APPENDIX 11.1 - FLOOD RISK ASSESSMENT

Updated Drainage Strategy included within the FRA and further information provided in relation to CCTV and ground investigations conducted following submission of the ES

West Sussex County Council

A29 REALIGNMENT - PHASE 1

Flood Risk Assessment

79718-FRA-01
APRIL 2021

PUBLIC

West Sussex County Council

A29 REALIGNMENT - PHASE 1

Flood Risk Assessment

REPORT (VERSION 2) PUBLIC

PROJECT NO. 70079718

OUR REF. NO. 79718-FRA-01

DATE: APRIL 2021

WSP

Mountbatten House
Basing View
Basingstoke, Hampshire
RG21 4HJ

Phone: +44 1256 318 800

Fax: +44 1256 318 700

WSP.com

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Signature				Metcalfe, Charlotte (UKCLM008) 2021.04.28 14:28:52 +01'00'
Checked by	E. Stoykova T. Eckhardt (Groundwater)	E. Stoykova T. Eckhardt (Groundwater)	E. Stoykova T. Eckhardt (Groundwater)	G. Hoad
Signature				Hoad, Gemma (UKGAH003) 2021.04.28 16:24:32 +01'00'
Authorised by	A. Wright	A. Wright	A. Wright	A. Wright
Signature				Wright, Adrian (UKAPW003) 2021.04.29 09:24:57 +01'00'
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EXECUTIVE SUMMARY

We have produced this Flood Risk Assessment (FRA) on behalf of West Sussex County Council to support a full planning application for the development site known as *A29 Phase 1 Realignment* in West Sussex.

This FRA investigates flood risk in the area and outlines the mitigation measures proposed to ensure the sustainable and safe development of the site in line with requirements of the National Planning Policy Framework (NPPF), the associated Flood Risk and Coastal Change guidance within Planning Policy Framework (PPG) and the Environment Agency's standing advice.

The proposed development comprises the following:

- A three-arm roundabout at the western end at a new junction with the A29 Fontwell Avenue;
- A three-arm roundabout in the centre of the Scheme to provide future access to housing;
- A four-arm roundabout at the southern end, at a new junction with the B2233 Barnham Road;
- One uncontrolled pedestrian crossing to enable users of the Public Rights of Way (PRoW) to cross the carriageway;
- Crossing points at the junctions to allow access by foot into the housing from surrounding areas;
- A shared 3m wide footway and cycleway with landscaping on one side of the carriageway;
- A 30 mph (48 kph) speed limit on the Scheme;
- New access to the Fordingbridge Industrial Estate (Halo) site from the realigned A29;
- Noise mitigation in the form of a barrier to protect dwellings at Murrell Gardens, Chantry Mead and Ewens Gardens;
- Street lighting at roundabout approaches;
- Relocation of the substation on Fontwell Avenue; and
- Construction compounds, the main one being south of Barnham Road on the Fleurie Horticultural Nursery site.

Overall the proposals will ensure the safe and sustainable development of the site.

The risk of flooding from tidal and coastal, and artificial sources is not considered to be significant.

Flood risk from existing drainage infrastructure is mostly related to SW foul assets in the vicinity of the site which is the responsibility of Southern Water. The Scheme is a road realignment and it will not impact on foul flows in the area.

The risk of flooding from fluvial, pluvial and groundwater sources is considered to be medium to high at the Site. The potential increase in flood risk from those sources would be managed though the implementation of the drainage design which was undertaken by Capita / Jacksons.

The FRA has been produced in consultation with West Sussex County Council (WSCC) acting as the Lead Local Flood Authority (LLFA), Arun District Council (ADC), Southern Water (SW) and the Environment Agency (EA).

Contact name Emiliya Stoykova

Contact details +44 12 5631 8871 | Emiliya.Stoykova@wsp.com

1 INTRODUCTION

1.1 APPOINTMENT AND BRIEF

1.1.1. This flood risk assessment (FRA) has been prepared by WSP on behalf of West Sussex County Council to accompany a full planning application for the development known as the *A29 Phase 1 Realignment* (hereafter referred to as the 'Application Site').

1.1.2. WSP has prepared this report in accordance with the instructions of their client, West Sussex County Council for their sole and specific use relating solely to the above site. Any person who uses any information contained herein does so at their own risk and shall hold WSP harmless in any event.

1.1.3. Whilst this report was prepared using the reasonable skill and care ordinarily exercised by engineers practicing under similar circumstances and reasonable checks have been made on data sources and the accuracy of the data, WSP accepts no liability in relation to the report should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP. In any event, WSP shall not be liable for any loss or damages arising under or in connection to the use of this report.

1.2 OBJECTIVE OF STUDY

1.2.1. The aim of this FRA is to identify flood risks, which require assessment under the National Planning Policy Framework (NPPF), to the Application Site and those that may arise as a result of the proposed development. Where risks are identified, mitigation measures are proposed to manage the risks over the lifetime of the development, accounting for the effects of climate change.

1.2.2. A surface water drainage strategy design has been prepared by Capita / Jackson (refer to the documents included in Appendix F2) and should be read in conjunction with this FRA.

1.2.3. The FRA has been produced in line with the requirement of the NPPF and associated Flood Risk and Coastal Change Planning Practices Guidance (PPG), and the Environmental Agency Standing Advice, as well as through consultation with the Environment Agency and West Sussex County Council (WSCC) [the Lead Local Flood Authority (LLFA)].

STUDY METHODOLOGY

1.2.4. The Environment Agency, WSCC and Arun District Council (ADC) have provided background information to inform the production of this FRA.

