



Oakford Homes Ltd

Ford Road, Arundel

Flood Risk Assessment & Surface Water Drainage Strategy

133309-R1(1)-FRA



INVESTORS
IN PEOPLE

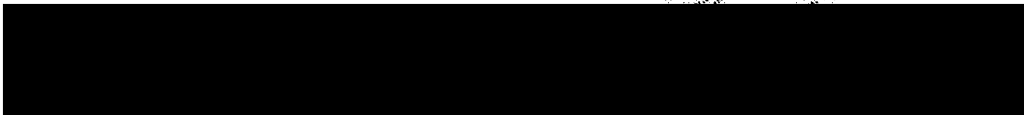
JUNE 2019





RSK GENERAL NOTES

Project No.: 133309-R1(1)-FRA
Site: Ford Road, Arundel
Title: Flood Risk Assessment & Surface Water Drainage Strategy
Client: Oakford Homes Ltd
Date: 5th June 2019
Office: Hemel Hempstead
Status: Final

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Issue No	Version/Details	Date issued	Author	Reviewed by	Approved by
R1(0)	Draft	29.05.19	JL	MEC	MEC
R1(1)	Final	05.06.19	JL	MEC	MEC

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK LDE Ltd.

Oakford Homes Ltd
Ford Road, Arundel
Flood Risk Assessment & Surface Water Drainage Strategy
133309-R1(1)-FRA

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1 INTRODUCTION

RSK Land and Development Engineering Ltd (RSK) was commissioned to carry out a Flood Risk Assessment (FRA) for Oakford Homes Ltd (the 'client'). The assessment is in support of the detailed planning submission for Ford Road, Arundel (the 'site').

The assessment has been prepared in accordance with the National Planning Policy Framework (NPPF) ^(Ref. 1) and its accompanying Planning Practice Guidance ^(Ref. 2), the Interim Code of Practice for Sustainable Drainage ^(Ref. 3), BS 8533-2011 Assessing and Managing Flood Risk in Development Code of Practice ^(Ref. 4), BS 8582:2013 Code of practice for surface water management for development sites ^(Ref. 5) and the Non-statutory technical standards for sustainable drainage systems ^(Ref. 6), with site-specific advice from the Environment Agency (EA), the Lead Local Flood Authority (LLFA), the Local Planning Authority (LPA), the architect and the client.

The NPPF sets out the criteria for development and flood risk by stating that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.

The key definitions within the PPG are:

- "Flood risk" is a combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources; and
- "Areas at risk of flooding" means areas at risk from all sources of flooding. For fluvial (river) and sea flooding, this is principally land within Flood Zones 2 and 3. It can also include an area within Flood Zone 1 which the EA has notified the local planning authority as having critical drainage problems.

For this site, the key aspects that require the assessment are:

- The EA's indicative flood zone map shows that the site is located within Flood Zones 1, 2 and 3; and
- The site area is approximately 0.4ha and therefore surface water drainage should be considered, and sustainable drainage systems (SuDS) incorporated, where possible.

The comments given in this report and opinions expressed are subject to RSK Group Service Constraints provided in **Appendix A**.

2 CONTEXT AND SCOPE OF WORK

A key element of project development is to prepare a FRA to establish the flood risk associated with the proposed development and to propose suitable mitigation, if required, to reduce the risk to a more acceptable level.

The scope of work relating to a FRA is based on the guidance provided in Section 14 of the NPPF ^(Ref. 1) and its accompanying Planning Practice Guidance ^(Ref. 2).

A site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. The scope of this assessment therefore comprises the following elements:

- To review architect plans, planning information and other studies to determine existing site conditions;
- To obtain information on the hydrology and hydrological regime in and around the site;
- To obtain the views of the EA/LLFA including scope, location and impacts;
- To determine the extent of new flooding provision and the influence on the site;
- To assess the impact on the site from climate change effects and anticipated increases in rainfall over a 100 year period for residential uses;
- To review site surface water drainage based on the proposed layout and, if necessary, to determine the extent of infrastructure required; and
- To prepare a report including calculations and summaries of the source information and elements reviewed.

This report is supported by the following additional key reports and information:

- Geoenvironmental Risk Assessment ^(Ref. 7) carried out by RSK;

Reliance has been placed on factual and anecdotal data obtained from the sources identified. RSK cannot be held responsible for the scope of work, or any omissions, misrepresentation, errors or inaccuracies with the supplied information. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

3 SITE DESCRIPTION

3.1 Location

Site Name and Address: Gas Works Site, Ford Road, Arundel, BN18 9DX

Site National Grid Reference: 501282, 106746

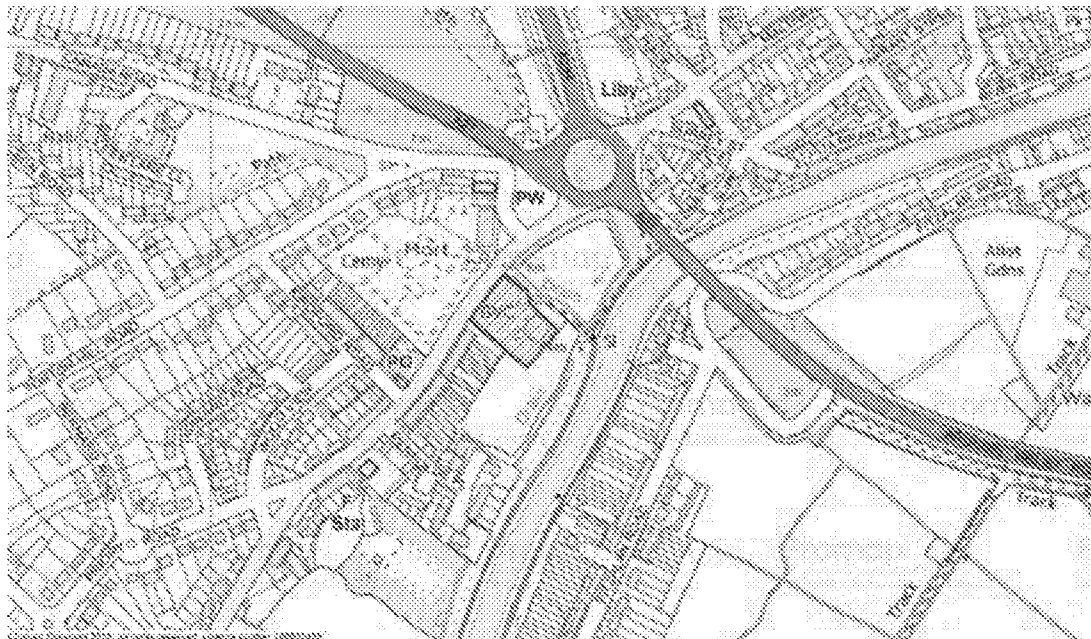
The site is approximately 0.4ha in size and is located on Ford Road, Arundel, West Sussex. The site is surrounded by residential properties and greenfield land.

Table 3.1: Site setting

Direction	Characteristic
North	Ford Road to the northwest, with cemetery beyond. Residential properties with woodland beyond the A27
East	River Arun to the southeast and open grazing land to the northeast
South	Grazing land, with River Arun, residential properties and greenfield land beyond
West	Residential properties

Figure 3.1 shows a site location map.

Figure 3.1: Site location map



3.2 Land use and topography

The site is currently a redundant former gasworks which is heavily overgrown.

The approximate land use of the site is as follows:

Table 3.2: Existing site land uses

Land use	Area (m ²)	Percentage
Impermeable	770	17%
Permeable	3,650	83%
Total	4,420	100%

A site-specific topographic survey has been carried out by Glanville. The survey shows the existing site levels vary from approximately 2.1m above ordnance datum (mAOD) along the southeast boundary to 5.64mAOD in the western corner. The land generally slopes from northwest to southeast, towards the River Arun. The survey shows an elevated concrete platform is located in the southeast of the site at approximately 3.5mAOD (0.5-1m higher than surrounding ground), along with a raised spoil heap. An electricity sub-station is located along the eastern site boundary, near the site access gate.

Levels along the access track to the northeast also mostly fall away towards the River Arun. Ford Road rises from 4mAOD at the access track junction to 5.5mAOD adjacent to the western site corner.

The topographic survey is included in **Appendix B**.

