included in the Southern England Region. It is projected (under a range of emissions scenarios modelled in UK Climate Projections (UKCP18[43])) to experience hotter and drier summers, and warmer and wetter winters.

For the assessment period of 60 years, from the anticipated scheme opening year (2027), the climate projections data for the 2080s (2080–2099) under Representative Concentration Pathway (RCP) 8.5[242] (the highest emissions

[242] RCP: Representative Concentration Pathways. RCPs are the new scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) and used by the UKCP18 climate projections. RCPs are based on the projected concentration of greenhouse gases in the atmosphere in 2100, e.g. RCP 8.5 is a radiative forcing of 8.5 in 2100. These replace the previous Low, Medium and High scenarios. There are 4 RCPs in UKCP18 (2.6, 4.5, 6.0 and 8.5). These do not directly map onto the Low, Medium, High scenarios used previously.

scenario available in UKCP18) has been selected. Projected changes in key climate variables under this scenario are summarised in Table 12-7 and Table 12-8. Some aspects of the design will have a shorter design life than the scenario detailed below, as such the projections for the earlier years will be considered in these situations.

The average summer temperature is estimated to increase by 5.8°C under the central estimate, which represents "as likely as not" probability of change (50th percentile), whilst the average winter temperature is estimated to increase by 3.6°C (in the 50th percentile or central estimate). Whereas, for the 90th percentile the average summer temperature is estimated to increase by 8.7°C, and the average winter temperature increase is estimated to be 5.8°C. This is shown in Table 12-7 below.

Table 12-7 : Projected climate change (RCP 8.5 2080-2099) for seasonal average temperatures

Climate variable	Climate projections	
	50th percentile value	**90th percentile value**
Temperature (summer)	5.8°C increase	8.7 °C increase
Temperature (winter)	3.6°C increase	5.8°C increase

Source: Met Office UKCP18[41]

The average summer rainfall is estimated to decrease by 41%, whereas the average winter rainfall rate is estimated to increase by 27% (in the 50th percentile or central estimate for both). Whereas, for the 90th percentile the average summer precipitation is estimated to increase by 7% and the average winter precipitation is estimated to increase by 75%. For the 10th percentile the average summer precipitation is estimated to decrease by 77% and the winter precipitation is estimated to decrease by 3%. This is shown in Table 12-8 below.

Table 12-8 : Projected climate change (RCP 8.5 2080-2099) for seasonal average rainfall

Climate variable	Climate projections		
	10th percentile value	**50th percentile value**	**90th percentile value**
Rainfall (summer)	77% decrease	41% decrease	7% increase
Rainfall (winter)	3% decrease	27% increase	75% increase

Source: Met Office UKCP18[44]

Where necessary for safety critical infrastructure, notably earthworks or electrical components within traffic signalling, the 90th percentile value of RCP 8.5 will be

used for the assessment. This acts as a proxy for the H++ scenario[243] in the which is only available for sea level rise in UKCP18. This scenario represents the less likely but upper plausible limits of climate change.

Climate projections for wind are more uncertain than those for temperature and precipitation, due to inherent difficulty in modelling future wind conditions. However, overall, an increase in extreme weather, including storms, is projected.

12.6 Potential impacts

12.6.1 Effects on climate

This section outlines the potential impacts on climate that could arise due to the scheme, detailed in Table 12-9. All scheme options have the potential to result in the same impacts through construction and operation. However, the magnitude of these effects potentially varies between the different options due to the scale of construction and the impact on traffic flows, consistent with DMRB LA 114.

Table 12-9 : Potential impacts on climate

Option	Potential construction impacts	Potential operation impacts
All options	• Embodied emissions from the construction materials used (A1-3) • Emissions from construction plant (A5) • Emissions from transport of materials to site (A4)	• Emissions from changes to traffic flows on the road network (B9)

12.6.2 Vulnerability of the scheme to climate change

This section outlines the potential impacts associated with climate change, as detailed in Table 12-10 below that could occur through construction and operation.

Table 12-10 : Potential impacts on the vulnerability of the scheme to climate change

Potential construction impacts	Potential operation impacts
Due to the short period anticipated for construction and considering the impacts of climate change are felt over a much greater period, it is	Drainage and flood risk may be affected due to: • Increased winter precipitation increasing standing water on the road surfaces

[243] H++ scenarios refer to the development of plausible 'high-end' climate change scenarios which are typically extreme climate change scenarios on the margins or outside of the 10th to 90th percentile range presented in the 2009 UK climate change projections (also known as 'UKCP09').

Potential construction impacts	Potential operation impacts
unlikely that the impacts of climate change will be experienced during construction of the scheme.	• Increased winter precipitation increasing flood risk for the road • Increased winter precipitation increasing flood risk for the surrounding area • Increased winter precipitation causing groundwater flooding due to the local chalk geology Earthworks may be affected due to: • Changes in the future precipitation regime, including fluctuation between wetter winters and drier summers, increasing the risk to earthworks stability Landscape planting may be affected due to: • Increased temperature, increased likelihood of disease, and changing precipitation patterns, in particular drier hotter summer and drought conditions Highway users may be affected by: • Hotter summers temperatures, resulting in overheating cars in slow traffic, and extended exposure of vehicle users to high temperatures • Hotter summer temperatures, resulting in exposure of cyclists and pedestrians to high temperatures • Inaccessible cycle and footpaths due to flooding during wetter winters • Impacts on the wider local transport network due to coastal storms and coastal flooding risk (in particular along the A259 rather than the scheme in question)

In regard to flood risk, the Road Drainage and Water Environment assessment undertaken within Chapter 11 identified that assets situated nearby Lyons Way Sompting Junction and Busticle Lane Junction are considered to have a medium to high and medium to low risk of surface water flooding respectively. The scheme is not considered to be at risk from artificial sources of flooding, such as failure of infrastructure or human interventions including reservoirs, canals and water retention ponds. The scheme is not considered to be at risk due to coastal flooding.

12.7 Design, mitigation and enhancement measures

12.7.1 Effects on climate

In line with DMRB LA 114, schemes should adhere to the design and mitigation hierarchy outlined within DMRB LA 104[244]:

- Avoid / prevent:
  - Maximise potential for re-using and/or refurbishing existing assets to reduce the extent of new construction required, and/or explore alternative lower carbon options to deliver the project objectives (i.e. shorter route options with smaller construction footprints)
  - Identify through projects and delivery programmes opportunities to influence user GHG emissions
- Reduce:
  - Apply low carbon and/or reduced resource consumption solutions (including technologies, materials and products) to minimise resource consumption during the construction, operation, and at end of life
- Remediate:
  - Identify, assess and integrate measures to further reduce carbon through on or off-site offsetting or sequestration

A CMP (HE608509-MMD-EGN-OP00-RP-LE-0002) has been produced for the scheme to act as a live document that ensures the consideration of carbon reduction throughout the design. The CMP outlines the process to be followed to reduce carbon, the methodology for the carbon assessment, and will be updated with progress made through the design. A Design for Resource Efficiency (D4RE) workshop was undertaken on 8 December 2021, some examples of the mitigation measures being considered are:

- Increasing the use of site-won material
- Promoting the use of longer life/harder wearing materials to reduce maintenance requirements
- Reducing the breaking up of existing pavements

The measures listed above and the other measures identified within the D4RE workshop, detailed in the CMP, are to be investigated and implemented where possible within PCF Stage 3. The efforts should focus on the actions determined to have a high impact with the greatest ease of implementation.

[244] National Highways (2020) *LA 104 Environmental assessment and monitoring* [online] available at: https://www.standardsforhighways.co.uk/prod/attachments/d1ec82f3-834b-4d5f-89c6-d7d7d299dce0?inline=true (last accessed June 2022).

The following high-level approach to mitigation (as defined within PAS 2080) has been applied and developed, with a particular focus on the hotspots identified through the carbon assessment:

- Build nothing: evaluate the basic need for an asset and explore alternative approaches to achieve outcomes set by the asset owner or manager
- Build less: evaluate the potential for re-using and refurbishing existing assets to reduce the extent of new construction required
- Build clever: consider the use of low carbon solutions (including technologies, materials, and products) to minimise resource consumption during the construction, operation, and user utilisation stages of the asset
- Build efficiently: use techniques that reduce resource consumption during the construction and operational phases

12.7.1.1 Monitoring

In line with DMRB LA 114 quarterly reporting on emissions during construction and operation will be required. Further detail on the monitoring requirements will be detailed in PCF Stage 3.

12.7.2 Vulnerability of the scheme to climate change

The design will consider climate change where appropriate to ensure the design will be resilient to the future changes for the design life of the aspects. At this stage few specific details of the construction are known, however, the design guidance for numerous aspects ensures consideration of temperature ranges and precipitation levels. The below assumed mitigation measures will be confirmed at PCF Stage 3 if considered feasible.

It is assumed that the drainage design for the scheme would consider predicted increases in precipitation and run-off rates to minimise any impacts from flood risk or standing water, as stated within Chapter 11 Road drainage and the water environment. The drainage design will consider known historic springs that may cause a groundwater flooding risk in wetter future winters. This will be considered as part of the Flood Risk Assessment to be undertaken at PCF Stage 3.

Additionally, it is assumed that the scheme earthworks would also be designed to consider future changes in precipitation patterns, including greater seasonal fluctuations, in terms of stability to minimise risk of earthwork failure including landslips and subsidence.

Finally, the planting for the scheme is assumed to be designed with consideration of predicted rising temperatures and decreased summer precipitation to ensure the planting is effective in its purpose to mitigate biodiversity or landscape impacts. Landscape planting could consider whether additional shading of footpaths can be provided, to create cooler routes for pedestrians in hotter future summers.

Landscape planting will also be considered as part of managing increased surface water run-off through nature-based sustainable drainage solutions.

If these assumptions change at a later stage, the assessment will need to be updated.

12.7.2.1 Monitoring

In line with DMRB LA 114 the operational scheme will be required to manage, maintain and monitor asset data to ensure the scheme is operating as intended. Adaptive management is assumed to be employed during the operational period where it is necessary to adapt the asset management in response to climate impacts. Where appropriate additional interventions will be determined and implemented.

12.8 Assessment of likely significant effects

12.8.1 Effects on climate

12.8.1.1 Construction

12.8.1.1.1 Option 1

The assessment predicts that Option 1 would result in approximately 430tCO_2e during the construction phase (lifecycle stages A1-3, A4 and A5). The carbon emissions from the materials (lifecycle stages A1-3) are estimated to be 244tCO_2e. The transport of materials to site (lifecycle stage A4) is estimated to be at 94tCO_2e and emissions from construction plant (lifecycle stage A5) at 93tCO_2e. These results are presented in Table 12-11.

Table 12-11 : Lifecycle stage carbon emissions (Option 1)

Lifecycle stage	Construction emissions (tCO_2e)	Percentage of total construction phase emissions (%)
A1-3	244	57
A4	94	22
A5	93	22

Source: Mott MacDonald

The three design aspect contributors, as split by category are shown in Table 12-12 below.

Table 12-12 : Construction carbon hotspots (Option 1)

Item	Construction emissions (tCO_2e)	Percentage of total construction phase emissions (%)
Site clearance	0.08	0.02[245]
Earthworks	30	7
Pavements	400	93

Source: Mott MacDonald

Option 1 would contribute 0.001% of the manufacturing and construction contribution of the annual UK emissions[36].

12.8.1.1.2 Option 2

The assessment predicts that Option 2 would result in approximately 546tCO_2e during the construction phase (lifecycle stages A1-3, A4 and A5). The carbon emissions from the materials (lifecycle stages A1-3) are estimated to be 321tCO_2e. The transport of materials to site (lifecycle stage A4) is estimated to be at 109tCO_2e and emissions from construction plant (lifecycle stage A5) at 115tCO_2e. These results are presented in Table 12-3.

Table 12-13 : Lifecycle stage carbon emissions (Option 2)

Lifecycle stage	Construction emissions (tCO_2e)	Percentage of total construction phase emissions
A1-3	321	59
A4	109	20
A5	115	21

Source: Mott MacDonald

The four design aspect contributors, as split by category are shown in Table 12-14 below.

[245] Note that due to rounding the total percentage figure stated may not total 100%.

Table 12-14 : Construction carbon hotspots (Option 2)

Item	Construction emissions (tCO_2e)	Percentage of total construction phase emissions (%)
Site clearance	0.06	0.01[14]
Earthworks	28	5
Pavements	495	90
Structural concrete	23	4

Source: Mott MacDonald

Option 2 would contribute 0.001% of the manufacturing and construction contribution of the annual UK emissions[36].

12.8.1.1.3 Option 3

The assessment predicts that Option 3 would result in approximately 406tCO_2e during the construction phase (lifecycle stages A1-3, A4 and A5). The carbon emissions from the materials (lifecycle stages A1-3) are estimated to be 234tCO_2e. The transport of materials to site (lifecycle stage A4) is estimated to be at 83tCO_2e and emissions from construction plant (lifecycle stage A5) at 89tCO_2e. These results are presented in Table 12-15.

Table 12-15 : Lifecycle stage carbon emissions (Option 3)

Lifecycle stage	Construction emissions (tCO_2e)	Percentage of total construction phase emissions
A1-3	234	58
A4	83	20
A5	89	22

Source: Mott MacDonald

The three design aspect contributors, as split by category are shown in Table 12-16 below.

Table 12-16 : Construction carbon hotspots (Option 3)

Item	Construction emissions (tCO_2e)	Percentage of total construction phase emissions (%)
Site clearance	0.06	0.01[44]
Earthworks	26	6
Pavements	372	92
Structural concrete	8	2

Source: Mott MacDonald

Option 3 would contribute 0.001% of the manufacturing and construction contribution of the annual UK emissions[36].

12.8.1.2 Operation

The operational assessment for the three scheme options used the Emission Factor Toolkit (EFT) v11 to calculate the emissions for the open and forecast years. The results from the EFT were then fed into the Carbon Valuation Toolkit v1.4.2 to provide the monetisation and net present value (NPV) of emissions over the 60-year appraisal period of the scheme.

12.8.1.2.1 Option 1

Using the EFT methodology, an increase of 43,160tCO_2e over a 60 year appraisal period for the operational phase of the scheme has been calculated, of which 934tCO_2e is traded.

12.8.1.2.2 Option 2

Using EFT methodology, an increase of 54,877tCO_2e over a 60 year appraisal period for the operational phase of the scheme has been calculated, of which 1162tCO_2e is traded.

12.8.1.2.3 Option 3

Using EFT methodology, an increase of 46,529tCO_2e over a 60 year appraisal period for the operational phase of the scheme has been calculated, of which 986tCO_2e is traded.

12.8.1.3 Summary

In line with the reporting requirements within DMRB LA 114 the emissions associated with the scheme have been compared to the carbon budgets in Table 12-17 below.

Table 12-17 : Carbon emissions associated with the scheme compared to the carbon budgets

Scheme stage	Estimated total carbon over carbon budget (tCO_2e) ('Do-Something' Scenario)	Net CO_2 project GHG emissions (tCO_2e) (Do-Something - Do-Minimum)	Relevant carbon budget
Option 1			
Construction	430	430	1,959 $MtCO_2e$ (4th)
Operation	1,205,350	43,160	1,959 $MtCO_2e$ (4th), 1,725 $MtCO_2e$ (5th) & 965 $MtCO_2e$ (6th)
Total	1,205,780	43,490	
Option 2			
Construction	546	546	1,959 $MtCO_2e$ (4th)
Operation	1,452,701	54,877	1,959 $MtCO_2e$ (4th), 1,725 $MtCO_2e$ (5th) & 965 $MtCO_2e$ (6th)
Total	1,453,247	55,423	
Option 3			
Construction	406	406	1,959 $MtCO_2e$ (4th)
Operation	1,654,626	46,529	1,959 $MtCO_2e$ (4th), 1,725 $MtCO_2e$ (5th) & 965 $MtCO_2e$ (6th)
Total	1,655,033	46,935	

Source: Mott MacDonald

In summary, the assessment of the effects on climate has shown that due to the relatively small scale of the emissions and with the inclusion of appropriate mitigation measures as outlined in Section 12.7, construction stage effects are not considered to be significant.

At this stage, Option 2 is anticipated to have the greatest adverse effect in terms of construction emissions, whilst Option 3 is anticipated to have the smallest effect in terms of construction emissions.

Option 3 is anticipated to have the greatest adverse effect in terms of operational emissions, whilst Option 1 is anticipated to have the smallest effect on operational emissions.

Overall, none of the options are considered likely to result in significant adverse effects, however the emissions associated with the scheme are not immaterial as all GHG emissions contribute to climate change and must be reduced wherever possible, particularly the strict government targets for net zero. Therefore, the mitigation must be considered through subsequent stages of the scheme and wherever possible GHG emissions must be minimised.

12.8.2 Vulnerability of the scheme to climate change

The assessment post-mitigation on the aspects scoped in is detailed in Table 12-8 including the mitigation specific to that aspect.