1.2.5. The report has been informed by, and refers where appropriate, to the following documents and policies:

- Arun District Council Strategic Flood Risk Assessment (2016);
- Arun Local Plan (2011 – 2031) Sequential & Exception Tests (2014);
- Arun Strategic Surface Water Management Study (2016);
- British Geological Survey Map;
- DEFRA Magic Map;
- Geotechnics (2019) – A29 Realignment, Eastergate. Factual Report – ground investigation to inform the A29 Realignment Transport Business Case;
- Land Science (2020) – ground investigations undertaken to inform the A29 realignment Phase 1

- The National Planning Policy Framework (NPPF) (2019);
- The NPPF Flood Risk and Coastal Change Planning Practice Guidance (PPG);
- West Sussex County Council's Strategic Transport Investment Programme (STIP) in June 2013 (HT07 (14-15);
- West Sussex Local Management Strategy (LFRMS) (2014);
- Wilson Bailey 2018, 2019 and 2020 – ground investigations undertaken on behalf of Barratts; and,
- WSP (2019) Flood Risk Statement in support of a Transport Business Case for the proposed A29.

1.2.6. This FRA makes partial use of third-party information and contains Environment Agency information © Environment Agency.

1.2.7. This study contains public sector information licensed under the Open Government Licence v3.0.

2 THE EXISTING SITE

2.1 SITE LOCATION

2.1.1. The existing A29 Frontwell Avenue road near its crossing with Eastergate Lane is situated to the west of the Site. The Barnham residential estate is adjacent to the east of the site.

2.1.2. Agricultural fields are located to the north and to the south of the site, as shown of Figure 1 below.

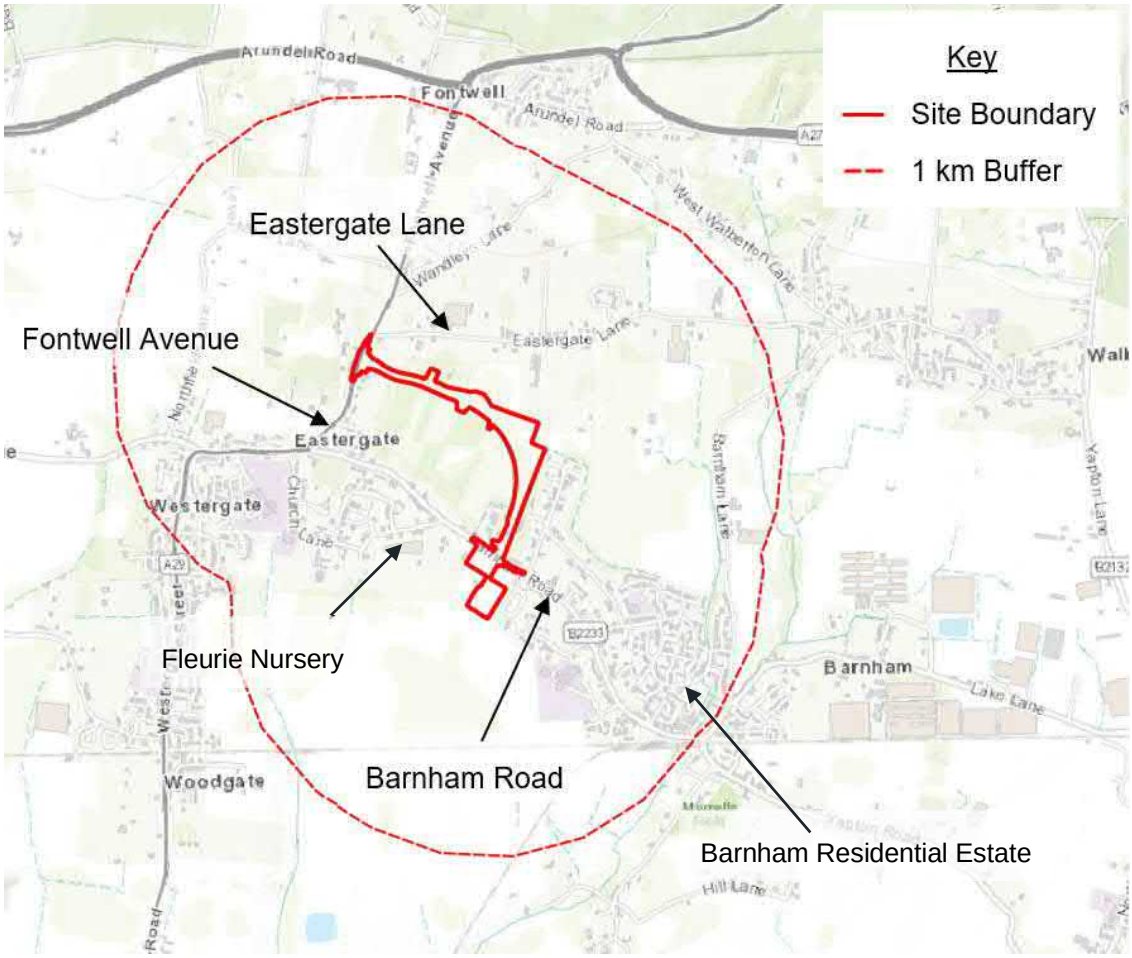

Figure 1: *Indicative site location plan*

2.2 SITE DESCRIPTION

2.2.1. The Application Site covers an area of approximately 11.8 hectares (ha) and currently comprises mainly agricultural fields. The southern end of the site crosses B2233 Barnham Road and comprises Fleurie Nursery, which is a plant nursery.

2.2.2. A topographical survey was undertaken at the site in February 2019 by 3D Engineering Surveys Limited; two more topographical surveys which cover part of the Site and the adjacent land proposed for development were provided by Barratts (survey dated June 2018) and Pellfrishman (survey dated November 2018). The surveys indicate that site gently slopes down to the south-east

and south. Ground levels range between approximately 8 and 16 meters above ordnance datum (m AOD). A copy of the surveys can be found in Appendix C.