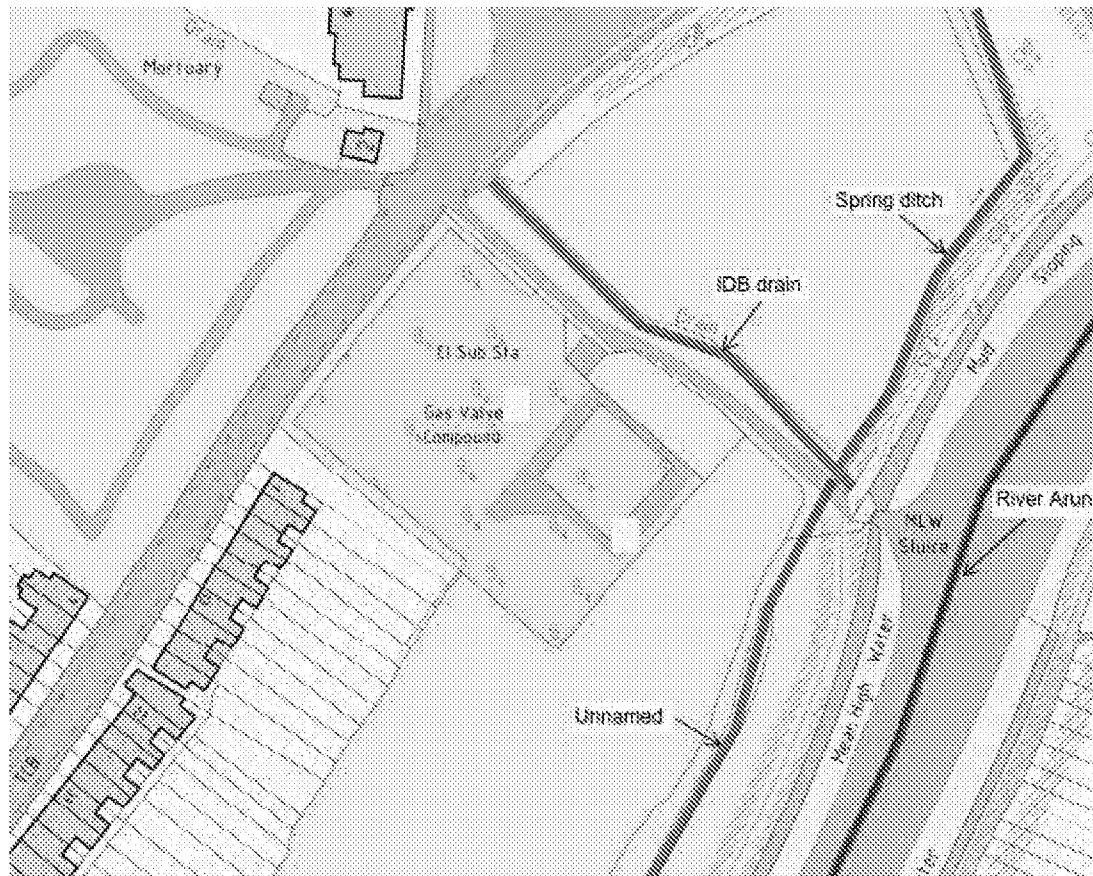
3.3 Hydrology

The nearest EA Main River to the site is the River Arun, situated approximately 40m to the southeast of the site, flowing from north to south towards the English Channel. The River Arun is a tidally influenced watercourse at this location.

There is also a network of drainage ditches in the immediate vicinity of the site. A drain is located alongside the access track beyond the eastern site boundary (IDB drain). It is understood this drain takes flows from land to the northwest, and then passes beneath Ford Road in culvert (450mm diameter). The drain discharges into the River Arun via a sluice gate to the south. A tributary of the River Arun, originating at Park Bottom, flows beneath the main roundabout to the north, before joining this junction into the Arun at the sluice gate (Spring Ditch). An additional drain is located to the southeast of the site, directly parallel to the River Arun, which drains land to the south (unnamed watercourse). Swanbourne Lake is located approximately 1.2km to the north of the site.

A plan of the relevant watercourse features within the site vicinity is included below:

Figure 3.2: Watercourse features



3.4 Geology

Based on published geological records for the area (British Geological Survey online mapping and paper map No. 317/332 – Chichester & Bognor Regis), the site exhibits the following geology:

- Superficial Geology: Raised Marine Deposits – Clay, Silt, Sand and Gravel; and
- Base rock Geology: Spetisbury Chalk member – Chalk.

The nearest BGS borehole to the site is borehole TQ00NW5, located approximately 50m to the northeast of the site. It shows alluvium underlain by chalk.

There are indications of areas of worked ground and made ground within the vicinity of the area with suggestions that made ground may be present in areas of development.

The proposed buildings within the development are largely to be located over areas of previously existing buildings and therefore foundations and other buried features are likely to be encountered.

A Geoenvironmental Site Assessment was produced by RSK carried in May 2019 ^(Ref. 7). The report provides an appraisal of factual information contained in a number of previous reports prepared by Atkins, with a view to identifying potentially complete pollutant linkages that will need to be addressed as part of the development proposals.

No intrusive investigations were undertaken by RSK. The key points related to potential flood risk are highlighted below:

- *“The aforementioned Atkins reports for the site have all been prepared as redacted documents with all associated opinions and interpretation blanked out. In addition to the absence of interpretative information, the reports have all been produced with a view to the site being assessed for a bulk storage end use rather than a more sensitive residential end use as is proposed moving forward”;*
- *“It is envisaged that further works will ultimately be required to fully establish the final remediation requirements. As part of these works, the existing groundwater baseline would need to be re-assessed given that the most recent testing was undertaken in 2012”;*
- *The Atkins 2012 report stated “During the most recent site investigation, the site surface was recorded as comprising approximately 25% tarmac, with the remainder comprising of either gravel, wood chippings or bare earth heavily overgrown with shrubs (e.g. buddleia), semi-mature trees and brambles”;*
- *The report states “The depth to the groundwater table at high tide has been measured (Atkins, July 2011) at approximately 2m AOD, and at low tide at approximately 0m AOD. Water had also been identified in the trial pits during [the] 2011 investigation at depths ranging from 1.3 to 2.65m bgl” and “It is also possible that localised perched water may also be present in the made ground”. The Atkins (2012) report also describes the most recent groundwater monitoring confirming “Groundwater flow at high tide is towards the west/north west, with a reversal in flow direction during low tide (flowing in a south easterly direction towards the River Arun). There is approximately 12.5 hours between peak high tides. The tidal monitoring indicates that there is significant tidal variation in the groundwater level at the site (up to approximately 2 m variance)”;*
- *There is one groundwater abstraction within 1km of the site located approximately 730m to the northwest of the site and two surface water abstractions within 1km of the site;*
- *“The base flow of the River Arun is likely to be recharged by groundwater in the shallow aquifer in the site area. A linkage between the river and any ground or groundwater contamination beneath the site may therefore exist”;*
- *“The environmental database report (Envirocheck report ref. 158393817_1_1, dated 5th March 2018) report that a discharge consents was in place for the site to discharge into the ‘Saline Estuary’ via the drainage ditch on the site’s northern boundary from 1971 to 1996”;*
- *“Surface drainage from the site appears to be discharged into the drainage ditches along the site’s north eastern and south eastern boundaries. The drainage ditch adjacent to the northern site boundary is reported to flow towards the River Arun via a sluice gate (Atkins’ reports). The environmental database report (Envirocheck report ref. 158393817_1_1, dated 5th March 2018) describes this ditch as an inland river, with a length of 186m on the ground surface. It is within the Rother and Arun catchment. A discharge consent is in place for the drainage ditch approximately 40m to the southeast of the intersection with Ford Road. In Harrison & Co.’s 1993 site visit, the presence of ‘a tree lined drainage ditch to the south-east’ was observed, and further describes the drainage thus:
*‘Within the south-eastern drainage ditch water flowed quite rapidly south-westwards from a concrete culvert at the northern end of the ditch. It seems likely that this culvert connects with the sluice gate at the end of the site access land. Between the ditch and the River Arun was a river levee or embankment, 2-3 m high. The face of the embankment was armoured against erosion with concrete blocks’”;**
- *“The results of the permeability testing undertaken during the Atkins’ 2011 investigation were not provided for review”;*

- Previous site investigations undertaken by Atkins show evidence of soil and groundwater contamination; and
- Given the presence of a locally deep made ground profile and widespread contamination attributable to the site's historical land-use, it was concluded that the site would not be suitable for the use of shallow point source drainage features whilst the existing water table would preclude the use of deeper infiltration.

3.5 Hydrogeology

Hydrogeological information was obtained from the online Magic Maps service. These maps indicate that the site is underlain by a Principal bedrock aquifer, defined as *“layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer”*. The maps also indicate that the site is underlain by a Secondary A superficial aquifer, defined as *“permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers”*.

The site is not located within a Groundwater Source Protection Zone. The nearest Groundwater Source Protection Zone is located approximately 680m to the northwest.

The site's close proximity to various watercourses, underlying sand and gravel soils and the results of the site investigation suggest that shallow groundwater will be present beneath the site.