Table 12-18: Assessment of vulnerability of the scheme to climate change for all scheme options

Design asset	Potential effect	Mitigation	Likelihood	Consequence	Significance
Drainage and water	Increased winter precipitation may increase standing water on the road surface	Precipitation uplift in drainage design	Low	Moderate adverse	Not Significant
	Increased winter precipitation may increase flood risk for the road	Precipitation uplift in drainage design	Low	Moderate adverse	Not Significant
	Increased winter precipitation may increase flood risk for the surrounding area	Precipitation uplift in drainage design	Low	Moderate adverse	Not Significant
	Increased winter precipitation causing groundwater flooding due to the local chalk geology	Consideration of known historic springs in the FRA and drainage design	Low	Moderate adverse	Not Significant

Design asset	Potential effect	Mitigation	Likelihood	Consequence	Significance
Earthworks	Changes in the future precipitation regime, including fluctuation between wetter winters and drier summers, may increase the risk to earthworks stability	Consideration of future seasonal precipitation regime in design	Low	Moderate adverse	Not Significant
Landscape planting	Increased temperate and changing precipitation pattern, in particular drier hotter summer and drought conditions, may result in loss of planting	Selection of drought tolerant species	Medium	Minor adverse	Not Significant
Highway users	Hotter summers, resulting in overheating cars in slow traffic, and extended exposure of vehicle users to high temperatures	Improvements in traffic flows	Medium	Minor beneficial	Not significant
	Hotter summer temperatures, resulting in exposure of cyclists and pedestrians to high temperatures	Shading by landscape planting	Medium	Minor beneficial	Not significant
	Inaccessible network of cycle and footpaths due to flooding during wetter winters	Precipitation uplift in drainage design	Low	Moderate adverse	Not significant

Design asset	Potential effect	Mitigation	Likelihood	Consequence	Significance
	Impacts on the wider local transport network due to coastal storms and coastal flooding risk	Increase in capacity provided by scheme improvements	Low	Moderate beneficial	Not significant
Pavement	High summer temperatures could cause pavement surfaces to melt, causing damage to the pavements	Innovation and improvement of industry standards for a hotter climate	Low	Moderate adverse	Not Significant

Source: Mott MacDonald

The assessment of the vulnerability of the scheme to climate change anticipates that there is the potential for significant adverse effects associated with the melting of pavement surfaces caused by high summer temperatures/extreme temperature events. However, this can be decreased to not significant as temperatures will not be high enough for this to occur on a regular basis whereby end users will be impacted within the relatively short timescales of road surface renewals post-construction.

There is a possibility that this risk will occur on an increasingly regular basis in the future, particularly given the location of the scheme within an area the UK projected to experience high summer temperatures. However, it is anticipated that industry standards will likely adapt in order to make pavement surfaces more resilient to both average and extreme future summer temperatures so that they do not melt or encounter faster rates of deterioration. As a result, no significant adverse effects following the implementation of mitigation for all three options of the scheme are anticipated.

13 Assessment of cumulative effects

13.1 Cumulative assessment methodology

Combined and cumulative effects result from multiple actions on receptors over time and are generally additive or interactive (synergistic) in nature. They can also be considered as effects resulting from incremental changes caused by other past, present, or reasonably foreseeable actions together with the project, identified as:

- A single project (e.g. numerous different effects impacting a single receptor)
- Different projects (together with the project being assessed)

The Design Manual for Roads and Bridges (DMRB) LA 104 – Environmental assessment and monitoring[246] states that, in general, cumulative assessment will be most successful when the assessment of all other environmental effects of the project is complete. This chapter therefore draws together findings from the respective topic-specific technical chapters of this Environmental Assessment Report (EAR) (Chapters 5 to 13); defines inter-relationships between these assessments and any other developments in the surrounding area; and establishes whether there are any other residual effects on the identified sensitive receptors which may require additional mitigation not previously identified.

Chapter 2 contains a detailed description of the three scheme options: Options 1, 2 and 3. The supporting figures and the technical appendices referenced in this chapter can be found in Appendix G and H.

13.1.1 Combined effects methodology

In accordance with DMRB LA 104, the assessment methodology for combined effects involves the identification of effect interactions associated with the scheme upon separate environmental receptors, to better understand the overall environmental effect of the scheme.

The significance of construction and operational phase environmental effects are brought forward from the preceding sections of this EAR into matrices, providing an overview of the potential effects on individual receptors. The assessment considers residual effects, after mitigation has been taken into account. The significance of the combined effects upon each environmental receptor group has been made based upon the balance of scores and using professional judgement.

The methodology for the assessment of combined effects follows DMRB LA 104 . For the purpose of this assessment, combined effects that score as Moderate

[246] Highways England (2020) LA 104 – Environmental assessment and monitoring [online] available at: 0f6e0b6a-d08e-4673-8691-cab564d4a60a (standardsforhighways.co.uk) (last accessed January 2022)

(Adverse or beneficial) or above are considered significant. However, those that do not score as significant are still considered worthy of note.

13.1.2 Cumulative effects methodology

The assessment methodology for cumulative effects involves the identification of incremental changes likely to be caused by potential 'other developments' together with the scheme.

The assessment of cumulative effects broadly follows The Planning Inspectorate's (PINS) Advice Note Seventeen: Cumulative Effects Assessment[247] with the four stages of assessment being as follows:

- Stage 1: Establish the Zone of Influence (ZoI) and identify a long list of 'other developments'248
- Stage 2: Identify shortlist of 'other developments' for the cumulative effects assessment
- Stage 3: Information gathering
- Stage 4: Assessment

For the purposes of the assessment, the following criteria, based on the type and scale of potential effects generated by a proposed development, has been used to determine 'other developments' contained within the long list (Stage 1). This criterion is based on the Screening Criteria contained within the Town and Country Planning (Environmental Impact Assessment) Regulations 2017:

- The development includes more than 1ha of development which is not dwelling house development
- The development includes more than 150 dwelling houses
- The area of the development exceeds 5ha

It is important to note that proposed developments that are close to the threshold limits but have characteristics likely to give rise to significant cumulative effects, or for which could give rise to a cumulative effect by virtue of its proximity to the scheme, have also been considered in the assessment, as recommended by Advice Note Seventeen: Cumulative Effects Assessment.

The 'other developments' are grouped into tiers, reflecting the likely degree of certainty attached to each development, with Tier 1 being the most certain, as shown in Figure 13-1. 'Other development' falling into Tier 3 is least certain and most likely to have limited publicly available information to inform assessments.

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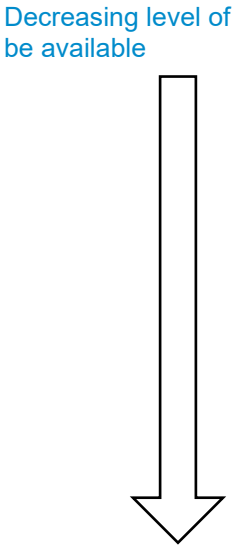
[247] The Planning Inspectorate (2019) Cumulative effects assessment [online] available at: Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects | National Infrastructure Planning (planninginspectorate.gov.uk) (Last accessed January 2022)

[248] Whilst the scheme is not considered a Nationally Significant Infrastructure Project, the guidance is still considered relevant to the assessment conducted.

Figure 13-1: Likely degree of certainty assigned to each tier

Tier	Likely Degree of Certainty
Tier 1	Under construction*. Permitted application(s), whether under the Planning Act 2008 or other regimes, but not yet implemented. Submitted application(s) whether under the Planning Act 2008 or other regimes but not yet determined.
Tier 2	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted.
Tier 3	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has not been submitted. Identified in the relevant Development Plan (and emerging Development Plans – with appropriate weight being given as the move closer to adoption) recognising that much information on any relevant proposals will be limited. Identified in other plans and programmes (as appropriate) which set the framework for future development consents / approvals, where such development is reasonably likely to come forward.



Source: Advice Note Seventeen: Cumulative Effects Assessment relevant to nationally significant infrastructure projects (The Planning Inspectorate, 2019).

In accordance with the EIA Regulations, the assessment of cumulative effects should include 'effects with other existing and/or approved projects'. However, taking the Precautionary Principle into account, and given the information provided in Figure 13-1 above, the assessment of cumulative effects also considers submitted applications which have not yet been determined (Tier 1), as well as those projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted (Tier 2).

Rather than reporting every interaction, the methodology for the assessment of cumulative effects concentrates on the main significant effects, and aims to differentiate between permanent, temporary, direct, indirect, and secondary effects, positive or negative.

Only the construction stage cumulative effects have been considered for air quality and noise within this assessment. This is because the operational air quality and noise assessments have used the traffic model data which includes all relevant proposed developments. Therefore, by default cumulative effects are included in the operational assessments, although not explicitly mentioned, within Chapter 4 and Chapter 10.

An assessment of the significance of cumulative effects upon each environmental resource has then been made based on the balance of scores and using

professional judgement. An on-balance approach has been taken when identifying the overall cumulative effect for the scheme on receptors in conjunction with the other proposed major developments.

13.1.3 Significance criteria

The assessment of the significance of the combined and cumulative effects arising from the scheme with other major developments has been based upon the definitions within Table 13-1. The significance of effects would be reported as 'Significant Adverse/Beneficial', 'Not Significant Adverse/Beneficial', or 'Neutral'. Where an effect is Moderate or above (Adverse or Beneficial), it is deemed to be significant.

For the purposes of the assessment, the value of a resource and magnitude of impact is determined according to the criteria set within the preceding sections of the EAR. The significance of effect is then carried forward from the preceding sections to enable an on-balance assessment of the significance of combined effects upon environmental receptors, as well as to identify the significance of cumulative effects with other developments. Typical descriptors of cumulative significance are included within Table 13-1, which reflects this on-balance approach. Overall significance is determined with mitigation included, as shown in Table 4.2.

Significance descriptors have also been aligned with the considerations included within PINS Advice Note Seventeen: Cumulative Effects. Accordingly, where effects are likely to be temporary, the overall significance of effect is considered to be reduced from a permanent effect on a receptor of the same value. Equally, localised and infrequent effects are likely to be of lower magnitude than those that cover a greater geographical scale and/or regularly occur, resulting in a reduced significance of effect. Effects can be additive (such as the loss of two pieces of woodland of 1ha, resulting in 2ha cumulative woodland loss) or synergistic (two discharges combining to have an effect on a species not affected by discharges in isolation).

Table 13-1 : Combined and cumulative significance criteria

Significance		Definition
Significant Adverse or Beneficial	Very Large (Adverse or Beneficial)	Where the combined effects of the scheme or cumulative effects of the scheme in association with other existing or more than likely / near certain future major development upon an individual or collection of environmental receptors would be highly significant.
	Large (Adverse or Beneficial)	Where the combined effects of the scheme or cumulative effects of the scheme in association with other existing or more than likely / near certain major future developments upon an individual or collection of environmental receptors would be significant.

Significance		Definition
	Moderate (Adverse or Beneficial)	Where the combined effects of the scheme or cumulative effects of the scheme in association with other existing or more than likely / near certain major development upon an individual or collection of environmental receptors would be significant.
Not Significant Adverse or Beneficial	Slight (Adverse or Beneficial)	Where the combined effects of the scheme or cumulative effects of the scheme in association with other existing or more than likely / near certain future major developments upon an individual or collection of environmental receptors would be slight.
Neutral	Neutral	Where the combined effects of the scheme or the cumulative effects of the scheme in association with other existing or more than likely / near certain future major developments would balance.

13.1.4 Study area

13.1.4.1 Combined effects

The study area for the assessment of combined effects, for both construction and operation, is defined by the study areas identified within the relevant environment topic sections of this EAR, ranging from 200m (for air quality) to 2km (for biodiversity).

13.1.4.2 Cumulative effects

The search area for the identification of 'other developments' for inclusion in the assessment of cumulative effects would reflect the 2km ZoI around the boundary of the scheme elements, for both construction and operation. This 2km ZoI is large enough to cover the proposed developments likely to contribute to cumulative effects, whilst being proportionate to the scope and scale of the scheme.

The study area used to identify the ZoI for environmental receptors included within the cumulative assessment, during both construction and operation, reflects the individual ZoIs of the topic sections.

13.1.5 Baseline conditions

13.1.5.1 Combined effects

The baseline for each environmental topic is described in detail for air quality, cultural heritage, landscape, biodiversity, materials, noise and vibration, population and human health, road drainage and the water environment, and climate, in the preceding chapters of this EAR (Chapters 5 to 13).

13.1.5.2 Cumulative effects

At this stage of the scheme (Project Control Framework Stage 1 and 2), the baseline for cumulative effects has been set. The assessment of potential

cumulative effects of this development in combination with other developments in the area, along with the identification of likely residual effects and proposed mitigation for each of the other developments is detailed below.

13.2 Assessment of combined effects

13.2.1 Construction

During construction, there is the potential for combined effects on receptors relating to the following environmental receptors (but not limited to) nearby residential receptors, designated sites, Air Quality Management Areas (AQMAs) and WFD waterbodies as a result of the scheme options due to the potential effects reported within the preceding chapters (Chapters 5 to 11). However, during construction, effects would be temporary in nature and best practice mitigation measures included in the Second Iteration of the Environmental Management Plan (EMP) would ensure that combined effects are reduced as far as possible.

Combinations of significant residual (post mitigation) effects from other assessment topics such as noise, vibration, poor air quality, and landscape and visual intrusions can result in amenity effects. Residual effects must combine at the same location for an amenity effect to be identified. Further assessment is required at the next PCF stage to predict potential amenity effects as the noise assessment for construction has not yet been undertaken. No traffic assessment will be undertaken.

Table 13-2 provides a summary of anticipated combined effects during construction.

13.2.2 Operation

During operation, there is the potential for combined effects on receptors relating to the following environmental topics (but not limited to) nearby residential receptors, designated sites, Air Quality Management Areas (AQMAs) and WFD waterbodies as a result of the scheme options due to the potential effects reported within the preceding chapters (Chapters 5 to 11).

Table 13-3 provides a summary of the combined effects anticipated during operation.

Table 13-2 : Combined residual construction phase effects of the scheme

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Residential Receptors									
Residential receptors in the immediate vicinity of Offington Corner Junction and the approach arms where interventions are proposed	Neutral	Moderate Adverse	-	-	Not Significant	Slight Adverse	-	-	**Significant Adverse**
Residential receptors in the immediate vicinity of Grove Lodge Junction and the approach arms where interventions are proposed	Neutral	Moderate Adverse	-	-	Not Significant	Slight Adverse	-	-	**Significant Adverse**
Residential receptors in the immediate vicinity of the	Neutral	Option 3: Moderate Adverse	-	-	Not Significant	Slight Adverse	-	-	**Significant Adverse (Option 3)**

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Busticle Lane Junction									**Not significant Adverse (Option 1 and 2)**
Residential receptors in the immediate vicinity of the Lyons Way Sompting Junction	Neutral	Option 2: Moderate Adverse	-	-	Not Significant	Slight Adverse	-	-	**Significant Adverse (Option 2)** **Not significant Adverse (Option 1 and 3)**
Residential receptors in the immediate vicinity of Upper Brighton Road	Neutral	Options 2 and 3: Moderate Adverse	-	-	Not Significant	Slight Adverse	-	-	**Significant Adverse(Option 2 and 3)** **Not significant Adverse (Option 1)**
Designated Sites									
The Mens Special Area of Conservation (SAC)	Neutral		Neutral	-	-	-	Slight Adverse	-	**Not Significant Adverse**
Ebernoe Common SAC	Neutral	-	Neutral	-	-	-	Slight Adverse	-	**Not Significant Adverse**

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Singleton and Cocking Tunnels SAC	Neutral	-	Neutral	-	-	-	Slight Adverse	-	**Not Significant Adverse**
Cissbury Ring Site of Special Scientific Interest (SSSI)	Neutral	-	Neutral	-	-	-	Slight Adverse	-	**Not Significant Adverse**
Lancing Ring Local Nature Reserve (LNR)	Neutral	-	Neutral	-	-	-	Slight Adverse	-	**Not Significant Adverse**
Water Environment									
Teville Stream (GB10704101 1940)	-	-	-	-	-	-	Slight Adverse	Not Significant	**Not Significant Adverse**
Worthing Chalk (GB40701G50 5300)	-	-	-	-	-	-	Slight Adverse	Not Significant	**Not Significant Adverse**
Teville Stream Waterbody Catchment	-	-	-	-	-	-	Slight Adverse	Not Significant	**Not Significant Adverse**

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Ferring Rife Waterbody Catchment	-	-	-	-	-	-	Neutral	Not Significant	**Neutral**

Table 13-3 : Combined residual operational phase effects of the scheme

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Residential Receptors									
Residential receptors in the immediate vicinity of Offington Corner Junction and the approach arms where interventions are proposed	Neutral	Slight Adverse	-	-	Neutral	Slight Beneficial	-	-	**Neutral**
Residential receptors in the immediate vicinity of Grove Lodge	Option 1 – Moderate Adverse	Option 1: Slight Adverse	-	-		Slight Beneficial	-	-	**Significant Adverse (Option 1)**

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Junction and the approach arms where interventions are proposed		Options 2 & 3: Neutral							**Not significant Adverse (Option 2 and 3)**
Residential receptors in the immediate vicinity of the Busticle Lane Junction	Option 2 and 3 – Slight Adverse	Option 3: Slight Adverse Options 1 &2: Neutral	-	-	Neutral	Slight Beneficial	-	-	**Not Significant Adverse (Option 2 and 3)** **Neutral (Option 1)**
Residential receptors in the immediate vicinity of the Lyons Way Sompting Junction	Neutral	Option 2: Slight Adverse Options 1 &3: Neutral	-	-	Neutral	Slight Beneficial	-	-	**Neutral**
Residential receptors in the immediate vicinity of Upper Brighton Road	Neutral	Neutral	-	-	Neutral	Slight Beneficial	-	-	**Neutral**
Designated Sites									
The Mens SAC	Neutral	-	Neutral	-	-	-	-	-	**Neutral**

Receptor	Topic area								Overall significance of combined effects
	Air quality	Landscape and visual	Biodiversity	Materials assets and waste	Noise and vibration	Population and human health	Road drainage and the water environment	Climate	
Ebernoe Common SAC	Neutral	-	Neutral	-	-	-	-	-	**Neutral**
Singleton and Cocking Tunnels SAC	Neutral	-	Neutral	-	-	-	-	-	**Neutral**
Cissbury Ring SSSI	Neutral	-	Neutral	-	-	-	-	-	**Neutral**
Lancing Ring LNR	Neutral	-	Neutral	-	-	-	-	-	**Neutral**
Water Environment									
Teville Stream (GB107041011940)	-	-	-	-	-	-	Slight Adverse	Neutral	**Not Significant Adverse**
Worthing Chalk (GB40701G505300)	-	-	-	-	-	-	Slight Adverse	Neutral	**Not Significant Adverse**
Teville Stream Waterbody Catchment	-	-	-	-	-	-	Slight Adverse	Neutral	**Not Significant Adverse**
Ferring Rife Waterbody Catchment	-	-	-	-	-	-	Neutral	Neutral	**Neutral**

13.3 Assessment of cumulative effects

The assessment of cumulative effects for the scheme during the construction and operational phases can be found in Tables G.1 and G.2 within Appendix G.