2.3 GEOLOGY AND HYDROGEOLOGY

2.3.1. The British Geological Survey (BGS) mapping shows that the Application Site is underlain by Head (gravel, sand, silt and clay) and River Terraced Deposits (sand, silt and clay). The bedrock geology which underlies the Head and River Terraced Deposits is the London Clay Formation. Refer to Figure 60779-BGS-001 in Appendix A3.

2.3.2. The Environment Agency classifies the superficial deposits as a "Secondary A" aquifer and the London Clay Formation as an "Unproductive Stata". Therefore, groundwater flow can be expected within the superficial deposits as they are more permeable strata. Refer to Figure 60779-BGS-002 in Appendix A3.

2.3.3. Available ground investigation and groundwater data in the area of interest has been reviewed and it is included in Appendix E1 for reference. The available data comprises of information provided by the adjacent development site (Wilson Bailey 2018, 2019 and 2020), data collected for the A29 Transport Business Case (Geotechnics 2019) and additional ground data and monitoring commissioned as part of the Phase 1 application (Land Science 2020). Figure No. 60779-BGS-003 is included in Appendix A and it shows the BGS superficial deposits as well as the groundwater monitoring locations. Borehole logs in the area of interest also indicate that groundwater was struck in some of these during drilling.

2.3.4. Ground investigation confirmed that groundwater is present within the superficial deposits which are overall consistent across the site:

Table 2-1 – Geology layers and depth at the Site

Geology layer	Depth range (m below ground level (bgl))
Topsoil	0 – 0.4
Clay	0 – 2.2
Gravel / sand	0.3 – >4

2.3.5. Groundwater was encountered in the gravel / sand layers (River Terrace Deposits) which underlay the clay (generally Head deposits). The recorded groundwater levels vary across the site. It has been inferred from the groundwater monitoring data that the groundwater flows in a south / south-easterly direction.

2.3.6. The groundwater monitoring data indicates that minimum groundwater levels in the area of the proposed scheme vary between 0.32m bgl and >3.0m bgl along the alignment. Generally, groundwater levels to the eastern and southern part of the scheme are recorded to be at shallower depths that the north-western end of the scheme.

2.3.7. In situ permeability tests in the gravels showed hydraulic conductivities between $6.98x10^{-6}$ m/s and $1.3x10^{-4}$ m/s suggesting that substantial groundwater flows can occur in particular within the gravels.

2.3.8. An additional ground investigation was carried out in February 2021, the results of which are included in Appendix E2 for reference. Three trial pits were excavated at the location of the proposed storage installations.TP201 was located in the centre of the proposed roundabout and TP202 and TP203 located south of the roundabout.

2.3.9. Three infiltration tests undertaken within each trial hole. TP201 had a worst case scenario soil infiltration rate of $3.32x10^{-4}$ m/s, TP202 had a worst case scenario rate of $9.14x10^{-6}$ m/s and TP203 had a worst case scenario rate of $7.38x10^{-6}$ m/s.

2.3.10. Groundwater was encountered 2.5m bgl in TP201, 2.7m bgl in T202 and was not encountered in TP203.

2.3.11. The latest investigation work has shown that infiltration rates in the centre of the roundabout are reasonable and exceed the values assumed in the design. Recorded groundwater levels were higher than previously assumed. The design of the storage cells in the centre of the roundabout as previously presented will include spare capacity to reduce the risk associated with fluctuating groundwater levels.

2.3.12. Infiltration rates to the south of the roundabout however are above the threshold for infiltration systems but were lower than the values assumed in the design. The plan area of the storage cells has been increased within the constraints of the site red line boundary and the storage volume provided is now 242m³. Groundwater levels recorded were slightly lower than that assumed for the design.

2.3.13. The results show that, while the distance between the invert of the tanks and the ground water level is less than expected the infiltration rates are still sufficient to enable the 100yr + 40% event to be fully managed within the proposed system.

2.3.14. It should be noted that groundwater levels may be higher under extreme wet conditions. The water level measurements are representative for the date of the trial pitting only which may not necessarily represent winter high levels. There is also a requirement to have 1m unsaturated thickness between the maximum groundwater level and the invert level of a soakaway structure to allow for some natural attenuation of potential pollution. In this case, groundwater levels could easily rise into the bottom zone of the basin. The encountered clay layer in TP201 (13.2-13.5m AOD) could potentially act as a confining layer for the gravels if groundwater levels rise further and would need to be considered if the basin base elevation was to be lifted up.

2.4 EXISTING WATERCOURSES

2.4.1. Barnham Lane Ditch, a tributary of the River Barnham Rife, is classified as an Environmental Agency Main River and is the closest river to the Application Site, bordering the east of the boundary of the Scheme. According to Arun District Council Strategic Flood Risk Assessment (2016), Barnham Lane Ditch flows in a south-easterly direction to its confluence with the Barnham Rife near Barnham Station. Barnham Rife flows through Barnham in a south-westerly direction until its confluence with the Lidsey Rife Regis.

2.4.2. Furthermore, the watercourse Lidsey Rife is approximately 1.5 km south from the far west of the Application Site, flowing from Eastgate southwards to its confluence near Whitfield Close in Bognor Regis. Westergate Stream is around 0.67 km west from the west of the Site and is a tributary of Aldingbourne Rife, originating north of Westergate and Nyton, flowing in a south-westerly direction.

2.4.3. Arun District Councils SFRA indicated that located adjacent to the south of the Proposed Development is an Ordinary Watercourse (School Ditch). ADC provided a map showing the location of the ditch (refer to Appendix B2) and it is understood that School Ditch flows to the south where it is currently culverted under the existing agricultural land.