3.6 History

The site was previously used as a gas works. The RSK Geoenvironmental Site Assessment provides a full review of the site history. The report includes review of historical maps dating back to 1840 showing a small gasworks, which expanded over time and was demolished mid-end 20th century.

4 DEVELOPMENT PROPOSALS

The proposed development is for the construction of approximately 38 residential units, in two apartment blocks (2-storey), with associated car parking and areas of communal amenity space. The residential units will be located at upper ground floor level and above, with car parking, cycle and refuse storage at lower ground floor level.

The approximate land uses of the proposed site are summarised in Table 4.1 below.

Table 4.1: Proposed site land uses

Land use	Area (m ²)	Percentage
Impermeable	2,901	66%
Permeable	1,519	34%
Total	4,420	100%

The proposed site plans are shown in **Appendix C**.

5 LEGISLATION AND POLICY CONTEXT

5.1 National policy

Table 5.1: National legislation and policy context

Legislation	Key provisions
National Planning Policy Framework (2018) (Ref. 1)	The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.
Planning Practice Guidance (2014) (Ref. 2)	The NPPF is supported by an online Planning Practice Guidance, which provide additional guidance on flood risk.
Flood and Water Management Act 2010 (Ref. 8)	The Flood and Water Management Act (FWMA) aims to implement the findings of the 2007 Pitt Review and co-ordinate control of drainage and flood issues. There are a number of increased responsibilities within the Act that affect adoption of SuDS features and the role of the EA to expand on the mapping data they provide. The implementation of SuDS features has many beneficial impacts on the treatment of surface water during remediation works.
Water Resources Act 1991 (Ref. 9)	Section 24 – The EA is empowered under this Act to maintain and improve the quality of ‘controlled’ waters Section 85 – It is an offence to cause or knowingly permit pollution of controlled waters Section 88 – Discharge consents are required for discharges to controlled waters
Water Framework Directive (2000) (Ref. 10)	The Water Framework Directive (WFD) requires all inland and coastal waters to reach ‘good’ chemical and biological status by 2015. Flood risk management is unlikely to have a significant impact on chemical water quality except where maintenance works disturb sediment (such as de-silting) or where pollutants are mobilised from contaminated land by floodwaters. The main impact of the WFD on flood risk management, both now and in the future, relates to the ecological quality of water bodies. Channel works, such as straightening and deepening, or flood risk management schemes that modify geomorphological processes can change river morphology. The WFD aims to protect conservation sites identified by the EC Habitats Directive and Birds Directive that have water-related features, by designating them as ‘protected sites’.

5.2 Local policy

Local policies ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and making development safe without increasing flood risk elsewhere and where possible, reducing flood risk.

The adopted Arun Local Plan 2018 contains a number of policies, set out below, that set out the District Council's requirements in respect of planning for flooding and on-site sustainable drainage.

In addition, and in respect of the application site specifically, Policy 4 of the Arundel Neighbourhood Plan 2014-2029 recognises that flood risk is an issue. Whilst the Neighbourhood Plan clarifies that the Sequential Test in respect of flooding was satisfied prior to the allocation of the site, the Exception Test will still apply. This is also largely dealt with by the supporting text of the Neighbourhood Plan although definitive clarity in respect of the test is set out in both Section 8 of this report and also the accompanying Planning Statement prepared by Armstrong Rigg Planning.

Table 5.2: Local policy context

LDF document	Key provisions and policies
ADC Adopted Local Plan 2018 (Ref. 11)	<u>Policy W DM2 – Flood Risk:</u> Development in areas at risk from flooding, identified on the latest Environment Agency flood risk maps and the Council's Strategic Flood Risk Assessment (SFRA), will only be permitted where all of the following criteria have been satisfied: • The sequential test in accordance with the National Planning Policy Guidance has been met; • A site specific Flood Risk Assessment demonstrates that the development will be safe, including access and egress, without increasing flood risk elsewhere and reduce flood risk overall; • The sustainability benefits to the wider community are clearly identified; • The scheme identifies adaptation and mitigation measures. • Appropriate flood warning and evacuation plans are in place; and • New site drainage systems are designed to take account of events which exceed the normal design standard i.e. consideration of flood flow routing and utilising temporary storage areas. <u>Policy W DM3 – Sustainable Urban Drainage Systems:</u> To increase the levels of water capture and storage and improve water quality, all development must identify opportunities to incorporate a range of Sustainable Urban Drainage Systems (SUDS), appropriate to the size of development, at an early stage of the design process. Proposals for both major and minor development proposals must incorporate SUDS within the private

LDF document	Key provisions and policies
	areas of the development in order to provide source control features to the overall SUDS design. These features include: • Green roofs; • Permeable Driveways and Parking; • Soakaways; and • Water harvesting and storage features including water butts. Proposals for major development must also integrate SUDS within public open spaces and roads, reflecting discussion with the appropriate bodies. SUDS must therefore be integrated into the overall design of a development and must: • Contribute positively to the appearance of the area, integrating access to allow maintenance of existing watercourses and the system; • Effectively manage water (including its quality); • Accommodate and enhance biodiversity by making connections to existing Green Infrastructure assets; • Provide amenity for local residents (ensuring a safe environment); • Retain the existing drainage network of the site and the wider area; and • Be maintained in perpetuity, supported through a Maintenance and Management Plan/Regime, including its financing, agreed with the Local Planning Authority. In order to ensure that SUDS discharge water from the development at the same or lesser rate, as prior to construction, developers must: • Follow the hierarchy of preference for different types of surface water drainage disposal systems as set out in Approved Document H of the Building Regulations and the SUDS manual produced by CIRIA; • Undertake up to six months groundwater monitoring within the winter period; • Undertake winter percolation testing in accordance with BRE365; • The proposed drainage system must be designed to ensure that there is no flooding on a 1 in 30 year storm event; and • The design must also take account of the 1 in 100 year storm event plus 30% allowance for climate change, on stored volumes, to ensure that there is no flooding of properties or the public highway or inundation of the foul sewerage system. Any excess flows must be contained within the site boundary, and within designated storage areas.

6 SOURCES OF INFORMATION

6.1 Environment Agency consultation

6.1.1 Flood zone maps

The EA Flood Zone mapping study for England and Wales is available on their website at <https://www.floodzone.gov.uk/>

The current displayed map is reproduced as **Figure 7.1** and shows the site to lie within Flood Zones 1, 2 and 3 showing the site with low to high risk of flooding from fluvial or tidal sources.

In December 2013, the EA released an additional form of mapping 'Risk of Flooding from Rivers and Sea', which is available at:

<https://www.floodzone.gov.uk/risk/>

This map has been reproduced as **Figure 7.2** and shows the EA's assessment of the likelihood of flooding from rivers and the sea at any location and is based on the presence and effect of all flood defences, predicted flood levels, and ground levels.

The relevant guidance note from the EA is available online through the following link:

6.1.2 Site specific consultation

The EA was formally consulted as part of this assessment, with request for flood related information (including flood levels) included in the consultation. Their full response to both the pre-planning enquiry and the flood data request can be found in **Appendix D**. The EA also provided details of their river model of the River Arun, which has been used in this assessment and is discussed further in Section 7.

The Product data request (contained in **Appendix D**) confirms the following points:

- The site is located within Flood Zone 3;
- The EA hold no record of flooding affecting the site however they are aware of localised surface water and groundwater issues in the vicinity of the site;
- There are flood defences in the form of an embankment (EA maintained), which has an estimated level of protection of 1 in 75 years (1.3% AEP). This is located to the southeast of the site adjacent to the River Arun; and
- Flood levels in relation to the site are explored in detail in Section 7.