Only those developments that have been included in the shortlist (Stage 2) have been brought through to the assessment of cumulative effects, which represents Stages 3 and 4 of the methodology outlined in the PINS Advice Note 17: Cumulative Effects[249] (see section 14.1.2 for a description of the stages of assessment). The assessment has been split by environmental topic, and the effects of the 'other developments' have been addressed where the ZoIs for each environmental topic overlaps.

Table 13-4 below provides a summary of the residual effects for the A27 and the relevant environmental topics during construction and Table 13-5 below summarises the residual cumulative effects during operation.

[249] The Planning Inspectorate (2019) Cumulative effects assessment [online] available at: Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects | National Infrastructure Planning (planninginspectorate.gov.uk) (Last accessed January 2022)

Table 13-4 : Summary of cumulative residual effects for the 'other development' with the scheme during construction

Other Development	Residual cumulative effects of 'other development' with the scheme for each environmental topic during construction					
	Landscape and Visual Effects	Biodiversity	Material Assets and Waste	Noise and Vibration	Road Drainage and the Water Environment	Climate
AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex	Not Significant Adverse	Neutral	-	-	Neutral	-
AWDM/0021/22 – Land East of Shadwells Road	Not Significant Adverse	Neutral	-	Not Significant Adverse	Neutral	-
Overall cumulative effect for each environmental topic during construction	**Not Significant Adverse**					

Table 13-5 : Summary of cumulative residual effects for the 'other development' with the scheme during operation

Other Development	Residual cumulative effects of 'other development' with the scheme for each environmental topic during construction					
	Landscape and Visual Effects	Biodiversity	Material Assets and Waste	Noise and Vibration	Road Drainage and the Water Environment	Climate
AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex	Not Significant Adverse	Neutral	-	-	Neutral	Not Significant Beneficial
AWDM/0021/22 – Land East of Shadwells Road	Not Significant Adverse	Neutral	-	Neutral	Neutral	Not Significant Beneficial
Overall cumulative effect for each environmental topic during operation	**Neutral**					

14 Glossary

Table 14-1 below provides the description of key words used throughout this Environmental Assessment Report.

Table 14-1: Glossary of terms

Glossary Term	Description
Air Quality Management Area (AQMA)	Any parts of a Local Authority's area where the air quality objectives are not being achieved, or are not likely to be achieved within the relevant period must be identified and declared an AQMA.
Air quality objectives	Objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedances, within a specified timescale.
Ambient Noise	Ambient noise is the total sound in a given situation at a given time usually composed of sound from many sources, near and far.
Area of Outstanding Natural Beauty (AONB)	A protected area recognised and classified by the International Union for the Conservation of Nature (IUCN). AONBs in England and Wales fall into Category V – Protected Landscapes and are protected by the Countryside and Rights of Way Act (2000) (CROW Act). AONBs are designated in recognition of their national importance and to ensure that their character and qualities are protected for all to enjoy. Under the CROW Act, Natural England can make orders to designate AONBs or vary the boundaries of existing ones.
Baseline conditions	The environment as it appears (or would appear) immediately prior to the implementation of the project together with any known or foreseeable future changes that will take place before completion of the project.
Birds Directive	EC Directive on the Conservation of Wild Birds (Birds Directive 1979) as amended (79/409/EEC).
Biodiversity	The biological diversity of the earth's living resources. The total range of variability among systems and organisms at the following levels of organisation: bioregional, landscape, ecosystem, habitat, communities, species, populations, individuals, genes and the structural and functional relationships within and between these different levels.
Biodiversity Action Plan (BAP)	It describes the biological resources of the UK and provides detail plans for conservation of these resources.
British Geological Survey	The British Geological Survey is a government organisation which aims to advance geoscientific knowledge of the United Kingdom landmass and its continental shell by means of systematic surveying, monitoring and research.
Congestion	Traffic experiences periods of excessive breaking and acceleration and is associated with higher vehicle emissions. On motorways this occurs at speeds less than 50mph and / or near complex junctions.
Contaminated Land Exposure Assessment (CLEA)	A CLEA provides methods of assessment that can be used to estimate exposure and assess risks to human health from contaminants in soil. The CLEA model estimates how much of a contaminant people are potentially exposed to if they live, work or play on contaminated sites over long periods.

Glossary Term	Description
Contamination Land Risk Assessment (CLRA)	It covers the main hazards that might happen during the construction project and the risk management that is required.
Conservation Area	An area designated by the Local Planning Authority under the Town and Country Planning (Listed Buildings and Conservation Areas) Act 1990 as possessing special architectural or historical interest. The Local Planning Authority will seek to preserve and enhance the character and appearance of these areas.
Cumulative Assessment	An assessment on how the effects of the proposed scheme would combine and interact with the effects of other developments. It considers the accumulation of, and interrelationship between effects which might affect the environment, economy or community as a whole, even though they may be acceptable when considered on an individual basis with mitigation measures in place.
Decibel (dB)	The decibel is a logarithmic unit that expresses the ratio of two values of a physical quantity, often power or intensity. One of these quantities is often a reference value and in this case the decibel expresses the absolute level of the physical quantity.
Design Manual for Roads and Bridges (DMRB)	Design Manual for Roads and Bridges is a set of documents published by the Highways Agency. The document provides a comprehensive manual system which accommodates all current standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads (including motorways).
Design Year	15 years after the Opening Year.
Development Consent Order (DCO)	Development Consent Order is a combination of grant planning permission with range of other separate consents such as Listed Buildings. It can also include rights to compulsorily purchase land
Do-Minimum network scheme	The 'Do-Minimum' forecast scenario in the Opening / Design Year is the base road and traffic network against which alternative improvements can be assessed. In many cases, the definition of the 'Do-Minimum' is straightforward; it is simply the 'Do-Nothing' scenario. However, one or more of the following four cases may arise, in which the 'Do-Minimum' differs from the 'Do-Nothing': i) The case where works will be carried out regardless of whether or not the 'Do- Something' scheme is built. ii) The case where the existing network may be improved to form a 'Do-Minimum scheme which can be tested as an alternative to carrying out major Do-Something improvements. iii) The case where traffic conditions can be improved without significant capital expenditure. iv) The case where the area covered by the modelled network includes road proposals other than the one under immediate consideration.
Effect	Term used to express the consequence of an impact (expressed as the 'significance of effect'), which is determined by correlating the magnitude of the impact to the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria. For example, land clearing during construction results in habitat loss (impact), the effect of which is the significance of the habitat loss on the ecological resource.

Glossary Term	Description
Emissions	Mass of a pollutant per time per vehicle at the point of exhaust and are used as inputs into an air quality model.
Enhancement	A measure that is over and above what is required to mitigate the adverse effects of a project.
Environment Agency	The Environment Agency is responsible for environmental protection and regulation in England and plays a central role in implementing the government's environmental strategy. The Environment Agency is the main body responsible for managing the regulation of major industry and waste, treatment of contaminated land, water quality and resources, fisheries, inland river, estuary and harbour navigations, and conservation and ecology. They are also responsible for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea.
Environmental Management Plan (EMP)	A EMP includes the specific measures that will be taken to control and manage the environmental impacts whilst the project is under construction that may otherwise occur for each of the environmental topics, such as noise, air quality, water resources and ecology. In addition, a description of the planned works and the general site arrangements should be included in the EMP. The Principal Contractor will be responsible for ensuring the measures specified within the EMP are implemented.
Farm / Individual farm holdings / Farm business	An area of land that consists of one or more land parcels or group of fields that are managed by a named person or named business entity as an owner, tenant or in any other commercial agricultural capacity, for the production of food, forage or fibre.
Flood Risk Assessment	An assessment of the likelihood of flooding in a particular area so that development needs and mitigation measures can be carefully considered.
Forecast (Traffic)	A model describing a future set of traffic conditions e.g. Do-Minimum, Do-Something, etc.
Habitat	A place where an organism lives; a type of environment inhabited by a particular species and/or community; often characterised by dominant plant forms, physical characters, or a combination of these.
Greenhouse Gas (GHG)	Gasses that once emitted into the atmosphere contribute to the 'greenhouse effect' of warming the planet.
Habitat Directive	EC Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna (Habitats Directive 1982) as amended (92/43/EEC).
Habitat Suitability Index (HSI)	A numerical index where a score of 0 and 1.0 are recorded for each habitat value which can include: geographic location, water quality and permanence.
Heavy Duty Vehicle (HDV)	HDVs are vehicles over 3.5 tonnes and includes rigid and articulate lorries.
Historic England	The public body that looks after England's historic environment. Championing historic places and helping people understand their value and care for them.
Historic Environment	All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora.
Impact	Change that is caused by an action; for example, land clearing (action) during construction which results in habitat loss (impact).

Glossary Term	Description
Landscape Character Area (LCA)	Geographically unique areas where a combination of factors such as topography, vegetation pattern, land use and cultural associations combine to create an area with a distinct, recognisable character.
Listed Buildings	A building which is considered by the Secretary of State (for Culture, Media and Sport) to be of special architectural or historic interest in accordance with the regime set out in the Town and Country Planning (Listed Buildings and Conservation Areas) Act 1990.
Local Enterprise Partnership (LEP)	The LEP is a partnership between private sector, local authorities, universities and colleges.
Main River	Main Rivers are larger rivers and watercourses, for which the Environment Agency carries out maintenance, improvement and construction work to manage flood risk
Materials Management Plan (MMP)	An MMP manages the recovery of material from the waste stream as opposed to producing new materials/ it also reduces the amount of waste and recyclables delivered to disposal or resource recovery facilities.
Minerals Local Plan	The purpose of a Minerals Local Plan is to provide a policy framework to guide decisions on planning applications for minerals development.
Mitigation	These measures intended to avoid, reduce and, where possible, remedy significant adverse environmental effects.
National Character Areas (NCAs)	A natural subdivision of England based on a combination of landscape, biodiversity, geodiversity and economic activity. The NCAs are defined by Natural England, the UK government's advisors on the natural environment.
National Planning Policy Framework (NPPF)	The NPPF sets out the Government's planning policies for England.
National Policy Statements	National policy statements are instruments issued under section 52(2) of the Resource Management Act 1991 and state objectives and policies for matters of national significance.
National vegetation classification (NVC)	The NVC assesses the full suite of vascular plant, bryophyte and macro-lichen species with a certain vegetation type.
Natural England	Natural England are responsible for: Helping land managers and farmers protect wildlife and landscapes; Advising on the protection of the marine environment in inshore waters (0 to 12 nautical miles); Improving public access to the coastline; Managing 140 National Nature Reserves and supporting National Trails; Providing planning advice and wildlife licences through the planning system; Managing programmes that help restore or recreate wildlife habitats; Conserving and enhancing the landscape; and, Providing evidence to help make decisions affecting the natural environment.
Lowest Observed Adverse Effect Level (LOAEL)	This the level of noise above which adverse effects on health and quality of life can be detected.
NOx	Oxides of Nitrogen – which encompasses all nitrogen species although mainly NO and NO2.
NO2	Nitrogen Dioxide.

Glossary Term	Description
Opening Year	The estimated year that the scheme would become operational.
Operation	The functioning of a project on completion of construction.
Publicly Available Specification (PAS)	PAS are streamlined standards, specifications and codes of practice or guidelines developed by sponsoring organisations to meet an immediate market need, produced by The British Standards Institute (BSI).
PAS2080	Publicly Available Specification (PAS) 2080 is a standard for managing infrastructure carbon which provides guidance on how to reduce carbon emission, improve efficiency and decrease the rate of climate change.
Peak Particle Velocity (PPV)	Peak particle velocity refers to the maximum speed of a particular particle as it oscillates about a point of equilibrium that is moved by a passing wave. It is a term used to describe vibration, or elastic movement, resulting from excitation by seismic energy as it passes a particular point.
PM10	Particulate matter with a diameter of 10 microns or less.
Project Control Framework	Project Control Framework supports the implementation of project management within an organisation because: It supports the development and replication of accepted practice. Helps communication within the team because of a common language. Streamlines the use of tools and techniques for key project management processes. Establishes a consistent approach which aid customers understand the project management processes. Ensure that focus is maintained on the early stage of the project lifecycle.
Preliminary Sources Study Report (PSSR)	PSSR relates to the preliminary stages of data collection. It can include a detailed summary of factual information included within various reports pertaining to historic data sources.
Public Rights of Way (PRoW)	A right to access land for walking or certain other leisure activities such as cycling, horse riding or for the use of powered wheelchairs. Definitive maps make a legal record of public rights of way in 4 categories: footpaths, bridleways, restricted byways and byways open to all traffic.
Receptor	A defined individual environmental feature that has the potential to be affected by a project.
Registered Park and Garden	A park or garden that has been registered under Historic England's 'Register of Historic Parks and Gardens of special historic interest in England' due to its high level of historic interest.
Scheduled Monument	A historic building or site that is included in the schedule of monuments kept by the secretary of state for culture, media, and sport. The National Planning Policy Framework sets out the Government's planning policies for England.
Significant Observed Adverse Effect Level (SOAEL)	This is the level of noise above which significant adverse effects on health and quality of life occur.
Site of Special Scientific Interest (SSSI)	A SSSI is a conservation designation denoting a protected area in the United Kingdom, designated due to special interest in its flora, fauna, geological or physiographical features. They are protected by law to conserve their wildlife or geology.

Glossary Term	Description
Soils Management Plan	A Soil Management Plan ensures soil sustainability during the construction phase of the development process. The plan can contain information on topsoil and subsoil types, methods for stripping, stockpiling and improving soils, location and content of each soil stockpile, who is responsible for supervising soil management.
Source Protection Zone (SPZs) (Groundwater)	The Environment Agency has designated SPZs for groundwater sources and include wells, boreholes and springs used for public drinking water supply. Zones are set up as pollution prevention measures in areas which are at a high risk, and to monitor the activities of potential polluters nearby.
Special Areas of Conservation (SAC)	Special Areas of Conservation (SACs) are strictly protected sites designated under the EC Habitats Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level.
Strategic Road Networks (SRN)	A strategic road network is made up of motorways and major trunk roads in England and that are managed by Highways England
Site Waste Management Plan (SWMP)	SWMPs encourage the effective management of materials and ensure waste is considered at all stages of a project - from design through to completion. Although no longer a regulatory requirement in England, SWMPs are still considered to be good practice.
Transport analysis guidance (TAG)	Transport analysis guidance is a document produced by the government for projects that require government approval. It provides guidance on a range of topics which include: creating a transport model for the appraisal of the alternative solutions.
Transport appraisal process/ WebTAG	WebTAG involves 3 stage process: Stage 1 – option development, identifying the need for intervention and developing options. Stage 2 – further appraisal – the focus of the analysis is on estimating the likely performance and impact of intervention(s) in detail. Stage 3 – implementation, monitoring and evaluation.
UKCP09	United Kingdom Climate Projections (UKCP) 2009 provides details on observed climate data and a number of different projected climate change scenarios.
Walkers, cyclists and horse-riders (WCH)	Someone walking, cycling or a horse rider, or using an electric-powered mobility vehicle.
World Heritage Site (WHS)	Cultural or natural heritage site of outstanding universal value and of importance to all humanity. World Heritage Sites are designated under the terms of the UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage (1972). In the UK, the Department for Culture, Media and Sport is responsible for the implementation of the World Heritage Convention and to support the achievement of UNESCO's goals and aspirations.
Zone of Theoretical Visibility (ZTV)	In the context of landscaping and investigating the visibility of the scheme, a study area should extend to all areas in which visual impacts have the potential to occur based on topographical indications only.