2.5 EXISTING ARTIFICIAL WATERCOURSES AND RESERVOIRS

2.5.1. There are no artificial watercourses within close proximity of the Application Site. The Environment Agency's Risk of Flooding from Reservoirs Mapping (refer to Figure 60779-EA-003 located in Appendix A2) indicates that the site does not lie within the extreme inundation area of any reservoirs.

2.6 EXISTING SEWER AND DRAINAGE NETWORK

2.6.1. Based on Asset Location Plans provided by Southern Water (refer to Appendix B), a foul gravity sewer can be found along Fontwell Avenue, to the northwest of the Site. The pipes are 225 mm in diameter and flows in a southward direction.

2.6.2. The Southern Water sewer network plans also indicate that there is a 175 mm diameter foul sewer running along Barnham Road in a south-west direction.

2.6.3. ADC confirmed the existing drainage mapping in the area including surface water drains along Barnham Road which connect to the School Ditch to the south. Refer to Appendix B2 for the plans provided by ADC.

2.7 EXISTING FLOOD DEFENCES AND OTHER INFRASTRUCTURES

2.7.1. Based on the Environment Agency's Flood Map for Planning (refer to Appendix A2), the Application Site is not shown to be protected by any formal flood defences.

2.7.2. The information provided by the Environment Agency as part of their 'Product 4' (Appendix B1) also indicates that the site does not benefit from flood defences.

2.8 HISTORIC FLOOD RECORDS

2.8.1. Data provided within the Environment Agency Flood Map shows that there are no records of historic flood events within the proximity of the Application Site.

2.8.2. Correspondence with ADC and WSC (refer to Appendix B2) have confirmed that there has been a previous flood event at Chantry Mead prior to the construction of the site. In addition, they confirmed that the junction of Wandleys Lane/Fontwell Avenue, including a highway and potential properties, had experienced numerous flood events. This is thought to be due to the Portsmouth borehole going artesian (i.e. groundwater sources).

2.8.3. Correspondence with SW (refer to Appendix B) have confirmed that there to have been recorded flood events within the site's vicinity and that those events are mainly related to foul sewers.

3 PROPOSED DEVELOPMENT

3.1 DEVELOPMENT PROPOSALS

Full description of the development proposals is included in Chapter 3 of the Environmental Statement (Ref. No. 70060779 Version 1). Vertical profiles of the proposed alignment have been provided by Capita / Jackson in April 2020 are included in Appendix F1 for reference.

Key features of the Scheme would include the following:

- A three-arm roundabout at the western end at a new junction with the A29 Fontwell Avenue;
- A three-arm roundabout in the centre of the Scheme to provide future access to housing;
- A four-arm roundabout at the southern end, at a new junction with the B2233 Barnham Road;
- One uncontrolled pedestrian crossing to enable users of the Public Rights of Way (PRoW) to cross the carriageway;
- Crossing points at the junctions to allow access by foot into the housing from surrounding areas;
- A shared 3m wide footway and cycleway with landscaping on one side of the carriageway;
- A 30 mph (48 kph) speed limit on the Scheme;
- New access to the Fordingbridge Industrial Estate (Halo) site from the realigned A29;
- Noise mitigation in the form of a barrier to protect dwellings at Murrell Gardens, Chantry Mead and Ewens Gardens;
- Street lighting at roundabout approaches;
- Relocation of the substation on Fontwell Avenue; and
- Construction compounds, the main one being south of Barnham Road on the Fleurie Horticultural Nursery site.

3.2 VULNERABILITY CLASSIFICATION

3.2.1. Within Table 2 (Flood Risk Vulnerability Classification) of the NPPF Planning Practice Guidance, the proposed Scheme is classified as ‘Essential Infrastructure’.

3.3 SEQUENTIAL AND EXCEPTION TESTS

3.3.1. The purpose of the NPPF Sequential Test is to ensure that land use planning takes due regard of flood risks, to ensure that areas at low or no risk of flooding are developed in preference to areas at higher risk.

Table 3-1 – Flood risk vulnerability and flood zone compatibility (PPG Table 3)

Flood Risk Vulnerability Classification	Flood Zone 1	Flood Zone 2	Flood Zone 3A	Flood Zone 3B
Essential Infrastructure	Development is appropriate	Development is appropriate	Exception Test Required	Exception Test Required

3.3.2. The proposed development is located almost entirely in Flood Zone 1, having a small portion of the red line boundary within Flood Zone 2 and 3.

3.3.3. Flood Zone 2 and Flood Zone 3 and due to the development being 'essential', an Exception Test is required. However, a Sequential Test is not needed as one has previously been carried out in the Barnham/Eastergate/Westergate area, according to the *Arun Local Plan (2011 – 2031) Sequential & Exception Tests* document.

3.3.4. The Exception Test requires the proposed development to show that:

- It will provide wider sustainability benefits to the community outweighing flood risk. Concerns relating to the wider sustainability benefits to the community are addressed by the supporting planning application documents;
- It will be safe for its lifetime without increasing flood risk elsewhere and where possible reduce flood risk overall.

3.3.5. The A29 Realignment scheme was identified as a priority for investment in WSCC Strategic Transport Investment Programme (STIP) in June 2013 (HT07 (14-15)). This investment supports the Arun Growth Deal that identifies the A29 road improvements as a key infrastructure project for delivery as early as possible.

3.3.6. Part 2 of the Exception Test is covered by this FRA.

4 DEFINITION OF FLOOD RISK

4.1 OVERVIEW

4.1.1. The following section provides an overview of flood risk to the Application Site, along with flood risk, to and from the proposed development. An assessment has been undertaken for each source that could affect the proposed development in accordance with the NPPF Flood Risk and Coastal Change PPG.