Further correspondence was held with the EA data team to establish any information about the sluice gate just downstream of the site. Key points from the ongoing correspondence (contained in **Appendix D**) indicates:

- The EA do not hold any height information about the embankment defence along the River Arun as these are EA maintained and not EA owned;

- The EA have confirmed there are three minor watercourses within the site vicinity, in addition to the River Arun (classified as Main River): IDB ditch, Spring Ditch and the backflow from the ditch to the south (shown in **Figure 3.2**);
 - The IDB Drain takes flow from Ford Road and further West towards Torton Hill and outfalls into the River Arun via a 940mm diameter pipe, with a dual flap sluice gate. The EA have confirmed the upstream flap is always open and the spindle can be used to close the gate should the downstream flap fail;
 - The Spring Ditch joins the IDB drain just downstream of the site and is the main inflow from a spring based supply rising from the Downs and partly controlled by Chalk Spring Fishery;
 - The unnamed watercourse is a ditch network flowing south from the sluice gate, running parallel to the River Arun for several miles into farmland. This ditch discharges through tidal outfalls further South, but in high tidal events water will backflow and head northwards back towards the IDB drain;
- *“The latest asset inspection of the sluice and the embankment has been assessed as ‘Fair’ in accordance with the [EA’s] assessment process. The flap valve is subject to a twice yearly inspection and maintenance regime. The rear ‘flood gate’ is maintained in the very same way, however the operation winding spindle was replaced a few years ago to ensure operational needs. At some stage this year we will be undertaking a confined space CCTV inspection of the outfall itself”*
- The EA have confirmed no knowledge of the existing culvert running beneath the site;
- The EA have provided tidal range data, taken from a river level gauge just upstream of the old Arundel road bridge in Queens Street. Values vary from 2.158mAOD (high) to -0.197mAOD (low) in winter and 2.366mAOD (high) to -0.092mAOD (low) in summer. The EA state *“the tidal range is also influenced by the fluvial flow. Sometimes the outfalls cannot fully discharge due to the high fluvial flows. Incoming high tides can also be affected by tidal surge, wind, etc.”*

The initial pre-application response confirms the following points:

- The site is located in Flood Zone 3 and is at risk of flooding from both fluvial and tidal sources;
- The site lies partially within Flood Zone 3b (functional floodplain) and the proposed development would be against the national policy if it is proposed to build within the Flood Zone 3b;
- If the Sequential Test has been successfully applied, then the Exception Test will need to be demonstrated;
- There are two IDB watercourses close to the site. Any works within 5m of these watercourses will require a Flood Defence Consent from the Environment Agency;
- The higher central (45%) and upper central (105%) climate change allowances should be used when assessing flood levels with respect to the onsite topography;
- Mitigation measures should use the worst case scenario between fluvial (1% AEP plus climate change), tidal (0.5% plus climate change), defended and undefended levels;
- FFLs for habitable rooms should be set 300mm above the design flood level plus an allowance for climate change;
- Loss of floodplain storage will need to be assessed within the FRA, and adequate flood plain compensation will be required (detailed requirements provided);
- Soakaways would not be permitted in contaminated ground unless remediation is carried out in those areas; and

- Groundwater is likely to be shallow there though as the site lies on Raised Terrace deposits over Chalk.

Further correspondence was held with the EA to agree the approach for incorporating new climate change allowances into this assessment, and the associated mitigation measures required. The full EA response is also contained in **Appendix D** and confirms the following:

- The intermediate approach to estimate the climate change design flood level is acceptable and so detailed modelling is not required;
- Following calculations put forward by RSK, the following levels have been accepted:
 - 1%AEP (1in100) event plus 45% CC: 3.64mAOD
 - 1%AEP (1in100) event plus 105%: 4.12mAOD.
- *“Using the conservative approach of taking the 105% level to set the minimum FFL at 4.42mAOD would be acceptable”;*
- *“We would not expect to see floor levels raised for non-residential areas such as cycle and refuse storage”;*
- *“We would expect to see floodplain compensation for the fluvial 1%AEP event plus 45%, 3.64mAOD”;*
- *“The FRA needs to show that the development is not increasing flood risk to any existing infrastructure on the site such as electricity substations. However, it would not be expected to actively reduce the risk of flooding to the substation”;* and
- *“The Lower Tidal River Arun Strategy recommended that the defences in Arundel are improved to sustain the current level of protection. We are not currently at a stage where we know when a scheme for the area will be delivered.”*

Further correspondence was held with the EA to agree the principles of specific design measures within the proposals and to agree the approach for floodplain compensation. The full EA response is also contained in **Appendix D** and confirms the following:

- *“In this case the ground floor will not have any habitable accommodation, therefore, on the basis of the information provided, we would have no objection to this being set at 2.8m AOD”;*
- *“We would not expect you to fully protect the ground floor as this will not have any habitable rooms”;*
- The EA have provided comments on the questionable suitability of voids for the purpose of floodplain compensation, due to the potential for blockage. Alternative suggestions were provided. Additional supporting information is contained within Section 10.4;
- *“In regards to Flood Zone 3b, we would expect no development to take place within the extent of Flood Zone 3b”;*
- The infilling of ground at the front entrance to the site to create a more appealing entrance is located outside the 1 in 100 year plus 45% CC flood extent and the EA have confirmed this is acceptable;
- The EA agree with the principle of the flood plain compensation (see Section 10.4);
- We would expect the Flood Risk Assessment to look at all sources of flooding. In particular the site might be vulnerable due to the effects of tide lock; and
- The site is next to an Internal Drainage Board (IDB) ditch. Any works in under or over or within 5 metres of the watercourse bank tops will require the formal consent of the Environment Agency.

6.2 County Council

West Sussex County Council (WSCC) is the Lead Local Flood Authority (LLFA) for the area and was contacted in May 2018 to establish the LLFA's guidance on any constraints related to the site and any historic flooding records. The enquiry and responses can be found in **Appendix E**. The responses confirmed:

- The site lies almost wholly within Flood Zones 2 and 3;
- There may be high groundwater levels due to the proximity of the River Arun; and
- Reference is given to 'West Sussex LLFA Policy for the Management of Surface Water', providing details on SuDS and climate change (details in Table 6.1).

6.3 District Council

Arun District Council (ADC) is the Local Planning Authority (LPA) for the area and was contacted in May 2018 to establish any guidance on any constraints related to the site and any historic flooding records. Multiple responses were received, which be found in **Appendix F**. The responses confirmed:

- ADC do not hold any records of flooding to the site, but do hold records of flooding in other parts of Arundel;
- The site is situated within the functional floodplain and floodplain compensation/raised FFLs will need to be considered;
- Reference is given to 'Supplementary Requirements for Surface Water Drainage Proposals' (details in Table 6.1);
- A small part of the site (2-4m²) is affected by surface water flooding;
- The site is at risk of fluvial and groundwater flooding;
- The EA produced a strategy for the Lower Tidal River Arun (LTRAS) and is currently looking at how best to provide a suitable level of protection to the Town;
- A series of land drains and highway drains discharge into the peripheral ditches, and then into the River Arun;
- ADC suggest following the drainage hierarchy, draining via soakage before watercourse and sewer discharge;
- *"The obvious route for the discharge of surface water would be to the River Arun but you would need to allow for tide locking both now and into the future with climate change allowance";* and
- ADC recommend undertaking groundwater monitoring over the winter period to ascertain worst case conditions and then using that information to guide the percolation rate investigations, FRA & drainage strategy.

Further correspondence was held with ADC to agree the proposed drainage principles and establish allowable discharge rates for the site. The correspondence is also included in **Appendix F** and in summary confirms that an off-site discharge of approximately 4l/s is considered appropriate (further discussion in Section 9).

Further correspondence was held with ADC to establish any information/requirements about the existing culvert crossing the site. The correspondence is also included in **Appendix F** and states *"We would require the watercourse to be left in place or diverted (with permission) unless conclusive evidence is submitted that it is no longer in*

use. The possibility to divert will depend on levels. We would require no buildings to then be located over the watercourse and a 3m easement to be provided."

6.4 Site walkover

A site walkover was undertaken on 7th September 2018. The following key points have been noted:

- The site is very overgrown and appears to have significant areas of hardstanding, although access was restricted;
- There is a drainage ditch to the northeast of the site which is culverted under Ford Road and under the access track to the field to the northeast of the site. Non-return valves were visible on the downstream side of the access track culvert. Standing water was observed at the lower reaches of the ditch, where an EA owned sluice gate was present, providing a controlled outfall to the River Arun;
- No inlet to the ditch was visible during the site walkover, however, subsequent site observations have identified an inlet from the site approximately halfway along the site boundary;
- No manholes were visible on site;
- The path along the River Arun has been artificially raised and is approximately 2m higher than the lowest part of the site;
- Land to the northeast of the site is at a lower level than the site itself;
- Ford Road is at a lower level to the northeast and higher level to the southwest;
- Current level of the existing substation appears to be approximately 100mm above the access gate, therefore the inferred level is approximately ~3mAOD;
- Land within the southeast corner of the site, although heavily vegetated was observed at a raised level (approximately 1m higher than surrounding land); and
- No evidence of recent flooding was observed on site.