Appendices

A. Environmental Constraints Plans

A.1 Option 1: noise, air quality and water environment

A.2 Option 1: ecology, heritage and landscape

A.3 Option 2: noise, air quality and water environment

A.4 Option 2: ecology, heritage and landscape

A.5 Option 3: noise, air quality and water environment

A.6 Option 3: ecology, heritage and landscape

B. Options design overview

B.1 Option 1 overview

B.2 Option 2 overview

B.3 Option 3 overview

C. Air Quality Model Verification

C.1 Verification

C.1.1 Overview

Model verification is a process by which checks are carried out to determine the performance of an air quality assessment model at a local level, primarily by comparison of modelled results with monitoring data. The verification process benefits an assessment by investigating uncertainties and minimising them through informed refinement of model input parameters if it is deemed necessary.

Technical guidance (TG16) produced by the Department for Environment Food and Rural Affairs[250] provides a methodology for model verification including calculation methods and advice on the suitability of monitoring data.

Verification of the Screening Model has been undertaken using the 2019 Base Year traffic data and the outputs have been compared against monitored 2019 annual mean NO_2 concentrations at relevant diffusion tube sites representative of the study area. Monitoring data from ADC and Adur and Worthing Councils Highways has been reviewed and 21 monitoring locations considered representative,

Background concentrations for the grid squares where the diffusion tubes are located, and which have been used in the Screening Model verification have been taken from Defra and are presented in Table 14-2 below.

Table 14-2: Defra background pollutant map data for verification

Grid Square	2019	
	Background concentrations	
	NOx (µg/m^3)	NO_2 (µg/m^3)
502_105	12.3	9.4
503_103	14.4	10.9
509_105	14.2	10.8
510_104	12.2	9.4
513_104	15.8	11.8
513_105	15.6	11.8
514_104	17.3	12.9

[250] Department for Environment, Food and Rural Affairs and Devolved Administrations (April 2021). Local Air Quality Management – Technical Guidance LAQM.TG16

514_105	14.2	10.8
515_105	14.8	11.1
516_105	14.9	11.2
517_105	15.8	11.8
518_105	17.6	13.1

The exact location of each of the sites selected has been confirmed using street photography and aerial mapping.

The locations of the monitoring sites used in model verification are indicated in Figure 5.4 of Chapter 5 Air quality. Table 5-21 presents the monitoring data used within the model verification.

Table 14-3 : Monitoring data used within model verification

Site ID	X	Y	2019 Annual Mean (NO_2) µg/m^3
S13	517291	105550	36.3
S14	516057	105190	23.7
S44	516466	105171	16.1
S40	518494	105464	38.4
WT2	514184	104963	32.9
6N	515190	105122	33.1
N5	514495	105020	28.3
N18A	513236	104651	28.6
N24	509777	105696	10.8
N25	515151	105109	23.5
N29	513845	105191	17.8
N30A	515014	105099	29.9
N35	514183	104948	56.6
N39	514266	104961	24.4
N43	514088	104906	28.5
N44A	514199	104982	19.9
N45	514184	104963	36.2
N53	514184	104963	35.7
N56	514184	104963	36.3
N8	514126	105063	15.4
N61	513278	105623	30.7

Source: Adur and Worthing Councils, 2021

C.1.2 Results

Table 5-22 presents a comparison of the monitored and modelled concentrations of NOx and NO_2 at the diffusion tube sites for the year 2019. The results show that there is no systematic under or over prediction of monitored concentrations across most of the study area; however, there were two areas where the model appears to perform differently to elsewhere.

The model predicts NO_2 concentrations between an under prediction of 6.1% to an over prediction of 7.5% within the vicinity of the Grove Lodge roundabout. The model is therefore predicting within 10% of the monitored concentrations within this area.

The model under-predicts by 35% at the Grove Lodge cottages diffusion tube N30a. This monitor is located approximately 2m from the kerbside of the westbound carriageway of the A27, to the east of Grove lodge roundabout. The underprediction is likely to be because traffic on the westbound carriageway of the A27 is highly congested with queueing traffic, resulting in a localised area of higher concentrations. This is reflected in the monitored concentration of 56.6µg/m^3 in 2019, which exceeds the annual mean NO_2 objective. An additional verification factor has therefore been calculated for this location.

Three verification zones have therefore been used within the assessment as follows:

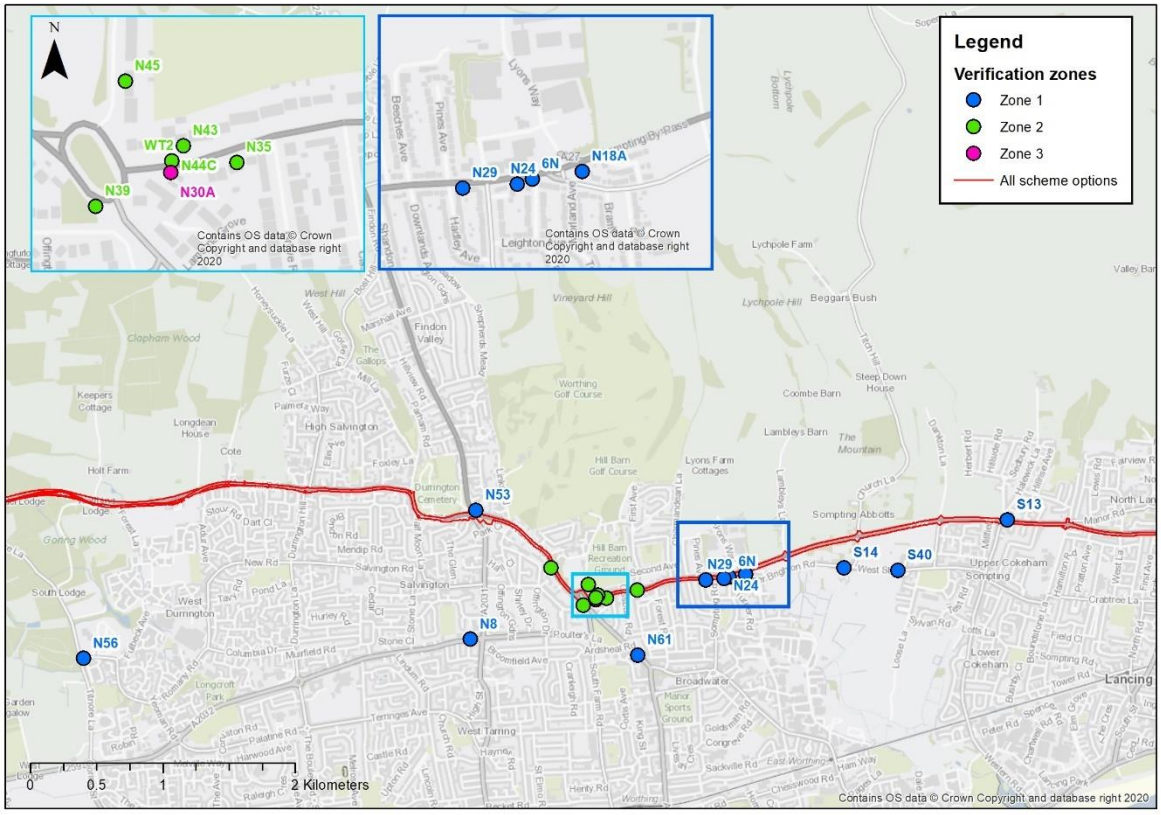
- Verification zone 1 – all monitoring locations outside of zone 2 or 3
- Verification zone 2 – monitoring locations within the vicinity of Grove Lodge Roundabout, apart from N30a
- Verification zone 3 – Monitoring location N30a.

Table 14-4 : Unadjusted model verification results

Site ID	Monitored road NO_x (µg/m^3)	Modelled road NO_x (µg/m^3)	Monitored total NO_2 (µg/m^3)	Modelled total NO_2 (µg/m^3)	Total NO_2 % difference	Verification zone
S13	49.3	29.3	36.3	27.0	-25.6	1
S14	23.8	9.1	23.7	16.1	-31.9	1
S44	51.4	41.8	38.4	34.1	-11.2	1
S40	9.0	7.0	16.1	15.0	-6.8	1
WT2	39.6	41.9	32.9	34.0	3.3	2
6N	43.6	38.2	33.1	30.6	-7.6	1
N5	33.9	34.7	28.3	28.7	1.3	2
N18A	20.0	16.3	21.7	19.8	-8.6	1
N24	23.5	21.9	23.5	22.7	-3.6	1
N25	11.1	12.0	17.8	18.3	2.6	2

N29	36.7	22.8	29.9	23.1	-22.6	1
N30A	96.7	48.1	56.6	36.8	-35.0	3
N35	21.9	21.7	24.4	24.3	-0.5	2
N39	30.3	34.7	28.5	30.6	7.5	2
N43	13.1	15.1	19.9	20.9	5.2	2
N44A	46.8	41.9	36.2	34.0	-6.1	2
N45	8.4	7.1	15.4	14.7	-4.7	2
N53	37.0	25.1	30.7	24.9	-18.8	1
N56	21.4	12.1	20.8	16.0	-23.3	1
N8	32.6	21.9	28.6	23.3	-18.4	1
N61	43.7	25.0	34.8	26.0	-25.4	1

Figure 14.1: Verification zones



C.1.2.1 Verification Zone 1

Figure 14.2 presents a graphical comparison of the monitored and modelled concentrations of NO_2 at the verification sites within Verification Zone 1. Following Defra guidance, modelled and measured road traffic concentrations have been compared to derive an adjustment factor to apply to the modelled results. As diffusion tubes only measure total NO_2, the road traffic NOx concentrations

measured by the diffusion tubes were calculated using Version 8.1 of the NOx to NO_2 calculator.

Following Defra guidance, a model adjustment factor of 1.391 has been calculated when comparing modelled and monitored road traffic NOx.

Figure 14.2 : Unadjusted model verification (annual mean NO_2; µg/m^3)

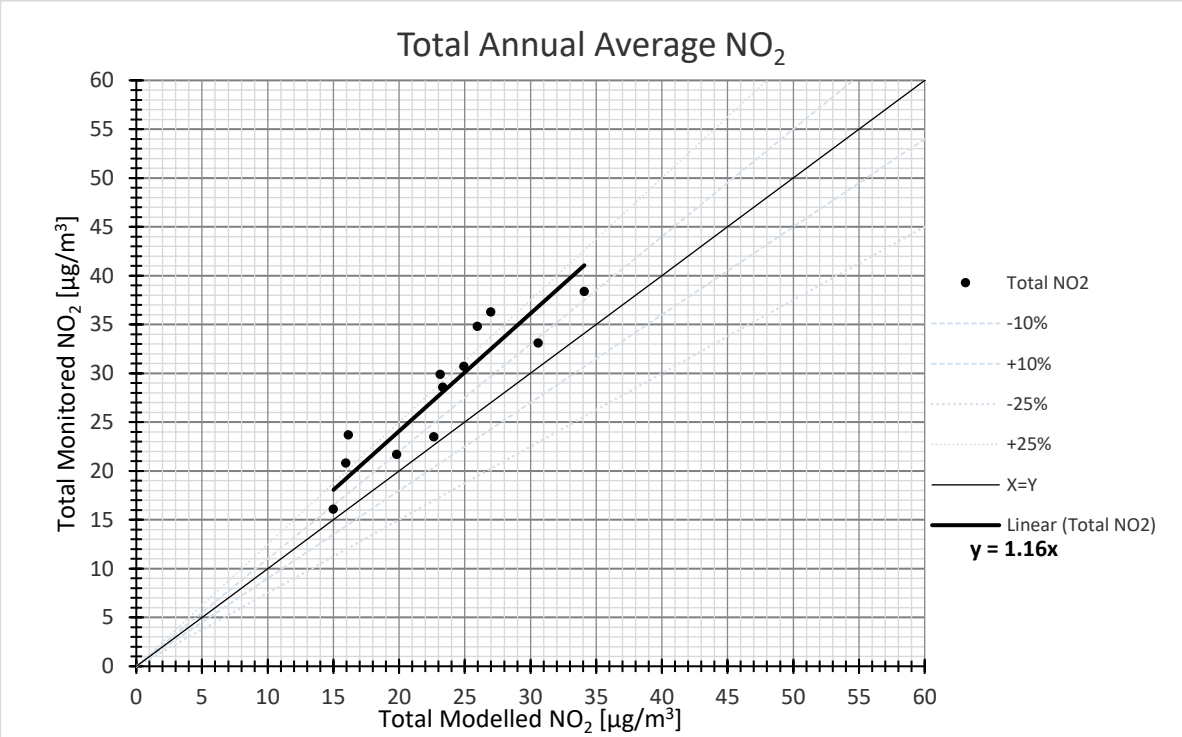


Table 14-5 and Figure 14.3 present the adjusted modelled NO_2 with monitored NO_2 at the verification sites. The Screening Model predicts NO_2 concentrations within 25% of the monitored concentrations at all but two monitoring sites. The Screening Model is therefore performing adequately at these locations following adjustment.

Table 14-5 : Adjusted model verification results

Site ID	Monitored total NO_2 (µg/m^3)	Modelled total NO_2 (µg/m^3)	% difference
S13	36.3	32.5	-10.6
S14	23.7	18.0	-23.9
S44	38.4	41.3	7.6
S40	16.1	16.5	2.2
6N	33.1	37.4	12.9
N18A	21.7	23.1	6.4
N24	23.5	26.9	14.4
N29	29.9	27.5	-8.0

N53	30.7	29.7	-3.3
N56	20.8	18.4	-11.3
N8	28.6	27.5	-3.7
N61	34.8	30.7	-11.8

Figure 14.3 : Adjusted model verification (annual mean NO_2; µg/m^3)

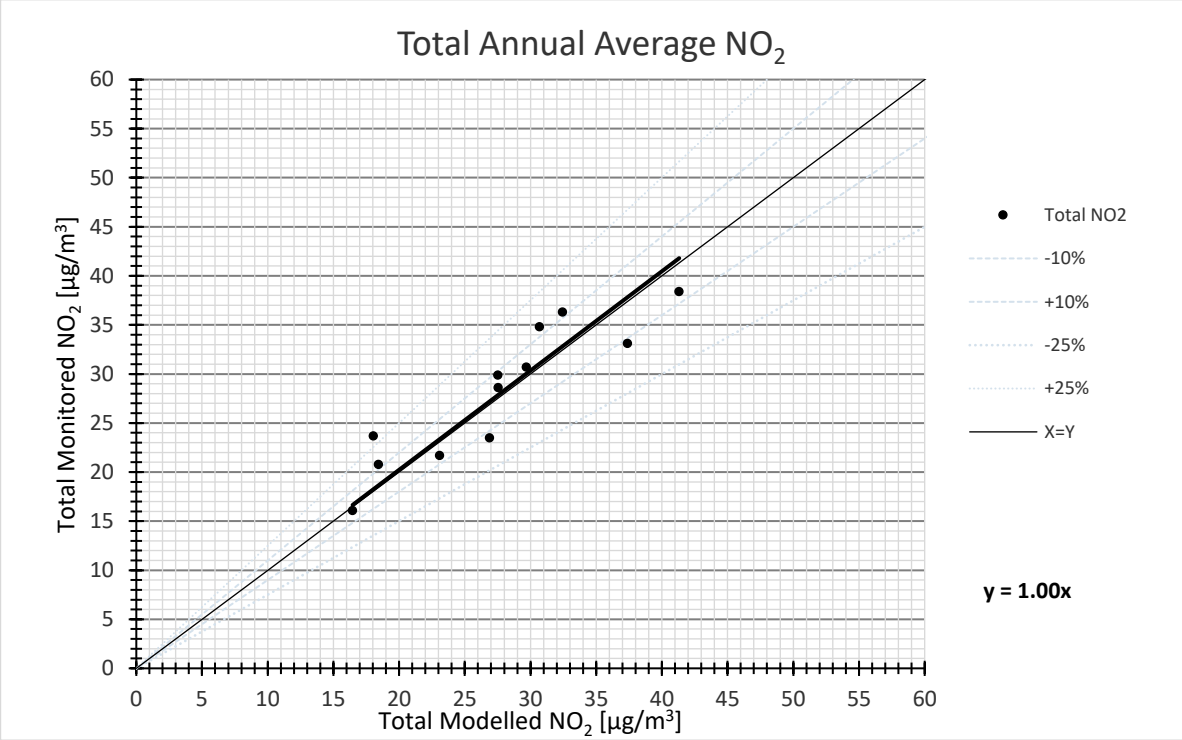


Table 14-5 presents statistical parameters for describing model uncertainty. The Root Mean Square Error (RMSE) is used to define the average error or uncertainty of the model. The results of the RMSE calculation in this case are concentrations of NO_2 measured in units of micrograms per metre cubed. Figure 14.3 shows that before adjustment the model uncertainty was ±5.6µg/m^3 or 14% of the annual mean NO_2 objective. After adjustment the model uncertainty is decreased to ±3.1µg/m^3 or 7.8% of the annual mean NO_2 objective. After adjustment the model uncertainty is within the desired 10% of the relevant objective, as recommended by Defra guidance.