4.1.2. Reference to consultation with the EA, SW and WSCC (LLFA) are made in the following sections and correspondence is attached in Appendix B.

4.2 FLOODING FROM COASTAL AND TIDAL SOURCES

4.2.1. The Application Site is not located within the vicinity of the coast, nor is it situated within the vicinity of an estuary or tidal watercourse. The risk of coastal and tidal flooding to the Application Site is negligible and therefore no mitigation measures are required.

4.3 FLOODING FROM FLUVIAL SOURCES

4.3.1. Based on the Environment Agency's Flood Map for Planning (Figure No. 60779-EA-001 located in Appendix A2), the majority of the Application Site lies within Flood Zone 1, an area assessed as having less than 1 in 1,000 annual probability of river or sea flooding (<0.1%), and consequently, it is subject to a Low Risk of fluvial flooding.

4.3.2. However, a small section to the east of the site is in Flood Zone 2, an area assessed as having up to a 0.1% (1 in 1000) annual probability of flooding, and Flood Zone 3, an area assessed as having >1% (1 in 100) annual probability of river or sea flooding. Therefore, this section is subject to a Medium to High Risk of fluvial flooding.

4.3.3. The overall risk of flooding from fluvial sources is considered to be Low as the Environment Agency Flood Zones are located only along a small portion of the eastern site boundary. Refer to Appendix A2 for the relevant mapping.

4.3.4. In addition, correspondence with the Environment Agency, ADC and WSCC have confirmed that they have no record of flooding from rivers at the site, which is consistent with its location, mainly in Flood Zone 1.

4.4 FLOODING FROM PLUVIAL / OVERLAND FLOW SOURCES

4.4.1. Based on the Environment Agency's Risk of Flooding from Surface Water (Figure No. 60779-EA-002 located in Appendix A2), certain areas of the site are at risk from surface water flooding. This includes the southernmost point of the site, where there is a low risk (between 0.1% and 1% annual exceedance probability) and the western most point of the Site where there is a medium (between 1% and 3.3% AEP) and high (greater than 3.3%) risk of flooding from surface water following the route of Fontwell Avenue.

4.4.2. The low surface water flood risk of the southernmost area is a small localised section associated with a topographically low point.

4.4.3. The flood risk from surface water along Barnham Road and Fontwell Avenue are associated with overland flow routes along those roads.

4.4.4. Correspondence with ADC and WSCC have confirmed that "*the surface water flood map pretty much replicates most potential/known flooding locations"*. For the highway outside Follyfoot Farm on Fontwell Avenue experienced flooding during 1993/94. Refer to Appendix B2.

4.4.5. Correspondence with the Environment Agency have confirmed that parts of the Application Site are at risk of surface water flooding.

4.5 FLOODING FROM GROUNDWATER SOURCES

4.5.1. As stated in Section 2.3 the Application Site's underlying bedrock geology is Head, River Terrace Deposits and London Clay.

4.5.2. Groundwater monitoring across and adjacent to the site indicates that in some locations the groundwater raises to up to 320 mm below ground level in one of the boreholes located at the eastern end.

4.5.3. Additional groundwater monitoring, carried out in February 2021, found groundwater was encountered 2.5m bgl in TP201, 2.7m bgl in T202 and was not encountered in TP203. In the centre of the roundabout groundwater levels were higher than previously assumed and south of the roundabout groundwater levels were slightly lower than that assumed for the design.

4.5.4. WSCC (LLFA) and ADC also confirmed that high groundwater is present in the area (refer to Appendix B2):

> *"Groundwater in Murrells Gardens/Chantry Mead has been known to peak at around 150mm to 300mm below ground level."*
>
> *"…the existing Portsmouth Water pumping stations which at times of elevated groundwater have gone artesian…"*

4.5.5. The risk of flooding from groundwater sources at the site is therefore considered to be Medium-High.

4.6 FLOODING FROM SEWER AND DRAINAGE INFRASTRUCTURE

4.6.1. As confirmed in paragraph 2.8.3., SW confirmed there to have been recorded flood events resulting from sewers infrastructure within the vicinity of the site, mainly attributable to foul sewers. Refer to Appendix B3 for relevant correspondence.

4.6.2. ADC, who are also responsible for some of the local drainage network, confirmed that they do not have records of flooding within the site area on in the immediate vicinity of the site. Please refer to Appendix B2 for the relevant correspondence.

4.6.3. The risk of sewer and drainage flooding at the Application Site is currently considered to be a Medium Risk as there have been incidents of sewer flooding near the Scheme.

4.7 FLOODING FROM ARTIFICIAL SOURCES

4.7.1. The Environment Agency's Risk of Flooding from Reservoirs mapping (refer to Appendix A2), indicates that the Application Site does not lie within the extreme inundation area of any reservoirs.

4.7.2. The risk of flooding from artificial sources at the Application Site is considered to be negligible.

5 CLIMATE CHANGE

5.1 BACKGROUND INFORMATION

5.1.1. As explained in the Climate Change Adaptation Sub-Committee Progress Report 2014, increased flood risk is the greatest threat to the UK resulting from climate change. Models of the climate system suggest floods of the type experienced in England and Wales in autumn 2000, between December 2013 and February 2014, and in winter 2019 have become more likely as a consequence of increased concentrations of greenhouse gases in the atmosphere.

5.1.2. More frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall could be expected. Sea levels are also expected to continue to rise.

5.1.3. Environment Agency guidance 'Flood risk assessments: climate change allowances' issued on the 19th February 2016, updated in April 2016, February 2017, February 2019, December 2019, March 2020, and July 2020 provides up to date information on expected changes in rainfall, river flows and sea level rise as a consequences of climate change.