6.5 Relevant studies

Table 6.1: Relevant studies

Study	Comments
SFRA: Arun District Council Strategic Flood Risk Assessment 2016 (Ref. 12)	The principle aim of the SFRA was to map all forms of flood risk in order to provide an evidence base to locate new development. It also aims to provide appropriate policies for the management of flood risk, and identify the level of detail required for site-specific FRAs. The SFRA contains information and maps detailing flood sources and risks. Information relevant to the site is detailed in Section 7 of this report.
PFRA: West Sussex County Council Addendum to Preliminary Flood Risk Assessment 2017 (Ref. 13)	Preliminary Flood Risk Assessments are produced by Lead Local Flood Authorities (LLFAs) in England and Wales. A Preliminary Flood Risk Assessment (PFRA) is the first part of the planning cycle for flood risk management as set out in the Flood Risk Regulations (2009), which implement the requirements of the European (EU) Floods Directive (2007). The EU Floods Directive aims to provide a consistent approach to managing flooding across Europe. The PFRA is organised by the River Basin District (in this case the South East River Basin District) and produced by the LLFA (in this

Study	Comments
	case WSCC). The PFRA considers local sources of flooding that the LLFA is responsible for: ordinary watercourses, surface water, groundwater and sewers where flooding is wholly or partially caused by rainwater or other precipitation entering or affecting the system. Information is gathered from existing sources on past floods and flood models to identify Flood Risk Areas. The WSCC PFRA was first produced in September 2011 with an update issued December 2017. The 2017 version does not contain any additional information relating to flooding associated with the Arundel area. The PFRA concludes that the borough did not experience any past floods with "significant harmful consequences" (definition based on EA guidance).
CFMP: Arun and Western Streams Catchment Flood Management Plan 2009 (Ref. 14)	Catchment Flood Management Plans (CFMP) give an overview of the flood risk from inland sources across each river catchment and recommend ways of managing those risks now and over the next 50-100 years. The EA is responsible for producing CFMPs. The site falls within the 'Lower River Arun' sub-catchment and the policy applicable to this site is Policy Option 5 which states "Areas of moderate to high flood risk where we can generally take further action to reduce flood risk". The CFMP provides the following key proposed actions: • Prepare Lower Tidal River Arun Strategy to address the gap in understanding of tidal flood risk in Lower and Middle Arun and tackle the problem of the condition of parts of the river wall through Arundel. This should also address the standard of protection from Arundel to Littlehampton and this may require us to carry out appropriate works to the river wall defences; and • Develop System Asset Management Plans (SAMPs) to review maintenance regimes, taking action to reduce flood risk where appropriate.
SMP: Shoreline Management Plan	Shoreline Management Plans (SMPs) give an overview of the flood risk from coastal sources. The EA and local authorities collaborate to produce SMPs. The site is not covered in a Shoreline Management Plan (SMP) due to its inland location beyond the influence of coastal flooding.
SWMP: Surface Water Management Plan	A Surface Water Management Plan (SWMP) outlines the preferred surface water management strategy in a given location. Surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall. Within West Sussex, SWMPs has been completed for Easebourne, Lancing, Upper Lavent, Lidsey and Manhood Peninsula, none of which cover the site area.
West Sussex Local Flood Risk Management Strategy 2013 (Ref.	The FWMA requires each LLFA to produce a Local Flood Risk Management Strategy (LFRMS) setting out how the LLFA will operate its flood risk responsibilities that are a statutory requirement of the FWMA.

Study	Comments
15)	
Arun District Council Strategic Surface Water Management Study July 2016 (Ref. 16)	The aim of the SSWMS is to identify the impacts of potential strategic housing and employment development sites as identified in the Arun Local Plan. The aim of the study is to identify the potential impacts that the sites would have on surface water and ground water and to identify opportunities for both on site and large-scale strategic off-site surface water management measures to address the likely impacts.
West Sussex LLFA Policy for the Management of Surface Water (Ref. 17)	This policy statement sets out the requirements that the LLFA, has for drainage strategies and surface water management provisions associated with applications for development. For all major developments, the LLFA would expect the scope of the drainage strategy to consider the topics set out in the document and to be consistent with the Sustainable Drainage Systems (SuDS) policies in Sections 5 and 6 of this document. The document includes the following key policies: • SuDS Policy 1 - Follow the drainage hierarchy • SuDS Policy 2 - Manage Flood Risk Through Design • SuDS Policy 3 - Mimic Natural Flows and Drainage Flow Paths • SuDS Policy 4 - Seek to Reduce Existing Flood Risk • SuDS Policy 5 - Maximise Resilience • SuDS Policy 6 - Design to be Maintainable • SuDS Policy 7 - Safeguard Water Quality • SuDS Policy 8 - Design for Amenity and Multi-Functionality • SuDS Policy 9 - Enhance Biodiversity • SuDS Policy 10 - Link to Wider Landscape Objectives
Supplementary Requirements for Surface Water Drainage Proposals (Ref. 18)	This guidance document provides advice from ADC on what should be considered within surface water drainage proposals. This includes guidance on SuDS Selection, infiltration drainage design, restricted discharge, flow exceedance routes, culverting and maintenance/management.
Water. People. Places. September 2013 (Ref. 19)	This guidance outlines the process for integrating sustainable drainage systems (SuDS) into the master planning of large and small developments. The South East Lead Local Flood Authorities expect this guidance to be used as part of the initial planning and design process for all types of residential, commercial and industrial development. It has been developed through a partnership of South East Authorities and it intends to provide a consistent approach to best practice design of SuDS at the master planning stage. The document provides an overview of SuDS features, site specific conditions which will dictate their use and a number of development typologies.

6.6 Drainage

6.6.1 Public sewer

Sewer details have been referenced from sewer record plans obtained from Southern Water (**Appendix G**). The plans indicate the following network of sewers around the site:

- There is a 600mm diameter foul water sewer flowing towards the southwest beneath Ford Road. A 150mm diameter connection spur is located adjacent to the site entrance road. Directly beyond the southwest site boundary, a 100-150mm diameter sewer flows north along the rear of the Ford Road property buildings, before joining the Ford Road trunk sewer. An additional foul sewer (of unknown diameter) appears to flow towards the south through the rear gardens of these properties, with an unknown discharge point. There is a further foul sewer network serving properties to the southwest; and
- A 450mm diameter surface water sewer is located beneath Ford Road, representing the culvert discharging into the ditch alongside the site. This appears to take flows from the residential areas to the north, although connections are not confirmed. A 225mm diameter surface water sewer is also located approximately 60m to the south of the site, discharging into the drain parallel to the River Arun.

6.6.2 Private drainage

No details of the site's existing on-site drainage were provided. It is presumed that drainage from the site either drains naturally to the ground or runs overland into the nearby IDB drain.

Due to an existing culvert thought to be present running beneath the site, a CCTV survey has been undertaken for the site, the report for which is included in **Appendix H** (split into 2, surveyed at two separate times). The CCTV survey indicates there is an existing pipe and culvert running beneath the site from west to east. A 150mm diameter pipe crosses beneath the site along its southwest boundary before upsizing to a 225mm diameter pipe and finally a 900x900mm brick culvert before outfalling into the IDB ditch to the east. This survey appears to show the drain is redundant as the pipe appears to be capped just upstream of the last point of survey. Based on this survey, it is considered possible that the minimal flow detected in this pipe could be from infiltration of groundwater through poor joints and damage to the pipe.

6.6.3 Internal Drainage Boards

The EA inherited the administration of 6 internal drainage districts in Sussex from its predecessors: River Ouse, River Cuckmere and Pevensey Levels in East Sussex and the South West Sussex, River Arun and River Adur in West Sussex. The River Arun is now the only IDD for which the EA Board acts as the internal drainage board. Correspondence with the EA is detailed in Section 6.1.

7 SOURCES OF FLOOD RISK

7.1 Criteria

In accordance with the NPPF ^(Ref. 1) and advice from the EA, a prediction of the flood sources and levels is required along with the effects of climate change from the present for the design life of the development (in this case assumed to be 100 years).

Changes to climate change guidance in February 2016 indicate that increased allowances in peak river flow and rainfall intensity should now be incorporated within any assessment. The appropriate allowance for peak river flow is based on the sites location in the country, the lifetime of development, the relevant flood zone and the vulnerability of the proposed end use.

The flood risk elements that need to be considered for any site are defined in BS 8533 as the “Forms of Flooding” and are listed as:

- Flooding from rivers (fluvial flood risk);
- Flooding from the sea (tidal flood risk);
- Flooding from the land;
- Flooding from groundwater;
- Flooding from sewers (sewer and drain exceedance, pumping station failure etc); and
- Flooding from reservoirs, canals and other artificial structures.