The statistical analysis above demonstrates that the model performs adequately versus monitoring data following adjustment and is suitable to inform the judgement of significance. An adjustment factor of 1.391 has therefore been applied to modelled road NOx contributions at all receptors within this zone.

Table 14-6: Description of model uncertainty

Statistical parameter	Before adjustment	After adjustment	Ideal value
Root Mean Square Error (RMSE)	5.6	3.1	0

C.1.2.2 Verification Zone 2

Figure 14.4 presents a graphical comparison of the monitored and modelled concentrations of NO_2 at the verification sites within Verification Zone 2. Following Defra guidance, modelled and measured road traffic concentrations have been compared to derive an adjustment factor to apply to the modelled results. As diffusion tubes only measure total NO_2, the road traffic NOx concentrations measured by the diffusion tubes were calculated using Version 8.1 of the NOx to NO_2 calculator.

Following Defra guidance, a model adjustment factor of 0.985 has been calculated when comparing modelled and monitored road traffic NOx.

Figure 14.4: Unadjusted model verification (annual mean NO_2; µg/m^3)

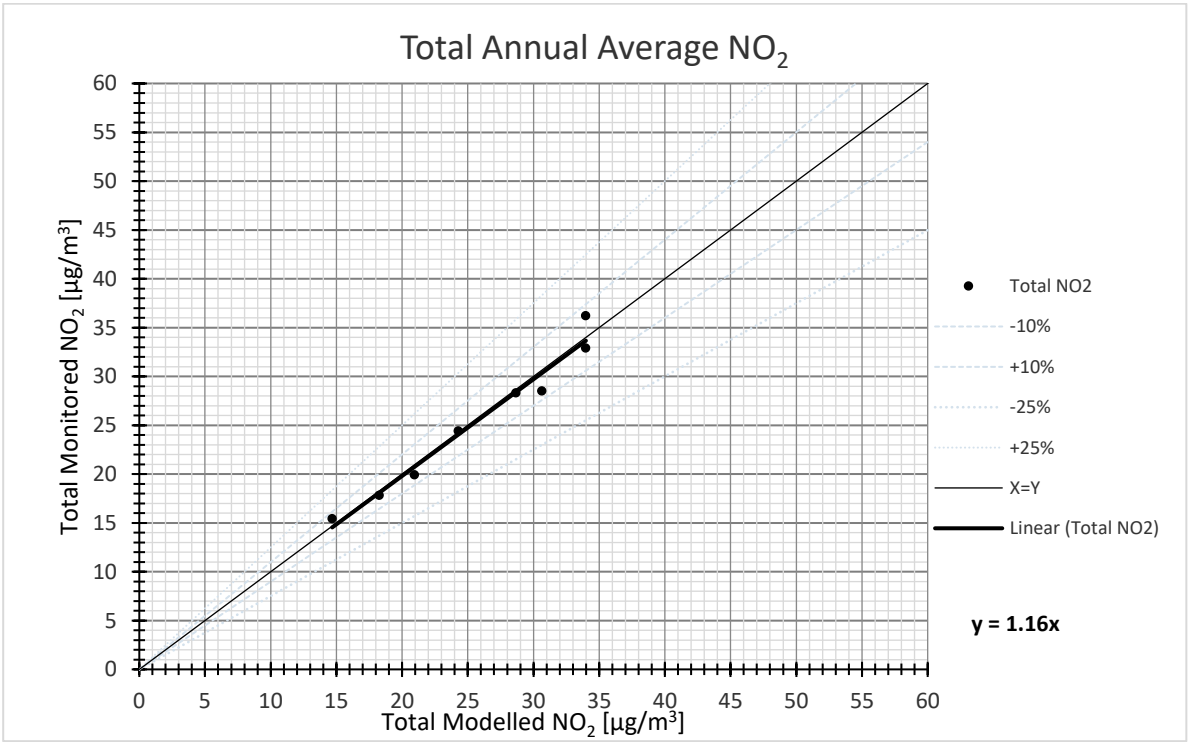


Table 14-7 and Figure 14.5 present the adjusted modelled NO_2 with monitored NO_2 at the verification sites. The Screening Model predicts NO_2 concentrations within 10% of the monitored concentrations at all but one monitoring site. The Screening Model is therefore performing adequately at these locations following adjustment.

Table 14-7: Adjusted model verification results

Site ID	Monitored total NO_2 ($\mu g/m^3$)	Modelled total NO_2 ($\mu g/m^3$)	% difference
WT2	32.9	33.7	2.4
N5	28.3	28.4	0.4
N25	17.8	18.2	2.0
N35	24.4	24.1	-1.2
N39	28.5	30.4	6.6
N43	19.9	20.8	4.6
N44A	36.2	33.7	-6.9
N45	15.4	14.6	-5.1

Figure 14.5 : Adjusted model verification (annual mean NO_2; $\mu g/m^3$)

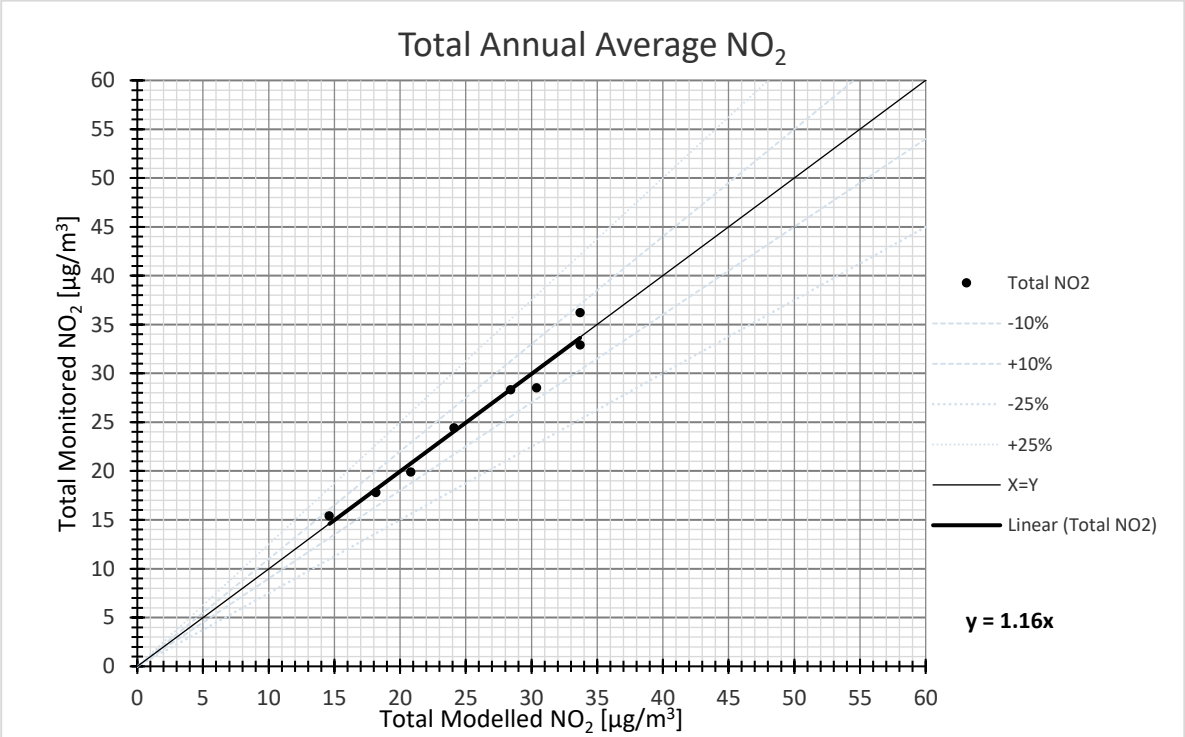


Table 14-8 presents statistical parameters for describing model uncertainty. The RMSE is used to define the average error or uncertainty of the model. The results of the RMSE calculation in this case are concentrations of NO_2 measured in units of micrograms per metre cubed. Table 14-8 shows that before adjustment the model uncertainty was ±1.3µg/m^3 or 3.3% of the annual mean NO_2 objective. After adjustment the model uncertainty is decreased to ±1.2µg/m^3 or 3.0% of the annual mean NO_2 objective. After adjustment the model uncertainty is within the desired 10% of the relevant objective, as recommended by Defra guidance.

The statistical analysis above demonstrates that the model performs adequately versus monitoring data following adjustment and is suitable to inform the judgement of significance. Although the model appears to be underpredicting, an adjustment factor of 1 (i.e. no adjustment) has been used within the assessment, to ensure that the modelled results of the assessment are robust and worst-case.

Table 14-8 : Description of model uncertainty

Statistical parameter	Before adjustment	After adjustment	Ideal value
Root Mean Square Error (RMSE)	1.3	1.2	0

C.1.2.3 Verification Zone 3

Figure 14.6 presents a graphical comparison of the monitored and modelled concentrations of NO_2 at the verification site within Verification Zone 3. Following Defra guidance, modelled and measured road traffic concentrations have been compared to derive an adjustment factor to apply to the modelled results. As diffusion tubes only measure total NO_2, the road traffic NOx concentrations measured by the diffusion tubes were calculated using Version 8.1 of the NOx to NO_2 calculator.

Following Defra guidance, a model adjustment factor of 2.010 has been calculated when comparing modelled and monitored road traffic NOx.

Figure 14.6: Unadjusted model verification (annual mean NO_2; µg/m^3)

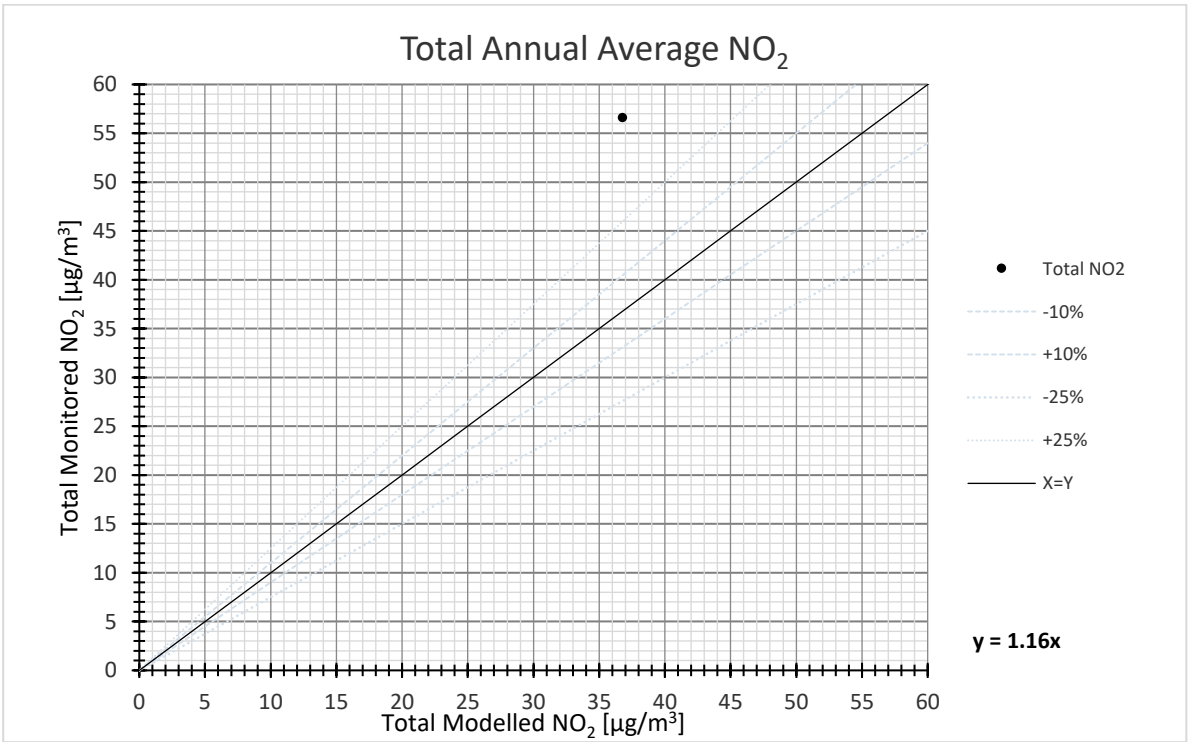


Table 14-9 and Figure 14.7 present the adjusted modelled NO_2 with monitored NO_2 at the verification site. The Screening Model predicts NO_2 concentrations within 10% of the monitored concentrations at all but one monitoring site. The Screening Model is therefore performing adequately at these locations following adjustment.

Table 14-9: Adjusted model verification results

Site ID	Monitored total NO_2 ($\mu g/m^3$)	Modelled total NO_2 ($\mu g/m^3$)	% difference
WT2	56.6	56.6	0

Figure 14.7: Adjusted model verification (annual mean NO_2; $\mu g/m^3$)

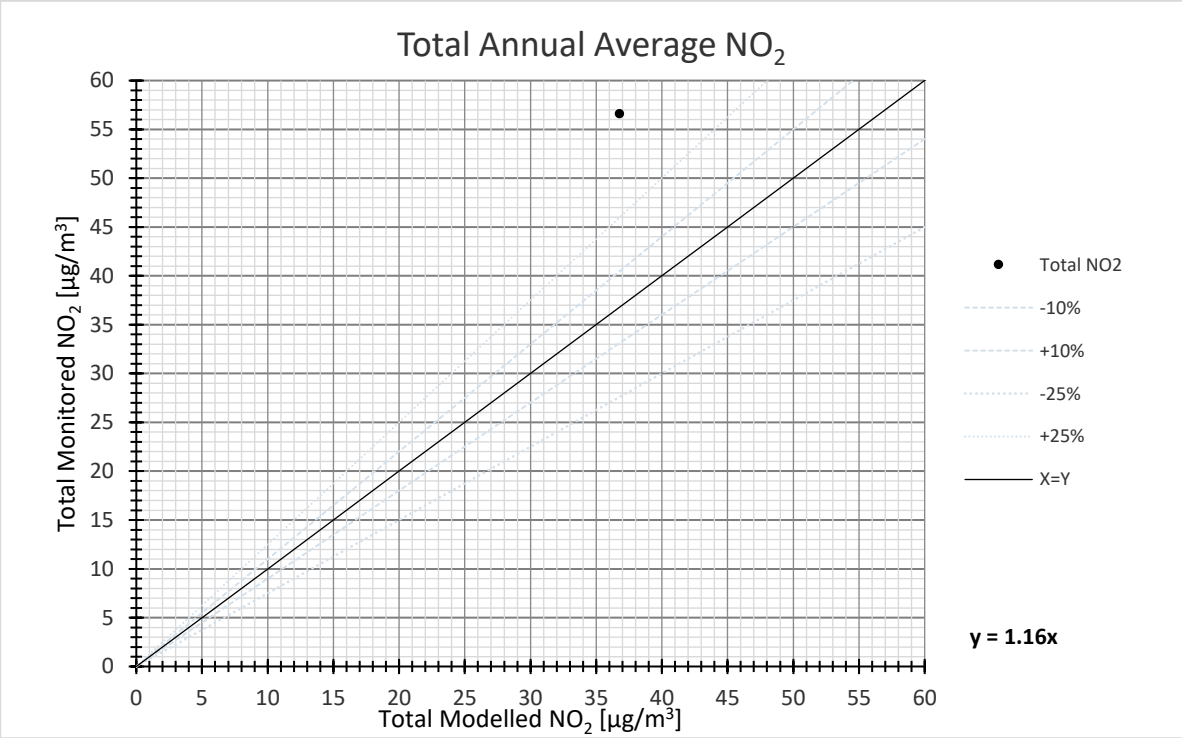


Table 14-10 presents statistical parameters for describing model uncertainty. The RMSE is used to define the average error or uncertainty of the model. The results of the RMSE calculation in this case are concentrations of NO_2 measured in units of micrograms per metre cubed. Table 14-10 shows that before adjustment the model uncertainty was ±19.8$\mu g/m^3$ or 49.5% of the annual mean NO_2 objective. After adjustment the model uncertainty is decreased to 0$\mu g/m^3$ or 0% of the annual mean NO_2 objective. After adjustment the model uncertainty is within the desired 10% of the relevant objective, as recommended by Defra guidance.