5.1.4. A key change from the previous guidance is that the climate change allowances for peak river flows are not shown as variable on a regional basis; allowances are also now based on percentiles, whereby a percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level (e.g. a 50% percentile means that the allowance has 50% chances of not being exceeded. Moreover, sea level rise allowances have been updated using UKCP18 projections.

5.1.5. For peak rainfall the Environment Agency guidance provides an upper end and central allowance depending on epoch; the guidance recommends assessing both the central and upper end allowances to understand the range of possible impacts.

5.2 DEVELOPMENT LIFESPAN

5.2.1. A typical lifespan for the proposed development is considered to be 100 years.

5.3 IMPACT OF CLIMATE CHANGE ON THE DEVELOPMENT

5.3.1. Surface water flood risk is generally expected to increase in the future as a consequence of climate change and the expected increase in extreme rainfall events.

5.3.2. In order to take into account the latest climate change guidance, the proposed surface water drainage strategy has been designed to cater for the 1:100-year return period rainfall event, including a 40% climate change allowance (refer to the drainage documents in Appendix F2).

5.3.3. The Scheme is not within a fluvial or tidal floodplain; hence it is not expected that climate change will significantly increase the associated risk. Please note that the development does not include the small portion of land within the red line boundary which borders the fluvial flood zones from Barnham Lane Ditch.

5.3.4. The climate change could also result in a higher fluctuation of groundwater levels due to climate change. However, it should be relatively insignificant in the Application Site due to high permeability of the gravel (ability to remove high volumes of water quickly).

5.3.5. No other potentially significant impact of climate change on flood risk has been identified.

6 FLOOD RISK MITIGATION MEASURES

6.1 BRIEF CONSIDERATIONS

6.1.1. Following a review of the existing flood risks to and arising from the proposed development, the following section discusses the measures necessary to mitigate the risk of flooding to the proposed development and that it does not exacerbate flood risk to neighbouring property (including allowances for the effects of climate change).

6.1.2. Were applicable, we have provided high level comments to the drainage design (Appendix F2) only. Both the LLFA and Capita / Jackson have acknowledged these and implemented were they have considered appropriate. Please note that WSP will not be liable for third party's design, i.e. the Drainage Strategy Note dated September 2020 (refer to A29-CAP-HDG-00-AN-D-0052 TN - Drainage Strategy S3-P05 and correspondence with Arun and the LLFA in Appendix F2).

6.2 MITIGATION MEASURES

6.2.1. The risk of the proposed development exacerbating flood risks from tidal / coastal, and artificial sources to neighbouring properties is assessed to be Negligible or Low. Therefore, no measures are considered necessary to mitigate against these sources.

6.2.2. Furthermore, flooding from existing drainage infrastructure is not further considered as the available historic flood events are mostly related to SW foul assets in the vicinity of the site which is responsibility of Southern Water. The Scheme is a road realignment and will not impact on foul flows in the area.

6.2.3. Based on the existing flood risk described in Section 4, the Scheme considers the mitigation measures for the below sources of flooding.

Flooding from Fluvial Sources

6.2.4. As described in Section 4.3, the development is located within the EA's Flood Zone 1 and therefore no mitigation measures are proposed for the risk of fluvial flooding to the Scheme.

6.2.5. Based on the proposed road design provided by Capita in April 2020, the proposed noise bund is also entirely within Flood Zone 1. The proposals indicate that the bund is located at least 12m to the west form Flood Zone 2, and therefore mitigation measures would not be required.

6.2.6. It should be noted that the scheme is proposed to discharge surface water at a controlled rate into Barnham Lane Ditch (a Main River) as indicated in A29-CAP-HDG-00-DR-C-0047 S0-P11 in Appendix F2. The scheme has the potential to increase fluvial flood risk downstream of the Site. The drainage design has been agreed with ADC (refer to Appendix F2) and A29-CAP-HDG-00-AN-D-0052 TN - Drainage Strategy S3-P05 indicates that there would be a betterment to the net discharge into the Barnham Lane Ditch. Therefore, the risk of increasing risk of fluvial flooding elsewhere would be mitigated through the implementation of the drainage strategy.

Flooding from Pluvial / Overland Flow Sources

6.2.7. By developing the Application Site, the runoff from the proposed development would likely increase in the absence of surface water management solutions. This is mainly due to the increase in impermeable areas at the site.

6.2.8. Capita / Jackson were instructed to undertake a surface water drainage strategy in support of the full planning application. The strategy aims to incorporate surface water attenuation to compensate for the increase in impermeable area and would provide sufficient attenuation for the proposed development, in accordance with the non-statutory technical standards for sustainable drainage and relevant policy. The overall surface water drainage proposals have been presented to Arun and the LLFA and formal acceptance is included in Appendix F2 for reference.

6.2.9. Two overland flow routes have been identified at Fontwell Avenue and Barnham Road and potential mitigation to incorporate in the design have been discussed with ADC and WSCC (LLFA) over a virtual meeting held on 3 July 2020. A follow-up email has been sent to ADC and WSCC (LLFA) on 30 July 2020 and both ADC and LLFA confirmed acceptance of the proposals on 6 August 2020 which include the below:

- *At the Fontwell Avenue tie-in, the existing alignment is relatively flat and the gradient does not have a constant fall with a number of low and high points existing along the existing kerb line. The overland flow route with the proposed roundabout will be along the west side kerb line, where we propose to provide extra gullies at the low points:*
  - *Along the retained section of the A29, for the service access between the north and south roundabout arms, and at the tie in locations where there are existing low points we would propose to install additional gullies for the runoff to discharge to the existing highway drainage.*
  - *At the northern end where the access is closed, proposed to provide a section of flat channel to allow the overflow to continue along the service road. This will mitigate against any increase in flooding depths that might otherwise occur once the new scheme is constructed.*
- *At the Barnham Road tie-in, the existing road is very flat to the west of the proposed roundabout where it has been indicated that some overland flow may be occurring. With our proposed alignment of roundabout raising the carriageway level there is a risk that an existing flooding issues may be exacerbated. We therefore propose to provide extra gullies at the low point, these will connect to the existing highway drainage. If the existing drainage network has insufficient capacity for the (existing) flows then we would recommend that WSCC consider upgrading the existing highway drainage that runs from this location to the school watercourse outfall. An alternative option for a highway ditch along the SW corner and the southern arm to the school watercourse would require additional land take and has therefore not been recommended. The proposed final solution is however subject to the CCTV condition survey of the existing highway drainage network.*

6.2.10. Refer to Appendices B2 and F2 for the relevant correspondence with ADC and WSCC (LLFA).

6.2.11. Two CCTV condition surveys were carried out along Barnham Road to confirm the final road design/mitigation measures at the proposed roundabout with Barnham Road. A copy of the surveys can be found in Appendix D.

6.2.12. During the first survey, carried out in July 2020, a total of 16 inspections were carried out, on a total length of 391.52m with a total inspected length of 365.79m. Sections 1, 2 and 3 are verified as 225mm circular, concrete pipes. Sections 4, 5, 6, 7, 8, 9, 10, 11 and 16 are 150mm circular, vitrified clay pipes. Section 4 has multiple fractures, a medium displaced joint and holes in the drain or sewer. Sections 5, 6, 7 and 16 have a large displaced joint. Sections 7 and 9 also have a

circumferential fracture. Section 12 is a 200mm vitrified clay pipe with multiple fractures. Sections 13 and 14 are 300mm circular, vitrified clay pipes, Section 13 with a hole in the drain or sewer. Section 15 is a 225mm circular, vitrified clay pipe.

6.2.13. During the second survey, carried out in September to October 2020, a total of four inspections were carried out, on a total length of 163.62m with a total inspected length of 163.41m. Section 1 is verified as a 225mm circular, concrete pipe, with a medium, displaced joint and fracture. Section 2 is a 225mm circular, vitrified clay pipe. Section 3 is a 225m circular, concrete pipe, with a fracture longitudinal at the joint. Section 4 is a 225mm circular, vitrified clay pipe. This was found to have 20% settled debris, an unknown obstruction, multiple fractures and a broken pipe.

6.2.14. A further CCTV survey was carried out, along Fontwell Avenue, in July 2020. A total of 10 inspections were carried out, on a total length of 247.97m with a total inspected length of 227.83m. Section 1 is verified as a 300mm circular, cast iron pipe. Sections 2 and 3 are 300mm circular, concrete pipes. Section 2 has multiple fractures and holes in the drain or sewer and Section 3 has holes in the drain or sewer. Section 4 is a 300mm circular, vitrified clay pipe, with a circumferential fracture and holes in the drain or sewer. Sections 5 and 6 are 300mm circular, vitrified clay pipes, with holes in the drain or sewer. Section 7 is a 300mm circular, polyvinyl chloride pipe. Sections 8, 9 and 10 are 225mm circular, cast iron pipes. Section 10 has a large displaced joint.

6.2.15. The surveys identified issues in the pipe work and the need for further works. The contractor will provide a quotation which will highlight the areas of concern, the most appropriate remedial technique and all associated costings. If the faults of and the obstruction in the pipes are not fixed then this will be a potential flood risk issue.

6.2.16. As described in the Drainage Strategy TN (Refer to Appendix F2), the *"existing drainage system and levels through this area are to be investigated and measures put in place, during the detailed design, to prevent any increase in flood water levels in this area".*

6.2.17. Based on the above, the risk of flooding from surface water sources after the implementation of the mitigation measures is considered to be Low.

Flooding from Groundwater Sources

6.2.18. Most of the proposed levels of the Scheme are at grade or raised in relation to the existing ground. Consequently, the risk of groundwater flooding to the scheme in these areas is considered to be low.

6.2.19. From chainage CH 0 to approximately CH 100, the proposed ground levels are proposed to be lowered by a maximum of 1.2m below the existing ground level, from 15.896 to 14.697m AOD. Maximum observed groundwater levels in the area are 13.88 m AOD which is lower than the levels of the proposed road alignment in that area. The maximum observed groundwater levels in the area are recorded in DS101. Based on that, risk of groundwater flooding to the Scheme level is considered to be low.

6.2.20. The drainage design of the scheme includes ponds, swales and cellular underground storage. The drainage strategy proposals split the Scheme area into 4 catchments as indicated in the documents in Appendix F2. The invert levels of the proposed ponds are close to or below the maximum recorded groundwater level near each location. A29-CAP-HDG-00-AN-D-0058 (refer to Appendix

F2) indicates the proposed drainage elements for catchments 3 and 4 would be lined and the risk of flooding from groundwater would therefore be mitigated for ponds 3 and 4.

6.2.21. The drainage elements for catchments 1 and 2 include swales and ponds which would use infiltration. The proposed invert levels for the infiltration features are close to or below the maximum recorded groundwater level in the area and therefore there is a risk of flooding from groundwater. A virtual meeting between the design team, ADC and WSCC (LLFA) took place on 3 July 2020 to discuss the high groundwater levels and the implication in the current drainage design. WSCC (LLFA) and ADC agreed that additional groundwater monitoring could be installed in the infiltration area and any amendments to the design would be made prior to construction. In addition, "*differences between the data available engineering judgement and interpretation would be required to support the design within the drainage strategy*". Refer to correspondence and provided drainage documents in Appendix F2.