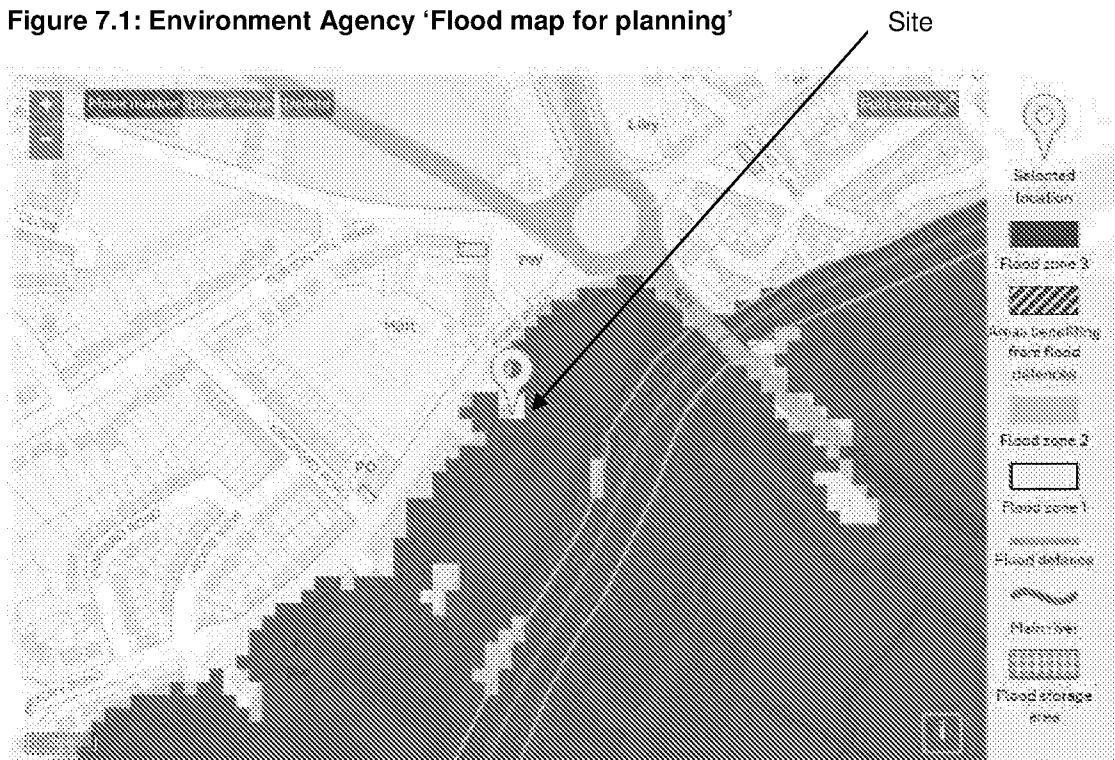
The following section reviews each of these in respect of the subject site.

7.2 Flooding from rivers (fluvial flood risk)

7.2.1 Main River

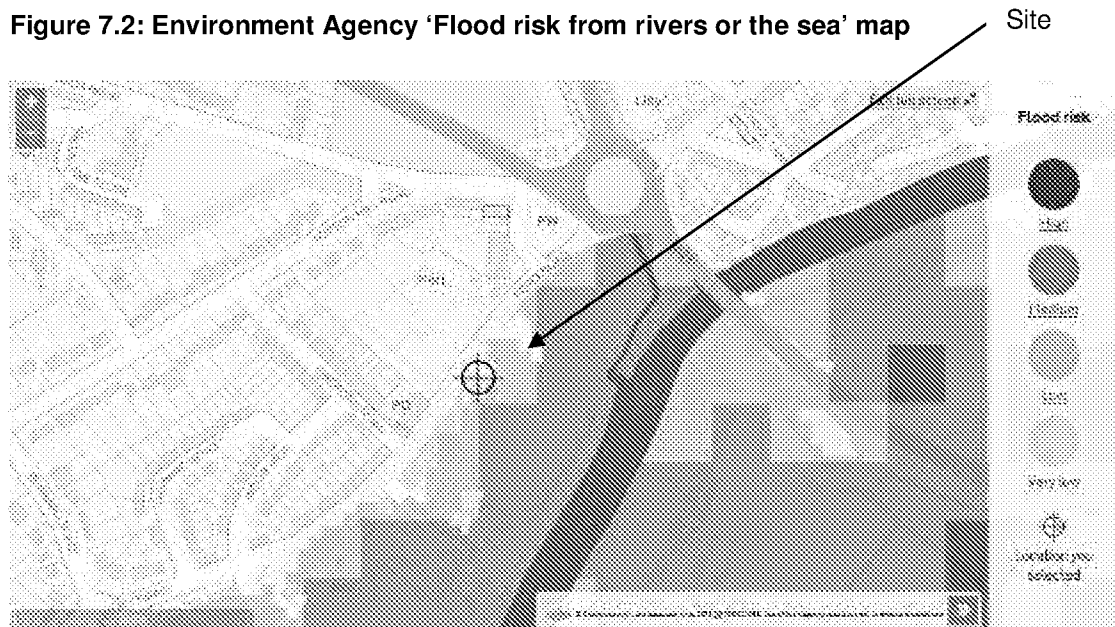
The latest EA published flood zone map (**Figure 7.1**) shows that the site lies within Flood Zones 1, 2 and 3, representing a 1 in 100 year or greater probability of flooding from fluvial sources or a 1 in 200 year probability of flood from tidal sources.

Figure 7.1: Environment Agency ‘Flood map for planning’



The latest ‘Flood risk from rivers or the sea’ map (**Figure 7.2**) indicates that the site is considered to be at ‘low’ to ‘medium’ risk of flooding, taking into account the presence of defences.

Figure 7.2: Environment Agency ‘Flood risk from rivers or the sea’ map



Fluvial flood levels have been supplied by the EA for two nodes on the site, taken from the Lower Tidal River Arun Strategy Study completed by Atkins in 2010 (**Appendix D**). The river levels for key flood events for the worst case node are given in Table 7.1.

Table 7.1: Environment Agency modelled fluvial flood levels for node 1

Annual probability of occurrence				
	5%	1%	1%+CC	0.1%
Undefended	2.25	2.41	3.33	2.65
Defended	2.05	2.50	2.82	2.78

For a 1 in 100 (>1%) year annual probability of flooding the maximum predicted water level is 2.41mAOD. The worst case 1 in 100 year plus 20% climate change water level is 3.33m AOD.

The topographical survey indicates that the lowest ground level on the site is 2.09mAOD, which indicates that the site lies within the fluvial floodplain. As the 1 in 20 year flood level is 2.25mAOD, this also indicates that a very small section along the southn site boundary falls within the fluvial functional floodplain.

The EA detailed flood maps also confirm this, showing that in both the defended and undefended scenarios, part of the site lies within the functional floodplain and in the worst case (undefended), the 1 in 100 year plus 20% climate change flood event extends across the whole site.

A review of the EA data on flood defences indicates that the estimated standard of protection in this area is 1 in 75 years, hence the site is not considered protected up to the design flood level required. As stated in section 6.1.2, the Lower Tidal River Arun Strategy is a proposed new scheme for improved defences in the future but there is no current timescale for delivery and implementation of such defences.

The SFRA mapping shows that the nearest historical fluvial flooding incidents to the site are located approximately 200m to the northwest and 200m to the southeast. It also shows that the site lies within Flood Warning Area 065FWF5005. The SFRA states that Arundel has the highest number of properties at risk of flooding along the River Arun.

7.2.1.1 Increased river levels due to climate change

Consideration has been given to increased fluvial flood levels due to climate change, as per guidance issued by the EA in February 2016 ^(Ref. 20). Correspondence from the EA states that the 'higher central' allowance of 45% and 'upper' allowance of 105% should be assessed with respect to flood levels on site.

Intermediate Approach

The intermediate approach involves extrapolating the stage-discharge relationship at EA node 1. Full calculations are included within **Appendix I**. The stage-discharge relationship yielded flood levels of **3.64mAOD** for the 1 in 100 year plus 45% climate change event and **4.12mAOD** for the 1 in 100 year plus 105% climate change event.

Using these revised climate change levels, it is possible to delineate the floodplain on site, comparing the flood levels against the site-specific topographic levels. The 'upper' allowance of 105% yielded a higher flood level and therefore represents the worst case scenario for the 1 in 100 year plus climate change flood event. The modelled flood level

of **4.12mAOD** was therefore used to map the 1 in 100 year plus 105% climate change outline.

Appendix J shows the delineation of the floodplain on the existing site and indicates the EA flood node used. Due to the comparison of site-specific ground levels, this is a more accurate representation of true flood risk on site.

The plotted outline illustrates that the true extent of the 1 in 100 year plus climate change flood event encroaches onto the vast majority of the site.

7.2.2 Ordinary watercourse

There is a network of drainage ditches located in the vicinity of the site, that could present a secondary fluvial flood risk to the site. Any flooding at the site from these ditches is considered unlikely to inundate the site to levels in excess of those caused by the River Arun. Therefore, the mitigation suggested in Section 10 should provide adequate freeboard in the event of any overtopping from these ditches. Fluvial flood risk associated with these minor ditch features is considered to be low.