The statistical analysis above demonstrates that the model performs adequately versus monitoring data following adjustment and is suitable to inform the judgement of significance. Although the model appears to be underpredicting, an adjustment factor of 1 (i.e. no adjustment) has been used within the assessment, to ensure that the modelled results of the assessment are robust and worst-case.

Table 14-10: Description of model uncertainty

Statistical parameter	Before adjustment	After adjustment	Ideal value
Root Mean Square Error (RMSE)	19.8	0	0

C.1.3 Modelling results

Table 14-11: Annual mean NO_2 concentrations at human receptors – Option 1

Receptor	NO_2 annual mean concentration (µg/m^3)			Change in concentration (µg/m^3)
	Base year (2019)	Do-minimum (2027)	Do-something (2027)	
R1	29.7	26.7	26.8	0.1
R2	23.6	22.9	22.9	0.0
R3	24.9	23.8	23.9	0.1
R4	17.2	14.3	14.3	0.0
R5	22.2	19.4	19.4	0.0
R6	23.6	20.5	20.6	0.1
R7	31.2	27.8	27.7	-0.1
R8	27.8	26.1	26.2	0.1
R9	28.0	24.1	24.2	0.1
R10	30.5	25.9	26.4	0.5
R11	26.2	22.4	22.1	-0.3
R12	26.7	23.0	22.9	-0.1
R13	21.9	18.6	19.0	0.4
R14	55.6	48.0	48.7	0.7
R15	29.7	25.7	26.5	0.8
R16	20.4	17.6	19.5	1.9
R17	19.7	16.7	18.1	1.4
R18	20.6	17.7	17.9	0.2
R19	20.0	17.6	17.5	-0.1
R20	19.7	16.8	17.8	1.0
R21	20.3	17.7	18.4	0.7
R22	18.6	16.3	16.7	0.4
R23	14.8	13.1	12.8	-0.3
R24	18.8	16.2	16.0	-0.2
R25	17.7	15.8	15.4	-0.4
R26	18.5	17.0	16.9	-0.1
R27	18.6	15.8	16.1	0.3
R28	35.0	30.1	30.4	0.3
R29	34.6	29.7	29.8	0.1
R30	26.8	23.0	23.1	0.1
R31	24.6	21.1	21.1	0.0

Table 14-12: Annual mean NO_2 concentrations at human receptors – Option 2

Receptor	NO_2 annual mean concentration (µg/m^3)			Change in concentration (µg/m^3)
	Base year (2019)	Do-minimum (2027)	Do-something (2027)	
R1	29.7	26.7	26.9	0.2
R2	23.6	22.9	23.1	0.2
R3	24.9	23.8	25.3	1.5
R4	17.2	14.3	12.6	-1.7
R5	22.2	19.4	19.9	0.5
R6	23.6	20.5	20.7	0.2
R7	31.2	27.8	28.6	0.8
R8	27.8	26.1	26.8	0.7
R9	28.0	24.1	24.1	0.0
R10	30.5	25.9	25.9	0.0
R11	26.2	22.4	21.6	-0.8
R12	26.7	23.0	22.1	-0.9
R13	21.9	18.6	18.6	0.0
R14	55.6	48.0	48.1	0.1
R15	29.7	25.7	26.5	0.8
R16	20.4	17.6	19.5	1.9
R17	19.7	16.7	20.5	3.8
R18	20.6	17.7	18.0	0.3
R19	20.0	17.6	17.3	-0.3
R20	19.7	16.8	17.8	1.0
R21	20.3	17.7	18.5	0.8
R22	18.6	16.3	16.8	0.5
R23	14.8	13.1	12.8	-0.3
R24	18.8	16.2	16.0	-0.2
R25	17.7	15.8	15.4	-0.4
R26	18.5	17.0	16.9	-0.1
R27	18.6	15.8	16.1	0.3
R28	35.0	30.1	30.1	0.0
R29	34.6	29.7	29.8	0.1
R30	26.8	23.0	22.9	-0.1
R31	24.6	21.1	21.0	-0.1

Table 14-13: Annual mean NO_2 concentrations at human receptors – Option 3

Receptor	NO_2 annual mean concentration (µg/m^3)			Change in concentration (µg/m^3)
	Base year (2019)	Do-minimum (2027)	Do-something (2027)	
R1	29.7	26.7	26.9	0.2
R2	23.6	22.9	23.3	0.4
R3	24.9	23.8	25.3	1.5
R4	17.2	14.3	12.7	-1.6
R5	22.2	19.4	19.7	0.3
R6	23.6	20.5	20.4	-0.1
R7	31.2	27.8	28.4	0.6
R8	27.8	26.1	26.3	0.2
R9	28.0	24.1	24.2	0.1
R10	30.5	25.9	25.9	0.0
R11	26.2	22.4	21.6	-0.8
R12	26.7	23.0	22.1	-0.9
R13	21.9	18.6	18.6	0.0
R14	55.6	48.0	48.0	0.0
R15	29.7	25.7	26.5	0.8
R16	20.4	17.6	19.5	1.9
R17	19.7	16.7	20.5	3.8
R18	20.6	17.7	18.0	0.3
R19	20.0	17.6	17.3	-0.3
R20	19.7	16.8	17.8	1.0
R21	20.3	17.7	18.4	0.7
R22	18.6	16.3	16.8	0.5
R23	14.8	13.1	12.8	-0.3
R24	18.8	16.2	16.0	-0.2
R25	17.7	15.8	15.4	-0.4
R26	18.5	17.0	16.9	-0.1
R27	18.6	15.8	16.1	0.3
R28	35.0	30.1	30.1	0.0
R29	34.6	29.7	29.7	0.0
R30	26.8	23.0	22.9	-0.1
R31	24.6	21.1	21.0	-0.1

Table 14-14: Nitrogen deposition rates at ecological receptors - Option 1

Receptor	Transect distance (m)	Habitat	Minimum Critical Load (kg N/ha/yr)	Nitrogen deposition rate (kg N/ha/yr)		Change in nitrogen deposition rate (kg N/ha/yr)
				Do-minimum (2027)	Do-something (2027)	
E1	0	Broadleaved, mixed and yew woodland	10	26.1	27.2	**1.1**
E2	0	Broadleaved, mixed and yew woodland	10	25.3	25.2	-0.1
E3	0	Broadleaved, mixed and yew woodland	10	30.9	32.2	**1.3**
E4	0	Broadleaved, mixed and yew woodland	10	31.7	35.4	**3.7**
E5	0	Calcaerous grassland	15	18.8	20.5	**1.7**
E6	0	Calcaerous grassland	15	22.2	21.9	-0.4
E1_2	10	Broadleaved, mixed and yew woodland	10	23.1	23.7	**0.5**
E2_2	10	Broadleaved, mixed and yew woodland	10	24.3	24.9	**0.6**
E4_2	10	Broadleaved, mixed and yew woodland	10	24.5	26.0	**1.5**
E5_2	10	Calcaerous grassland	15	15.6	16.4	**0.8**
E6_2	10	Calcaerous grassland	15	16.7	16.5	-0.3
E1_3	20	Broadleaved, mixed and yew woodland	10	22.1	22.5	0.4
E2_3	20	Broadleaved, mixed and yew woodland	10	22.5	22.8	0.4
E4_3	20	Broadleaved, mixed and yew woodland	10	22.6	23.5	**1.0**
E5_3	20	Calcaerous grassland	15	14.5	15.1	**0.6**
E6_3	20	Calcaerous grassland	15	15.2	15.0	-0.2
E1_4	30	Broadleaved, mixed and yew woodland	10	21.6	21.9	0.3

Receptor	Transect distance (m)	Habitat	Minimum Critical Load (kg N/ha/yr)	Nitrogen deposition rate (kg N/ha/yr)		Change in nitrogen deposition rate (kg N/ha/yr)
				Do-minimum (2027)	Do-something (2027)	
E3_4	30	Broadleaved, mixed and yew woodland	10	21.6	21.9	0.3
E4_4	30	Broadleaved, mixed and yew woodland	10	21.7	22.4	**0.7**
E5_4	30	Calcaerous grassland	15	14.0	14.4	0.5
E6_4	30	Calcaerous grassland	15	14.5	14.3	-0.2
E1_5	40	Broadleaved, mixed and yew woodland	10	21.2	21.5	0.2
E3_5	40	Broadleaved, mixed and yew woodland	10	21.1	21.3	0.2
E4_5	40	Broadleaved, mixed and yew woodland	10	21.1	21.7	**0.6**
E5_5	40	Calcaerous grassland	15	13.6	14.0	0.4
E6_5	40	Calcaerous grassland	15	14.0	13.9	-0.1
E1_6	50	Broadleaved, mixed and yew woodland	10	21.0	21.2	0.2
E3_6	50	Broadleaved, mixed and yew woodland	10	20.7	20.9	0.2
E4_6	50	Broadleaved, mixed and yew woodland	10	20.7	21.3	**0.5**
E5_6	50	Calcaerous grassland	15	13.4	13.7	0.3
E6_6	50	Calcaerous grassland	15	13.7	13.6	-0.1

Note: Numbers in bold are those where the change in nitrogen deposition rate is greater than 0.4 kg N/ha/yr and the DS concentration is above the critical load

Table 14-15: Nitrogen deposition rates at ecological receptors - Option 2

Receptor	Transect distance (m)	Habitat	Minimum Critical Load (kg N/ha/yr)	Nitrogen deposition rate (kg N/ha/yr)		Change in nitrogen deposition rate (kg N/ha/yr)
				Do-minimum (2027)	Do-something (2027)	
E1	0	Broadleaved, mixed and yew woodland	10	26.1	27.3	**1.2**
E2	0	Broadleaved, mixed and yew woodland	10	25.3	25.2	-0.1
E3	0	Broadleaved, mixed and yew woodland	10	30.9	32.3	**1.4**
E4	0	Broadleaved, mixed and yew woodland	10	31.7	35.5	**3.8**
E5	0	Calcaerous grassland	15	18.8	20.5	**1.7**
E6	0	Calcaerous grassland	15	22.2	21.8	-0.4
E1_2	10	Broadleaved, mixed and yew woodland	10	23.1	23.7	**0.6**
E2_2	10	Broadleaved, mixed and yew woodland	10	24.3	24.9	**0.6**
E4_2	10	Broadleaved, mixed and yew woodland	10	24.5	26.1	**1.5**
E5_2	10	Calcaerous grassland	15	15.6	16.4	**0.8**
E6_2	10	Calcaerous grassland	15	16.7	16.5	-0.3
E1_3	20	Broadleaved, mixed and yew woodland	10	22.1	22.5	0.4
E2_3	20	Broadleaved, mixed and yew woodland	10	22.5	22.8	0.4
E4_3	20	Broadleaved, mixed and yew woodland	10	22.6	23.6	1.0
E5_3	20	Calcaerous grassland	15	14.5	15.1	**0.6**
E6_3	20	Calcaerous grassland	15	15.2	15.0	-0.2
E1_4	30	Broadleaved, mixed and yew woodland	10	21.6	21.9	0.3
E3_4	30	Broadleaved, mixed and yew woodland	10	21.6	21.9	0.3

Receptor	Transect distance (m)	Habitat	Minimum Critical Load (kg N/ha/yr)	Nitrogen deposition rate (kg N/ha/yr)		Change in nitrogen deposition rate (kg N/ha/yr)
				Do-minimum (2027)	Do-something (2027)	
E4_4	30	Broadleaved, mixed and yew woodland	10	21.7	22.4	**0.7**
E5_4	30	Calcaerous grassland	15	14.0	14.4	0.5
E6_4	30	Calcaerous grassland	15	14.5	14.3	-0.2
E1_5	40	Broadleaved, mixed and yew woodland	10	21.2	21.5	0.3
E3_5	40	Broadleaved, mixed and yew woodland	10	21.1	21.3	0.2
E4_5	40	Broadleaved, mixed and yew woodland	10	21.1	21.7	**0.6**
E5_5	40	Calcaerous grassland	15	13.6	14.0	0.4
E6_5	40	Calcaerous grassland	15	14.0	13.9	-0.1
E1_6	50	Broadleaved, mixed and yew woodland	10	21.0	21.2	0.2
E3_6	50	Broadleaved, mixed and yew woodland	10	20.7	20.9	0.2
E4_6	50	Broadleaved, mixed and yew woodland	10	20.7	21.3	0.5
E5_6	50	Calcaerous grassland	15	13.4	13.7	0.3
E6_6	50	Calcaerous grassland	15	13.7	13.6	-0.1

Note: Numbers in bold are those where the change in nitrogen deposition rate is greater than 0.4 kg N/ha/yr and the DS concentration is above the critical load

Table 14-16: Nitrogen deposition rates at ecological receptors - Option 3

Receptor	Transect distance (m)	Habitat	Minimum Critical Load (kg N/ha/yr)	Nitrogen deposition rate (kg N/ha/yr)		Change in nitrogen deposition rate (kg N/ha/yr)
				Do-minimum (2027)	Do-something (2027)	
E1	0	Broadleaved, mixed and yew woodland	10	26.1	27.3	**1.2**
E2	0	Broadleaved, mixed and yew woodland	10	25.3	25.2	-0.1
E3	0	Broadleaved, mixed and yew woodland	10	30.9	32.3	1.4
E4	0	Broadleaved, mixed and yew woodland	10	31.7	35.5	**3.8**
E5	0	Calcaerous grassland	15	18.8	20.5	1.8
E6	0	Calcaerous grassland	15	22.2	21.9	-0.3
E1_2	10	Broadleaved, mixed and yew woodland	10	23.1	23.7	**0.6**
E2_2	10	Broadleaved, mixed and yew woodland	10	24.3	24.9	**0.6**
E4_2	10	Broadleaved, mixed and yew woodland	10	24.5	26.1	**1.5**
E5_2	10	Calcaerous grassland	15	15.6	16.4	**0.8**
E6_2	10	Calcaerous grassland	15	16.7	16.5	-0.3
E1_3	20	Broadleaved, mixed and yew woodland	10	22.1	22.5	0.4
E2_3	20	Broadleaved, mixed and yew woodland	10	22.5	22.8	0.4
E4_3	20	Broadleaved, mixed and yew woodland	10	22.6	23.6	1.0
E5_3	20	Calcaerous grassland	15	14.5	15.1	**0.6**
E6_3	20	Calcaerous grassland	15	15.2	15.0	-0.2
E1_4	30	Broadleaved, mixed and yew woodland	10	21.6	21.9	0.3
E3_4	30	Broadleaved, mixed and yew woodland	10	21.6	21.9	0.3

Receptor	Transect distance (m)	Habitat	Minimum Critical Load (kg N/ha/yr)	Nitrogen deposition rate (kg N/ha/yr)		Change in nitrogen deposition rate (kg N/ha/yr)
				Do-minimum (2027)	Do-something (2027)	
E4_4	30	Broadleaved, mixed and yew woodland	10	21.7	22.4	**0.7**
E5_4	30	Calcaerous grassland	15	14.0	14.4	0.5
E6_4	30	Calcaerous grassland	15	14.5	14.3	-0.2
E1_5	40	Broadleaved, mixed and yew woodland	10	21.2	21.5	0.3
E3_5	40	Broadleaved, mixed and yew woodland	10	21.1	21.3	0.2
E4_5	40	Broadleaved, mixed and yew woodland	10	21.1	21.7	**0.6**
E5_5	40	Calcaerous grassland	15	13.6	14.0	0.4
E6_5	40	Calcaerous grassland	15	14.0	13.9	-0.1
E1_6	50	Broadleaved, mixed and yew woodland	10	21.0	21.2	0.2
E3_6	50	Broadleaved, mixed and yew woodland	10	20.7	20.9	0.2
E4_6	50	Broadleaved, mixed and yew woodland	10	20.7	21.3	**0.5**
E5_6	50	Calcaerous grassland	15	13.4	13.7	0.3
E6_6	50	Calcaerous grassland	15	13.7	13.6	-0.1

Note: Numbers in bold are those where the change in nitrogen deposition rate is greater than 0.4 kg N/ha/yr and the DS concentration is above the critical load

D. Landscape and visual effects baseline information

D.1 Introduction

Details of the landscape character areas and types pertaining to the study area, as well as relevant management guidelines are set out below.

D.1.1 National landscape character

The A27 at Worthing and Lancing straddles the boundary between National Character Area (NCA) 125 South Downs (NE432) to the north, and NCA 126 South Coast Plain (NE525) to the south.