6.2.22. As the drainage strategy and the highways design has been delivered by Capita / Jackson, we have assumed that the design has been undertaken following ADC and WSCC agreed requirements, i.e. engineering judgment and interpretation given the available groundwater data. Therefore, it is assumed that the risk of flooding from groundwater due to the use of infiltration SuDS techniques has been considered within the proposed design. We recommend the proposed design to be reviewed prior to construction against all available groundwater monitoring data including the additional groundwater monitoring agreed with WSCC (LLFA) and ADC. The additional groundwater monitoring, as described in Section 2.3, fed into the revised drainage strategy design.

6.2.23. Maximum groundwater levels in the southern part of the site are very shallow and even if the road is protected surrounding land will not be raised as part of this development. Other developments in the area have to develop drainage strategies and it is important that cumulative impacts on groundwater levels are considered, i.e. avoiding an increase in groundwater recharge during prolonged wet conditions.

7 SURFACE WATER DRAINAGE STRATEGY

7.1.1. The documents related to the Surface Water Drainage Strategy has been prepared by Jackson / Capita and provided in September 2020. As stated at the beginning of this document, WSP will not be held liable for information or documents (e.g. surface water drainage strategy for A29 Phase 1 realignment) as it has been provided by a third party. The provided drainage strategy documents are saved in Appendix F2 for reference.

7.1.2. The drainage proposals include discharging into Barnham Lane Ditch which as a Main River would require a discharge consent from the EA. Discharge to the ordinary watercourse School Ditch would require a consent form the LLFA. Correspondence with the LLFA and the EA regarding the discharge consents are saved in Appendix F3 for reference.

8 RESIDUAL RISK

8.1.1. The risk of flooding from fluvial, pluvial and groundwater sources would be mitigated through the road and drainage designs.

8.1.2. The residual risk related to those sources of flooding could be managed through additional groundwater monitoring. This was undertaken in February 2021 and fed into the revised drainage strategy design. ~~and any amendments to the design will be made prior to construction of the Scheme as suggested by WSCC (LLFA) and ADC in their correspondence dated 6 August 2020 (Appendix E2).~~ The amendment to the drainage design prior to construction of the Scheme as was suggested by WSCC (LLFA) and ADC in their correspondence dated 6 August 2020 (Appendix E2). The results showed that, while the distance between the invert of the tanks and the ground water level is less than expected the infiltration rates are still sufficient to enable the 100yr + 40% event to be fully managed within the proposed system. The risk of increasing risk of groundwater flooding would be mitigated through the implementation of the drainage strategy.

9 CONCLUSIONS

9.1.1. WSP has undertaken this Flood Risk Assessment (FRA) on behalf of West Sussex County Council to support the proposed A29 realignment Phase 1 in West Sussex. It has been prepared in accordance with the guidelines set out in the NPPF as well as other national and local policy.

9.1.2. The Application Site is approximately 11.8 ha and comprises on mainly agricultural land.

9.1.3. The Application Site is located largely in Flood Zone 1, but the east of the site is also situated in Flood Zone 2 and 3. As the development is classes as 'Essential' an Exception Test is required, however, a Sequential Test has already been carried out in the Barnham/Eastergate/Westergate area and the Scheme is key to deliver this strategic development.

9.1.4. The risk of flooding from tidal and coastal, and artificial sources is not considered to be significant.

9.1.5. Flood risk from existing drainage infrastructure is mostly related to SW foul assets in the vicinity of the site which is responsibility of Southern Water. The Scheme is a road realignment and it will not impact on foul flows in the area.

9.1.6. The risk of flooding from fluvial, pluvial and groundwater sources is considered to be medium to high at the Site. The potential increase in flood risk from those sources would be managed though the implementation of the drainage design which was undertaken by Capita / Jackson and in consultation with WSCC (LLFA), ADC and the EA.

9.1.7. The residual risk related to those sources of flooding could be managed through additional groundwater monitoring. This was undertaken in February 2021 and fed into the revised drainage strategy design. The amendment to the drainage design prior to construction of the Scheme as was suggested by WSCC (LLFA) and ADC in their correspondence dated 6 August 2020 (Appendix E2). The results showed that, while the distance between the invert of the tanks and the ground water level is less than expected the infiltration rates are still sufficient to enable the 100yr + 40% event to be fully managed within the proposed system. The risk of increasing risk of groundwater flooding would be mitigated through the implementation of the drainage strategy.

~~9.1.8. The residual risk related to those sources of flooding could be managed through additional groundwater monitoring and any amendments to the design will be made prior to construction of the Scheme as suggested by WSCC (LLFA) and ADC in their correspondence dated 6 August 2020. Additional monitoring was undertaken in February 2021.~~

9.1.9. Maximum groundwater levels in the southern part of the site are very shallow and even if the road is protected surrounding land will not be raised as part of this development. Other developments in the area have to develop drainage strategies and it is important that cumulative impacts on groundwater levels are considered, i.e. avoiding an increase in groundwater recharge during prolonged wet conditions.

9.1.10. The potential increase in flood risk due to climate change have been considered for the lifespan of the Scheme. The Scheme is within Flood Zone 1, i.e. outside a fluvial floodplain and therefore it is not expected that climate change would significantly increase the fluvial flood risk. The proposed drainage design provided by Capita / Jackson incorporates attenuation for the 1:100 year return period rainfall event, including a 40% climate change allowance.

9.1.11. The report has been prepared taking into account the requirements of the NPPF and associated Flood Risk and Coastal Change Planning Practice Guidance, Environment Agency Standing Advice and through consultation with the EA, Southern Water, WSCC (LLFA) and ADC.

Appendix A

REFERENCE MAPPING