The overall risk of fluvial flooding is considered **high** and appropriate mitigation will be required to reduce the risk of flooding (see Section 10).

7.3 Flooding from the sea (tidal flood risk)

In addition to fluvial flooding, the River Arun also poses a tidal threat to the site. Tidal flood levels have been supplied by the EA for two nodes on the site, taken from the Lower Tidal River Arun Strategy Study completed by Atkins in 2010 (**Appendix D**). The tidal flood levels for key flood events for the worst case node are given in Table 7.3 and Table 7.4.

Table 7.3: Environment Agency modelled tidal flood levels for node 1

	Annual probability of occurrence			
	5%	0.5%	0.5% (2115)	0.1%
Undefended	2.67	2.92	3.58	2.98
Defended	-	-	4.02	-

For a 1 in 200 (>0.5%) year annual probability of flooding the maximum predicted water level is 4.02m AOD, for the 2115 scenario (i.e. including climate change).

The topographical survey indicates that the lowest ground level on the site is 2.09mAOD, which indicates that the site lies within the tidal floodplain. As the 1 in 20 year flood level is 2.67mAOD, this also indicates some of the site falls within the tidal functional floodplain.

The EA detailed flood maps also confirm this, showing that in both the defended and undefended scenarios, the 1 in 200 year (2110) flood event extends across the whole site.

As explained in Section 7.2.1.1 above, **Appendix J** shows a detailed delineation of on-site flood levels. This overlay includes the worst case tidal flood level of 4.02mAOD and also the worst case functional floodplain level of 2.67mAOD. The plan indicates that whilst the 1 in 20 year flood outline encroaches on the site itself, its extent is outside the proposed building area.

The SFRA mapping confirms that the site is partially within Flood Zone 3b (functional floodplain).

Tidal flooding is likely to increase as a result of climate change. The EA data includes an allowance for future climate change up to the year 2115.

The overall risk of tidal flooding is considered **high** and appropriate mitigation will be required to reduce the risk of flooding (see Section 10).

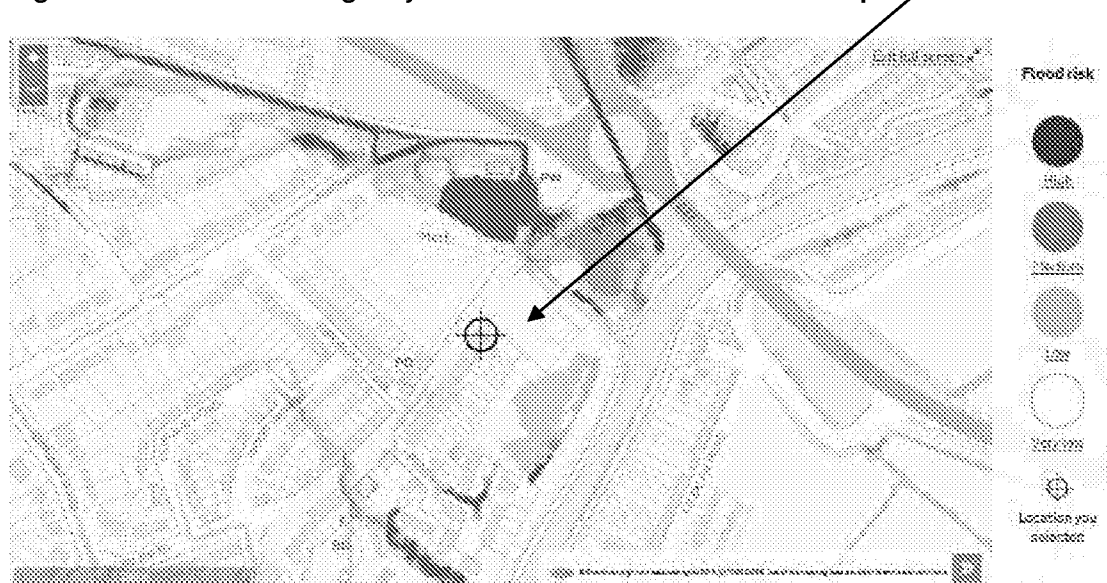
7.4 Flooding from the land (overland pluvial flood risk)

If intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or other watercourse.

Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff can occur. Excess surface water flows from the site are believed to drain naturally to the local water features, either by overland flow or through infiltration.

The EA's surface water flood map (**Figure 7.3**) shows that the site is at 'very low' risk of flooding from pluvial sources. Land to the north is at 'high' risk, and the area of land adjacent to the north-eastern site boundary is at 'low' to 'high' risk of surface water flooding.

Figure 7.3: Environment Agency 'Flood risk from surface water' map



ADC have stated that a small part of the north of the site is considered at risk from surface water flooding, although the site to the northeast is mostly at risk.

The updated 'Flood Map for Surface Water' (FMfSW) contained within the SFRA shows that the site is not at risk of flooding from surface water. The adjacent fields to the northeast and south of the site are both at risk of flooding from surface water. The PFRA has identified a number of clusters considered to have a substantial future flood risk, and the area of Arundel is not located within any of these clusters.

The topography on site shows the site falls away towards the southwest and therefore any surface water runoff will likely fall away in this direction. Any on-site surface water runoff from the site will need to be controlled to prevent surface water flooding elsewhere. This is discussed further in Section 9.

The surrounding topography indicates that land to the west falls towards the site, therefore it is possible that some runoff from the surrounding areas may flow towards the site.

The risk of surface water flooding at the site is considered to be **low**.

Surface water flooding is likely to increase as a result of climate change in a similar ratio to fluvial flooding. Increased intensity and frequency of precipitation is likely to lead to reduced infiltration and increased overland flow. Climate change guidance for rainfall intensity has recently been updated by the EA in late February 2016. Revised allowances for climate change have been included in the indicative drainage strategy herein.

7.5 Flooding from groundwater

Groundwater flooding tends to occur after much longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.

WSCC and ADC have both identified the site is susceptible to high groundwater levels.

The 'Areas Susceptible to Groundwater Flooding Map' (ASfGWF) contained within the SFRA shows that groundwater may emerge in over 75% of the 1km grid square in which the site is situated.

Available geological mapping indicates that the site is underlain by a bedrock of chalk and with superficial clay, silt, sand and gravel deposits. The RSK Geoenvironmental Assessment confirms that the site is underlain by made ground, alluvium and chalk and that the depth to the groundwater table measured by Atkins in 2011 was 2mAOD (high tide) and 0mAOD (low tide). The report also states *"BGS flood data reports that there is potential for groundwater flooding to occur at the surface on the site."*

It is considered likely that perched groundwater may be encountered during the groundworks phase, and therefore could present a risk to the site at the construction stage. During the operational phase, the absence of basement features within the proposals minimises the potential hazards posed by groundwater flooding.

The resultant groundwater flood risk is considered to be **moderate**.

Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. If winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers. This is less likely to cause a significant change to flood risk than from other sources, since groundwater flow is not as confined. It is probable that any locally perched aquifers may be more affected, but these are likely to be isolated. The change in flood risk is likely to be low.

7.6 Flooding from sewers

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. A sewer flood is often caused by surface water drains discharging into the combined sewer systems; sewer capacity is exceeded in large rainfall events causing the backing up of floodwaters within properties or discharging through manholes.

Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption ^(Ref. 21). One of the design parameters is that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30 year rainfall event. By definition a 1 in 100 year event would exceed the capacity of the surrounding sewer network as well as any proposed drainage.

When exceeded, the surcharged pipe work could lead to flooding from backed up manholes and gully connections. This could lead to immediate flooding within highways surrounding the site. As described above, surface water would most likely flow away from the site to the River Arun to the south.

The DG5 register contained within the SFRA shows that out of 315 sewer flooding incidents occurring within the Arun District, 8 of these occurred within the BN18 9 postcode area.

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure.

To ensure that sewer and surface water flooding is not exacerbated; surface water must be considered within the design of the site. This ensures that any additional surface water and overland flows are managed correctly, to minimise flood risk to the site and the surrounding area. The proposed surface water network on the site should be designed to ensure exceedance of the network has been considered.

Given the lack of sewers on the site itself, the resultant sewer flood risk is considered to be **low**.