The described key characteristics of NCA 125 South Downs include:

- “A broad elevated east–west chalk ridge with a predominantly steep north-facing scarp slope and a gentle southerly dip slope.
- The majority of the area falls within the South Downs National Park, a recognition of its natural beauty and importance for access and recreation.
- Public rights of way following drove roads and ancient routes along the accessible downland tops, benefiting from panoramic views across the downs.
- The South Downs Way National Trail follows the ridge of the northern scarp and provides extensive panoramic views.
- Some eight per cent of the NCA is classified as urban. Over 80 per cent of the South Downs NCA is farmed.
- 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 in agriculture and forestry.
- Woodland a feature of the central downs.
- Roads and villages concentrated in the river valleys, the more elevated areas sparsely settled with scattered farmsteads…also an almost continuous string of seaside towns.
- Enclosure and remoteness can be found in woodland and even in close proximity to urban areas.
- A rich variety of wildlife and habitats.
- A wealth of well-conserved historical features... a landscape with a rich cultural heritage of art, music and rural traditions. Many well-known writers, poets, musicians and artists have drawn inspiration from its distinctive sense of place.

- Bronze-age round barrows and prominently sited iron-age hill forts, such as Cissbury Ring… are notable prehistoric features of the scarp and hill tops."

The statements of environmental opportunity (SEO) for NCA 125 include, within SEO 3: "Conserve and promote the South Downs' rich historic environment, its unique geodiversity and national and local geological sites for the contribution they make to cultural heritage, biodiversity and landscape. Maintain and enhance quality of access".

The described key characteristics of NCA 126 South Coast Plain include:

- "A flat, coastal landscape with an intricately indented shoreline lying between the dip slope of the South Downs and…the waters of the English Channel." The River Adur "drains south from the higher ground of the Downs."
- "East–west trunk roads define the northern boundary", including the A27. East-west railway line.
- "There is significant urban development, with settlements along the coast. Although heavily developed and highly populated, there is a feeling of openness, particularly where sea views reveal wide expanses of sea and sky.
- There are stretches of farmed land between developed areas, often with large arable fields defined by low hedges or ditches". Also, "A few traditional flint hamlets and farm buildings…fragmented by trunk roads and infrastructure."
- Along the north of the area there is a network of small and medium-sized broadleaved woodlands, including ancient and semi-natural, well linked by hedgerows and garden exotics providing an enclosed field framework. Elsewhere tree cover varies.
- The area is generally very low lying", and "slopes gently southwards towards the coast."

NCA 126 South Coast Plain SEO 2 states: "Plan for the creation of a strong landscape framework within and around major settlements and identified growth areas, while managing and enhancing existing greenspace and access, and balancing the needs of agriculture, communities and the natural environment."

D.1.2 South Downs National Park landscape character

The South Downs Landscape Character Assessment shows that the majority of the northern part of the study area and land beyond this, falls within landscape character type (LCT) A: Open Downland and landscape character area (LCA) A3: Arun to Adur Open Downs.

The described characteristics of LCT A Open Downland include:

- “Large scale open elevated landscape of rolling chalk downland, with distinctive dry valleys and ‘mini-scarps’ that relate to faults in the chalk.
- Underlain by solid chalk geology with very occasional surface clay capping and windblown sand creating local pockets of variation in the landscape.
- Large scale geometric arable fields.
- Strong seasonal variation in the landscape.
- General absence of surface water…although the ephemeral winterbournes and dew ponds are distinctive features.
- Fragments of chalk downland grassland and rare chalk heath, together with associated scrub and woodland habitats are confined to steep slopes.
- Sparse settlement, with occasional isolated farms and barns.
- Large open skies and distant panoramic views – creating a dramatic and dynamic landscape changing according to prevailing weather conditions.
- A tranquil landscape, often seemingly remote and empty, with a windswept exposed character.
- The elevated landform and open character enable panoramic views, including long views along the downland and out to the sea.
- Strong artistic and literary associations.
- Good access opportunities associated with areas of chalk downland.
- The low noise levels, sense of naturalness arising from the presence of chalk grassland, elevation and views combined with low presence of overt built human influences, and low density of roads, settlement and people all contribute to a sense of remoteness and tranquillity across the majority of the downs.
- The dark skies associated with the South Downs International Dark Skies Reserve, which are vulnerable to light sources, particularly in the 'Dark Sky Core' to the west of the LCT.”

The Guidance for Integrating Development into the Landscape for LCT A Open Downland includes:

- “Consider effects of any development beyond the National Park boundary. In addition to being visible in views from the South Downs, secondary effects such as light spill, noise and increased traffic will all have an impact on the special qualities of remoteness and tranquillity associated with the Open Downland.
- Consider views to and from the Open Downland in relation to any change.”

The described characteristics of LCA A3 Arun to Adur Open Downs include the following:

- “Vast open rolling upland chalk landscape of blunt, whale-backed downs reaching 238m at Chanctonbury Hill.
- Furrowed by extensive branching dry valley systems which produce deep, narrow, rounded coombes - the main dry valley (the Findon Valley) contains the A24.
- Dominated by large scale irregular fields of arable and pasture (of 19th and 20th century date) bounded by visually permeable post and wire fencing or sparse thorn hedgerows creating a very open landscape supporting a range of farmland birds. Hedgerows and tracks survive from the earlier manorial downland landscape.
- Significant areas of unimproved chalk grassland, for example at Cissbury Ring…which support nationally scarce plant species.
- Occasional scrub and woodland on steeper slopes and beech clumps on hill tops contribute to biodiversity and provides visual texture in the landscape.
- A landscape managed for country sports…which preserves the shape and form of the landscape and creates a distinctive landcover including small woodlands and game cover plots.
- Large open skies…a dynamic landscape, with considerable seasonal variation.
- A strong sense of remoteness and tranquillity.
- Large number of prehistoric and later earthworks, including causewayed enclosures, long barrows and round barrows, providing a strong sense of historical continuity. Iron Age hillforts at Cissbury Ring…form prominent features on the skyline.
- Four flint mines of Neolithic date (Cissbury…) are associated with minor scarps.
- Good public access with a network of public rights of way and open access land.
- The typical settlement form is relatively late in origin and comprises isolated farmsteads of 18th-19th century origin.
- Building materials are typically flint, red brick and clay tiles, with more modern materials used in farm buildings.
- Extensive views…over the coastal plain to the south.”

It goes on to state “This area is especially sensitive to development change beyond the park boundary given the proximity to and views over development on the coastal plain.”

In addition to the guidance for the LCT, the development considerations specific to LCA A3 Arun to Adur Open Downs include: “Consider the effect of proposed changes on views to and from the South Downs, particularly iconic views from Cissbury Ring.”

The South Downs Landscape Character Assessment shows that a very small part of the 1km study area to the east of Lancing falls within LCT G: Major Chalk Valley Sides and LCA G3: Adur Valley Sides.

The described characteristics of LCT G: Major Chalk Valley Sides include:

- “Valley sides of varying steepness enclosing the major river floodplains and linking to the adjacent downland. The sides are often indented by dry valleys, and occasionally form steep chalk cliffs.
- An expansive large-scale landscape containing, and providing the setting for, the floodplain.
- Soils support arable land on shallower slopes, where large 20th century fields represent extensive re-organisation of the landscape. A mix of pasture/chalk grassland, scrub and woodland occupies steeper slopes.
- Minor lanes and unsurfaced tracks typically descend the valley sides.
- Woodlands along the lower slopes are particularly distinctive and form a strong wooded edge to the floodplain.
- Away from the roads, the valley sides form a tranquil, rural setting to the floodplain.
- The settlement pattern is characterised by strings of nucleated settlements along both sides of the valley, linked by rural roads which follow the edges of the floodplains.”

The ‘Guidance for Landscape Management’ for LCT G: Major Chalk Valley Sides includes: “Conserve the tranquil, rural character of the landscape, and its function as a rural setting and containment to the major river floodplains”.

The described characteristics of LCA G3: Adur Valley Sides include:

- Valley sides carved from chalk, relatively steep along their whole length.
- Pasture, chalk grassland and woodland occupy steeper slopes.
- The valley sides support an extensive road network.
- Minor lanes and unsurfaced tracks descend the valley sides – many of these are now public rights of way that allow access up onto the adjacent downs.

- A string of shrunken medieval villages lie along the lower slopes of the western valley side e.g. Botolphs, Coombes, Applesham Farm. These are surrounded by early enclosures.
- Woodlands along the lower slopes are particularly distinctive and form a strong wooded edge to the floodplain.
- Away, from the roads, the valley sides form a tranquil, rural setting to the floodplain.
- The prominent Gothic chapel of Lancing College is a particularly distinctive landmark standing at the southern end of the Adur valley. The chimney of the Shoreham Cement Works is also a key landmark feature."

In addition to the guidance for the LCT, the development considerations specific to LCA G3: Adur Valley Sides include: "Maintain views to the Gothic chapel of Lancing College and its open setting which stands as a major landmark at the southern end of the valley. Refer to guidance in the View Characterisation and Analysis report."; and, "Consider views from the parking area and nature reserve at Mill Hill in planning any change."

The South Downs Landscape Character Assessment shows that a small part of the study area to the north-west of Worthing, falls within LCT B: Wooded Estate Downland and LCA B4: Angmering and Clapham Wooded Estate Downland.

The described characteristics of LCT B Wooded Estate Downland include:

- "Chalk geology forming an elevated ridge with typical folded downland topography, with isolated patches of clay-with-flints…which has given rise to acidic soils.
- A landscape transformed in the 18th century…with much of the downland bought up to create large holdings and planted with woodland for economic and aesthetic reasons.
- Supports extensive woodland including semi-natural ancient woodland plus beech, mixed and commercial coniferous plantation, which creates a distinctive dark horizon in views from the south.
- Significant ancient woodland cover.
- Woodland cover creates an enclosed landscape with contained views, occasionally contrasting with dramatic long distance views from higher, more open elevations.
- Occasional areas of unimproved chalk grassland are found on the steeper slopes and ridge tops.
- Ancient settlement earthworks, field systems and other archaeological features are often buried beneath the woodland. Large number of prehistoric and later earthworks.

- Settlement pattern is characterised by villages and shrunken hamlets of Saxon or early medieval origin interspersed by scattered farmsteads of 18th-19th century origin. Chalk flint is the dominant building material, often edged with red brick.
- Designed parkland landscapes with important visual influences.
- A deeply rural secluded landscape with large tracts devoid of roads and settlement. A good network of public rights of way.
- Perception of a large scale and simple landscape", and "a strong sense of enclosure and remoteness".

The 'Guidance for Landscape Management' for LCT B Wooded Estate Downland includes: "Avoid road upgrades and 'improvements' that would alter the rural character of the unmarked lanes", while the Guidance for Integrating Development into the Landscape includes: "Pay particular attention to the introduction of any new lighting into the landscape."

The described characteristics of LCA B4 Angmering and Clapham Wooded Estate Downland include the following:

- "Folded downland topography masked by large woodland blocks including oak, birch and holly on the thicker soils, and beech dominating on thinner soils.
- A landscape transformed in the 18th century…with much of the downland bought up to create vast holdings and planted with woodland for economic and aesthetic reasons.
- Woodland is interlocked with straight-sided, irregular open arable fields linked by thick hedgerows.
- Rare survival of ancient settlement, field systems and other archaeological features beneath the woodland, for example the earthworks at Rewell Wood and Bexley Bushes.
- A low density of dispersed settlement.
- A deeply rural secluded landscape with large tracts devoid of roads and settlement. However, parking places, signed walks, picnic sites, a good network of public rights of way …provide many opportunities for recreational use of the landscape.
- Panoramic views across the coastal plain from high, open ridges."

In addition to the guidance for the LCT, the development considerations specific to LCA B4 Angmering and Clapham Wooded Estate Downland include: "Conserve the woodland cover, particularly areas of ancient woodland for example at Clapham Wood."

D.1.3 Landscape Character Assessment of West Sussex

The West Sussex Landscape Character Assessment shows that several areas of undeveloped land within the 1km study area fall within LCA SC11/SC13 Littlehampton and Worthing Fringes/Worthing and Adur Fringes. These include land to the east of Lancing, between Worthing and Lancing, and to the west of Worthing around the A2032.

The described key characteristics of LCA SC11/SC13 Littlehampton and Worthing Fringes/Worthing and Adur Fringes include:

- “Low lying flat open landscape. Dominant urban fringe…Settlement edges often sharply contrast with adjacent open countryside.
- Frequent urban fringe influences of horse paddocks, light industry, airport, and recreational open space.
- Narrow gaps of open land at…Sompting and Lancing provide views to the sea and separation between the urban areas.
- Medium scale arable farming.
- A low density of native hedgerows and hedgerow trees, interspersed with shelterbelts, single species hedges or individual standards planted using tall trees… Clusters of windblown trees.
- Nucleated villages such as at...Sompting Abbots scattered across the area. Mixed building materials of flint, brick, half timber and stone.
- Occasional farmsteads along roads, and on dead-end tracks.
- Long views to the Downs.
- Busy minor and major roads. Industry in the countryside. South Coast railway line.”

Land Management Guidelines for LCA SC11/SC13 Littlehampton and Worthing Fringes/Worthing and Adur Fringes include: “Encourage bold tree planting adjacent to roads to enhance both the visual and wildlife value of these areas.”

Land to the west of Worthing on both sides of the A27, falls within LCA SC12 Angmering Upper Coastal Plain and covers a small part of the 1km study area.

Key characteristics of LCA SC12 Angmering Upper Coastal Plain include:

- “Very gently undulating landform more intricate in the east, encompassing the distinctive landscape of Highdown Hill (an isolated chalk hill).
- Mainly gently undulating farmland enclosed by woods with frequent hedgerows…Hedgerow trees and medium to large blocks of woodlands.
- Pastures and arable fields.
- Historic landscape features.”

- Scattered settlement “accessed by rural lanes mostly linked by the A27.
- Numerous rural tracks, byways and rights of way.”

Land Management Guidelines for LCA SC12 Angmering Upper Coastal Plain include “Ensure any new development, including any associated with the A27 trunk road, is well integrated into the wider landscape… Use new woodland and hedgerow planting as appropriate.”

The remaining part of the 1km study area falls within West Sussex LCA SD3 Central Downs. This area lies predominantly to the north of the A27, except for a small area of the open land at Sompting, south of the road. LCA SD3 is broadly consistent with South Downs National Park LCA A3 Arun to Adur Open Downs.

Key characteristics of LCA SD3 Central Downs include:

- “Elevated chalk hills. Smooth, gently rolling landform, cut by trough-shaped dry valleys, sometimes branching. Dramatic, steep, mostly open escarpment, deeply indented by rounded coombes.
- Open, expansive landscape mostly with few trees and hedgerows. Areas of woodland mostly limited to narrow belts along the edge of the scarp slope.
- Arable farming predominates in large, rectilinear fields.
- Isolated blocks of species-rich chalk grassland on steeper slopes and on the escarpment.
- Distinctive historic landscape features.
- Strong sense of remoteness and solitude in some areas.”

Land Management Guidelines for LCA SD3 Central Downs include: “Encourage landscape enhancements of the existing urban edge” and “Protect the open skyline of the upper crest of the Chalk Downs.”

In addition, A Strategy for the West Sussex Landscape sets out landscape guidelines for new roads, major road improvements and maintenance. These include:

- “Secure mitigation measures including new planting, earthworks and hardworks reflecting the pattern and character of the local landscape.
- Ensure, where appropriate, habitat creation and enhancement within the road curtilage.
- Limit the extent and intensity of lighting to the levels required for road safety.
- Develop landscape enhancement schemes to help to integrate them more effectively into the landscape.
- Secure bridges and other engineering structures of elegant design.”

D.2 South Downs National Park Landscape Character Areas

D.3 West Sussex County Council character areas

D.4 South Downs National Park dark skies mapping

D.5 South Downs National Park tranquillity mapping

D.6 South Downs National Park representative viewpoints

E. Preliminary Ecological Appraisal Report

F. Population and human health figures

F.1 Land use and accessibility impact area

F.2 Human health impact area

F.3 Residential properties within land use and accessibility impact area

F.4 Community resources within the local impact area

F.5 Businesses within land use and accessibility impact area

F.6 Open space and recreation area

G. Combined and cumulative tables

G.1 Proposed developments to take forward to Stage 3 and 4

'Other Development' details					Stage 1		Stage 2			
Application reference/policy reference	**Applicant for 'other development' and brief description**	**Distance from scheme**	**Status**	**Tier**	**Within ZoI?**	**Progress to Stage 2?**	**Overlap in temporal scale**	**Scale and nature of development likely to have significant effect**	**Other factors**	**Progress to Stage 3/4**
AWDM/1853/21	**Type of development:** Application for public service infrastructure project: Construction of a part one, part two storey school building to serve as a two form of entry primary school and nursery, with associated parking, landscaping and hard and soft play areas. Erection of associated boundary fencing up to 2.4m in height and formation of access and associated highway works.	490 metres	Decided – application approved	Tier 3	Within ZoI for Biodiversity, Cultural Heritage, Landscape, and Road drainage and the water environment.	Yes	There is not anticipated to be an overlap in the temporal scale of construction, the A27 is anticipated to be in its construction phase between 2024 and 2027, this project has assumed an opening year of 2023.	Due to the scale of this development and the temporal variation between developments it is unlikely that this project would result in cumulative effects with the A27.	Once constructed this development could be susceptible to the construction of the scheme as it is a primary/ nursery school.	No
AWDM/1861/21	**Type of development:** Non-Material amendment to approved AWDM/0166/20 for repositioning of car park spaces.	760 metres	Decided - approved	Tier 3	Within ZoI for landscape, biodiversity and cultural heritage.	Yes	Information not available.	Due to the limited scope and scale of this development it is unlikely that it would result in significant effects.	N/A	No
AWDM/0166/20	**Type of development:** Application under Regulation 4 for full planning permission for the erection of 152 apartments including 30% affordable provision, consisting of 51 no. 1-bedroom apartments and 101 no. 2-bedroom apartments, with associated car and cycle parking, open space,	760 metres	Decided - permitted	Tier 3	Within ZoI for landscape, biodiversity and cultural heritage.	Yes	The construction of this development will overlap with the A27, predicted to begin construction in 2025, within the period between stages 6-7 for the A27 (2024-2027).	Yes, this project represents a large development, there is the potential for significant cumulative impacts due to construction emissions, traffic and noise.	N/A	Yes

	landscaping and new access and temporary sales suite at land to the west of Fulbeck Avenue | Land Site West Of Fulbeck Avenue Northbrook Worthing West Sussex.									
AWDM/1718/21	**Type of development:** Non Material Amendment to Approved AWDM/1131/19 for reduction in height of the proposed 2m high earth bund to match the height of the adjacent raised natural grass turf football pitch.	1,730 metres	Application permitted	Tier 3	Within the ZoI for biodiversity	Yes	No construction date information.	Due to the small scope and large distance between developments, it is not anticipated that this development would result in a significant cumulative effect.	N/A	No
AWDM/1596/21	**Type of development:** Consultation by WSCC on Reg 3 application WSCC/036/21 New standalone special education needs classroom block, including external works. To achieve this a section of the school grounds, which is currently not in use, will be cleared of all shrubs and vegetation.	1,700 metres	Application Permitted	Tier 3	Within the ZoI for biodiversity	Yes	No construction date information.	Due to the scope and large distance between developments, it is not anticipated that this development would result in a significant cumulative effect.	N/A	No
AWDM/2327/21	**Type of development:** Approval of Details Reserved by Condition 3 (Management Plan) & 5 (Construction Management Plan) of Application No AWDM/1519/21.	1,300 metres	Registered	Tier 3	Within the ZoI for biodiversity	Yes	No construction date available, however from supporting documents it is expected that construction will be complete before the construction of the scheme begins.	Due to the small scope and large distance between developments, it is not anticipated that this development would result in a significant cumulative effect.	N/A	No

AWDM/0149/22	**Type of development:** Consultation by WSCC on Reg 3 application WSCC/003/22 for the installation of a 2m high mesh welded fencing to secure the boundary of the rear field.	115 metres	Registered	Tier 3	Within the ZoI for all disciplines	Yes	No construction date information.	Due to its small scope, this development is not anticipated that this development would result in a significant cumulative effect.	N/A	No
AWDM/1732/21	**Type of development:** Construction of a new sports hall with dry changing rooms, sports storage, accessible WC, and plantroom, open air-source heat pump enclosure, and minor modifications to the existing footpath.	1180 metres	Application Permitted	Tier 3	Within the ZoI for Biodiversity	Yes	No construction date available.	Due to the small scope and large distance between developments, it is not anticipated that this development would result in a significant cumulative effect.	N/A	No
AWDM/0021/22	**Type of development:** Erection of 385 dwellings and Community Hub (Flexible Class E/F1/F2 use) along with associated access, landscaping, car parking and public open space (an increase of 34 dwellings from the outline approval of 351 dwellings (AWDM/0961/17).	280 metres	Registered	Tier 2	Within the ZoI for Biodiversity, landscape, cultural heritage, road drainage and the water environment, and noise and vibration.	Yes	Likely to overlap – phased construction – 2029 starting 2023, as in such close proximity it is likely to have cumulative impacts.	Due to the proximity of works and the likely overlap there is the potential for cumulative effects.	N/A	Yes

G.2 Cumulative Assessment Stage 4: Assessment

Tier	Application reference	Assessment of cumulative effects	Need for additional mitigation
Landscape and Visual Effects **The effects on landscape as a result of the scheme have been assessed in Chapter 7 (Landscape and Visual Effect). The residual on-balance effects on landscape are as follows:** Construction: Options 1 and 2: Slight Adverse (landscape / townscape character), Moderate Adverse (visual effects) Option 3: Moderate Adverse (landscape / townscape character), Moderate Adverse (visual effects) Operation: Options 1 and 2: Neutral (landscape/townscape character), Slight Adverse (visual effects) Option 3: Slight Adverse (landscape/townscape character), Slight Adverse (visual effects)			
3	AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex	<u>Land Site West of Fulbeck Avenue Residual Effects</u> The residual effects during construction and operation on Landscape and Visual Effects have been taken from the Landscape and Visual Impact Appraisal produced by Neil Tully Associates for BoKlok (2019). The residual effects on visual effects as a result of the development are reported as slight-negligible adverse on long distance views and moderate adverse on short distance views. The effect on the landscape character of the site is being changed from one which is predominantly wooded with scrubland to a pavilion of built forms, in the short term having detrimental effects, but in the longer term providing enhancement in the form of ecological features and the enhancement of existing vegetated features, protecting long distance views. The overall residual effects as a result of Land Site West of Fulbeck Avenue are as follows: **Construction** Landscape Character: Moderate Adverse Visual Effects: Moderate Adverse **Operation** Landscape Character: Slight Adverse Visual Effects: Slight Beneficial **Cumulative residual effects for Land Site West of Fulbeck Avenue and Options 1, 2, and 3.** The 1km ZoI buffers overlap for both construction and operation and includes the northern half of the other development therefore the northern half of the 1km ZoI buffer, and west of the scheme (shown in Figure H.1). During construction moderate adverse impacts are anticipated as a result of the other development, and in combination with the scheme options would result in Moderate Adverse effects (with the scheme options taken in isolation). Cumulative effects during operation are not anticipated as slight beneficial impacts are anticipated due to the enhancement of existing vegetation features associated with the other development. **Construction:**	**Construction and operation:** The significant adverse cumulative effects anticipated during construction can be attributed to the fact that the scheme options would result in these effects in isolation. During PCF Stage 3 mitigation will be developed to reduce significant effects for landscape during construction. If during PCF Stage 3 significant cumulative effects for cumulative impacts during construction are still predicted then further mitigation will be developed.

Tier	Application reference	Assessment of cumulative effects	Need for additional mitigation
		Landscape character: Significant Adverse Visual Effects: Significant Adverse **Operation:** Landscape Character: Not Significant Adverse Visual Effects: Not Significant Adverse	
2	AWDM/0021/22 – Land East of Shadwells Road	The residual effects during construction and operation on Landscape and Visual Effects have been taken from the Environmental Statement produced by DMH Stallard on behalf of Cala Homes Limited (2021). The residual effects are due to the temporary change to the landscape character during construction. During operation the development would bring about a permanent change to the landscape and the views of it. The effects on landscape would be localised to the site and those in its immediate vicinity and due to a mixture of minor adverse and beneficial changes no significant impacts are predicted. **Construction:** Townscape character: Slight Adverse Visual effects: Slight Adverse **Operation** Townscape character: Not significant Visual effects: Not significant	Significant adverse cumulative effects during construction and operation are not anticipated at this stage. During PCF Stage 3 mitigation will be developed to reduce effects for landscape. If during PCF Stage 3 significant cumulative effects are predicted then further mitigation will be developed. Therefore, no additional mitigation on top of the individual mitigation specified in the EAR is considered necessary at this point.
		Cumulative residual effects for Land East of Shadwells Road and Options 1, 2 and 3. The 1km ZoI buffer overlaps for both construction and operation and includes the majority of the other development. During construction Slight Adverse impacts are anticipated as a result of the other development, and in combination with the scheme options would result in Slight Adverse effects (with the scheme options taken in isolation). Cumulative effects during operation are not anticipated as slight beneficial impacts are anticipated due to the enhancement of existing townscape features associated with the other development. **Construction:** Landscape character: Not Significant Adverse Visual Effects: Not Significant Adverse **Operation:** Landscape Character: Not Significant Adverse Visual Effects: Neutral	
Biodiversity **The effects on biodiversity as a result of the scheme have been assessed in Chapter 8 (Biodiversity). The residual on-balance effects on biodiversity are as follows:** **Construction: Slight Adverse** **Operation: Slight Adverse**			

Tier	Application reference	Assessment of cumulative effects	Need for additional mitigation
1	AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex	Land Site West of Fulbeck Avenue The residual effects during construction and operation on Biodiversity have been taken from the Ecological Impact Assessment produced by Lizard Landscape Design and Ecology (January 2020). Through the implementation of avoidance and mitigation measures there are negligible impacts predicted during the operation of this other development. There are small areas of habitat loss associated with this development which result in a minor adverse impact during construction. **Construction:** Slight Adverse **Operation:** Not Significant	**Construction and operation:** No significant cumulative effects are anticipated. As such, no additional mitigation is required.
		Cumulative residual effects for Land Site West of Fulbeck Avenue and Options 1,2 and 3 The 2km ZoI overlap is shown on Figure H.1 in Appendix H, and covers the entire other development and the majority of the other developments in the 2km buffer. Given that no significant effects are anticipated as a result of the other development or the scheme options, and with best practice mitigation measures to be employed for both the other development and all scheme options, there are not anticipated to be any additional cumulative effects on biodiversity. **Construction:** Not significant **Operation:** Not significant	
2	AWDM/0021/22 – Land Site East of Shadwells Road	Land East of Shadwells Road The residual effects during construction and operation on Biodiversity have been taken from the Environmental Statement produced by DMH Stallard on behalf of Cala Homes Limited (2021). The implementation of green infrastructure and habitat enhancements on and off site before and during construction and use of best practice mitigation measures result in no significant residual impacts being anticipated due to this development. **Construction:** Not Significant **Operation:** Not Significant	**Construction and operation:** No significant cumulative effects are anticipated. As such, no additional mitigation is required.
		Cumulative residual effects for Land East of Shadwells Road and Options 1,2 and 3 The 2km ZoI overlap shown on Figure H.1 in Appendix H, and covers the entire other development and the majority of the other developments in the 2km buffer. Given that no significant effects are anticipated as a result of the other development or the scheme options, and with best practice mitigation measures to be employed for both the other development and all scheme options, there are not anticipated to be any additional cumulative effects on biodiversity. **Construction:** Not Significant **Operation:** Not Significant	

Tier	Application reference	Assessment of cumulative effects	Need for additional mitigation
Noise and Vibration **The effects on Noise and Vibration as a result of the scheme have been assessed in Chapter 10 (Noise and vibration). The residual on-balance effects on Noise and Vibration are as follows:** **Construction: Not Significant**			
The study area for AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex does not overlap with the noise study area for this development therefore cumulative effects have not been considered.			
1	AWDM/0021/22	<u>Land Site East of Shadwells Road</u> The residual effects during construction and operation on Noise and Vibration have been taken from the Environmental Statement produced by DMH Stallard on behalf of Cala Homes Limited (2021). The implementation of green infrastructure and habitat enhancements on and off site before and during construction and use of best practice mitigation measures result in no significant residual impacts being anticipated due to this development. **Construction:** Neutral **Cumulative residual effects for Land Site East of Shadwells Road and Options 1, 2 and 3** The 300m construction noise and vibration buffer for the other development intersects with the buffer for the scheme options. This overlap is very minor and as no significant residual effects are anticipated as a result of the scheme options, and the implementation of best practice measures and suitable mitigation, no significant residual cumulative effects are anticipated. **Construction:** Not Significant Adverse	**Construction:** No significant cumulative effects are anticipated. As such, no additional mitigation is required
Road Drainage and the Water Environment **The effects on Road Drainage and the Water Environment as a result of the scheme have been assessed in Chapter 12 (Road Drainage and the Water Environment). The residual on-balance effects on Road Drainage and the Water Environment are as follows:** **Construction: Slight Adverse** **Operation: Slight Adverse**			
1	AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex	<u>Land Site West of Fulbeck Avenue</u> The residual effects during construction and operation are taken from the Flood Risk Assessment addendum produced by Stantec on behalf of BoKlok (2020) which is the only document available relating to the water environment. **Construction:** Slight Adverse	**Construction and operation:** No significant cumulative effects are anticipated. As such, no additional mitigation is required

Tier	Application reference	Assessment of cumulative effects	Need for additional mitigation
		Operation: Slight Adverse **Cumulative residual effects for Land Site West of Fulbeck Avenue and this development** The 500m ZoI overlap is shown on Figure H.1 in Appendix H. The overlap is minimal and includes a small area which does not overlap onto either the scheme options or the other development. Given the effects on the water environment as a result of the other development are Slight Adverse, and with best practice mitigation measures employed for all scheme options, it is not anticipated that there would be any cumulative effect associated with the other development. This is primarily because the overlapping area is very small in size and that effective mitigation techniques will be employed in the other development, therefore meaning that overall the cumulative residual effects during both construction and operation are unlikely to be any larger than the scheme options in isolation. **Construction:** Not Significant **Operation:** Not Significant	
2	AWDM/0021/22 – Land East of Shadwells Road	Land East of Shadwells Road The residual effects during construction and operation are taken from the Environmental Statement produced by DMH Stallard on behalf of Cala Homes Limited (2021). Through the utilisation of construction management techniques and sustainable drainage systems no significant effects are anticipated during construction or operation of development at Land Site East of Stadwells Road. **Construction:** Not Significant **Operation:** Not Significant **Cumulative residual effects for Land Site East of Stadwells Road and Options 1, 2 and 3** The 500m ZoI buffer overlap is shown on Figure H.1 in Appendix H. The overlap includes a small area which does not overlap onto either the scheme options or the other development. Given the effects on the water environment as a result of the other development are Not Significant, and with best practice mitigation measures employed for the scheme options, it is not anticipated that there would be any cumulative effect associated with the other development. This is primarily because the overlapping area is very small in size and that effective mitigation techniques will be employed in the other development, therefore meaning that overall the cumulative residual effects during both construction and operation are unlikely to be any larger than the scheme options in isolation. **Construction:** Not Significant **Operation:** Not Significant	**Construction and operation:** No significant cumulative effects are anticipated. As such, no additional mitigation is required
Climate **The effects on Climate as a result of the scheme have been assessed in Chapter 13 (Climate). The residual on-balance effects on Climate are as follows:** **Construction: Not Significant** **Operation: Not Significant**			
1		Land Site West of Fulbeck Avenue	**Construction and operation:**

Tier	Application reference	Assessment of cumulative effects	Need for additional mitigation
	AWDM/0166/20 – Land Site West of Fulbeck Avenue Northbrook Worthing West Sussex	The residual effects during operation are taken from the Energy and Sustainability Statement produced by Hydrock on behalf of BoKlok (2020). Due to energy efficient design and the provision of sustainable energy sources in the other development there is a moderate beneficial residual effect associated with the other development. No information was available in respect of effects during construction. **Operation:** Moderate Beneficial	No significant cumulative effects are anticipated. As such, no additional mitigation is required
		Cumulative residual effects for Land Site West of Fulbeck Avenue and Options 1, 2 and 3 Given the slight beneficial effects predicted due to the other development and the non-significant effects predicted due to the scheme options, no significant residual effects are anticipated. **Operation:** Not Significant	
2	AWDM/0021/22 – Land East of Shadwells Road	<u>Land Site East of Shadwells Road</u> The residual effects to climate during construction and operation are taken from the Energy and Sustainability Strategy produced by Method Consulting on behalf of Cala Homes Limited (2021). Through the utilisation of low and zero carbon technologies and the reduction of energy demand the other development is anticipated to have a slight beneficial effect on climate. During construction low carbon materials and processes to reduce waste will be implemented, however there is still a slight adverse impact anticipated due to emissions associate with construction plant. **Construction:** Not Significant **Operation:** Slight Beneficial	**Construction and operation:** No significant cumulative effects are anticipated. As such, no additional mitigation is required
		Cumulative residual effects for Land Site East of Shadwells Road and Options 1, 2 and 3 Given the slight beneficial impacts predicted due to the other development and the non-significant effects predicted due to the scheme options, no significant residual effects are anticipated. **Construction:** Not Significant **Operation:** Not Significant	

H. Cumulative impact assessment figure

H.1 Cumulative impact assessment

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