The impact of climate change is likely to be negative regarding flooding from sewers. Increased rainfall and more frequent flooding put existing sewer and drainage systems under additional pressure resulting in the potential for more frequent surcharging and

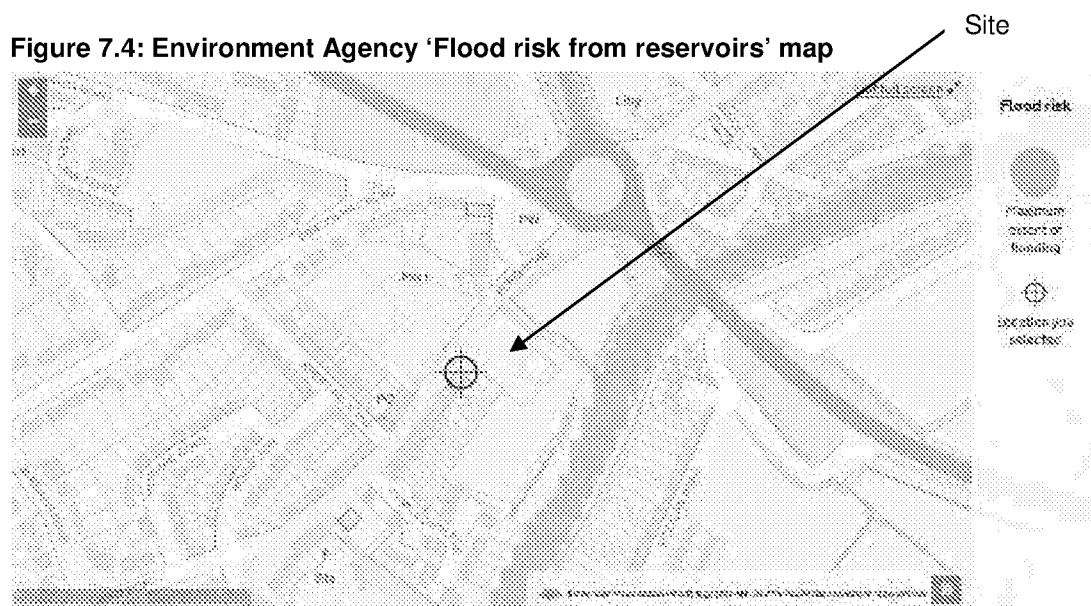
potential flooding. This would increase the frequency of local sewer flooding but would not be significant in terms of the proposed development.

7.7 Other sources of flooding

7.7.1 Reservoirs

Flood events can occur from a sudden release of large volumes of water from reservoirs, canals and artificial structures.

The EA reservoir flood map (reproduced as **Figure 7.4**) shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a worst-case scenario, it is unlikely that any actual flood would be this large. According to the EA Reservoir flood maps the site is not at risk of flooding from reservoirs.



Reservoir flooding is also extremely unlikely. There has been no loss of life in the UK from reservoir flooding since 1925. Since then reservoir safety legislation has been introduced to ensure reservoirs are maintained.

The resultant flood risk is considered to be **low**.

Reservoirs can be managed over time, controlling inflow/outflow of water and therefore there is the capacity to control the effects of climate change. Increased rainfall has the potential to increase base flow, but this should be minimal. It is unlikely that there will be a substantial change to the risk of flooding for this site.

7.7.2 Canals

There are no Canal & River Trust owned canals within the vicinity of the site.

7.7.3 Blockages of artificial drainage systems

There is a possibility that flooding may result due to culverts and/or sewers being blocked by debris or structural failure. This can cause water to backup and result in localised flooding, as well as placing areas with lower ground levels at risk.

The drainage ditch to the northeast of the site is culverted underneath Ford Road and the entrance to the field to the northeast of the site. Therefore, there is the possibility for blockage and overtopping of such features with overflow on to the site. Best practice measures should be incorporated to ensure any culverts on site and within the vicinity are adequately maintained, therefore reducing the risk of blockage.

As detailed in section 6.6.2, there is a pipe and culvert located underneath the site. However, as detailed in that section, the pipe appears to be capped approximately 50m upstream of the site. Therefore, it has been assumed that this connection is abandoned and blockages are considered unlikely.

The risk of flooding from artificial drainage systems is considered to be **low**.

Climate change is unlikely to affect the flooding risk to the site from such blockages.

7.7.4 Tide Locking

Tide locking occurs when a high rainfall event coincides with a high tide rather than a fluvial flood. Tide locking can often be a regular and frequent occurrence. However, the period of tide lock is confined to the peak of the tide and therefore its duration is generally limited and any flooding is both minor and localised.

Given the proposed discharge of surface water into the tidal River Arun, via the nearby sluice gate, tide locking needs to be considered as part of the development proposals. Section 9.4.2 contains further details about how a surcharged outfall condition has been included within the drainage model.

The effect of tide locking could be exacerbated by climate change as a result of more frequent higher tides and increased surface runoff.

7.8 Flood risk resulting from the development

In theory any development can increase flood risk downstream, if it is not designed properly. This potential is much increased where the site is on greenfield land, as development tends to increase impermeable surfaces, resulting in increased runoff from the site.

In contrast, redevelopment of brownfield sites may offer opportunities to reduce peak runoff, as well as removing connectivity to foul or combined sewerage systems, with consequent benefits for reducing sewer flooding and the potential of pollution from combined sewer overflows.

The proposed development will use the latest best practice guidance to ensure that flood risk is not increased as a result of the development. This will require the provision of a suitable surface water management plan to ensure that the surface water generated from the site does not exceed the pre-development rates; this is investigated further in Section 9 of this report.

8 PLANNING CONTEXT

8.1 Application of planning policy

Section 14 of the NPPF includes measures specifically dealing with development planning and flood risk using a sequential characterisation of risk based on planning zones and the EA Flood Map. The main study requirement is to identify the flood zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

8.2 Land use vulnerability

Planning Practice Guidance (PPG) includes a list of appropriate land uses in each flood zone dependent on vulnerability to flooding. In applying the Sequential Test, reference is made to Table 8.1 below, reproduced from Table 3 of PPG.

Table 8.1: Flood risk vulnerability and flood zone 'compatibility'

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

With reference to Table 2 of the PPG, the proposed development, based on its residential end use, is classed as 'More Vulnerable'. This classification of development requires the Exception Test to be passed in Flood Zone 3a. As shown in **Appendix J**, the proposed building footprint lies outside of the functional floodplain outline.

8.3 Sequential Test

The Sequential Test is required to assess flood risk and the PPG recommends that the test be applied at all stages of the planning process to direct new development to areas with the lowest probability of flooding (Flood Zone 1).

A review of the Sequential Test background has been undertaken by Armstrong Rigg Planning. It concludes that the Sequential Test does not need to be satisfied as the site

has been selected as an Allocated Site as part of the Arundel Neighbourhood Plan. The review states *“Land at Ford Road is identified for future allocation through plan review, following the flood risk Exception Test being passed, and subsequently to be delivered in the period 2020-2029” and “a sequential test document will not be required in support of any future planning application at the site. It is, however, acknowledged that any development will still need to pass the exception test relating to the demonstration of public benefit and future resilience against flood risk.”*

It is confirmed in both the Neighbourhood Plan and once again in the Officer response to the recent pre-application enquiry that the sequential test has been passed due to the allocation of the site within the Neighbourhood Plan.

8.4 Exception Test

The stipulations of the Exception Test (reproduced from Section 14, Paragraph 102 within NPPF), both of which will have to be passed for development to be allocated or permitted, are:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared;
 - The development will provide additional housing to the area in keeping with the local housing policies and bringing long term derelict, heavily contaminated land back into use;
 - The development will provide controls on surface water drainage, thereby reducing the risk of flooding to the surrounding area;
 - Community open space is to be provided in the west and east of the site, providing amenity to the local residents;
 - As clarified within the adopted Neighbourhood Plan development will deliver important community benefits by removing a prominent and long-term derelict site within a residential area;
- A site-specific FRA must demonstrate the development will be safe for its lifetime taking into account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.
 - The design will incorporate mitigation measures (see Section 10 for details) which will improve flood risk on site;
 - The ground floor will be set at 2.8mAOD, which is below the predicted fluvial and tidal flood levels. The majority of this floor will be allowed to flood except the stairwells, which will be constructed to be flood resistant. Residential accommodation will be provided at first floor level and above at 5.3mAOD, which is 1.18m above the worst case predicted flood level;
 - Safe refuge will be available onto Ford Road. This will be via a ramp from the first floor level of the block to the front of the development (closest to Ford Road). Egress from the rear block will be available via a raised access deck to the front block. Site users at ground floor level in the event of a flood can escape to first floor level via an internal staircase in each block; and
 - Floodplain compensation will be provided where built footprint encroaches into the floodplain to avoid any increase in flood risk elsewhere.

9 SURFACE WATER DRAINAGE ASSESSMENT

9.1 Scope

The EA requires new development to focus on the management of surface water run-off. This section discusses the potential quantitative effects of the development on both the risk of surface water flooding on-site and elsewhere within the catchment, as well as the type of potential SuDS features that could be incorporated as part of the masterplan.

The NPPF states that SuDS should be considered wherever practical. The use of SuDS is also encouraged by regional and local policy (see Section 5). In accordance with the Defra Non-Statutory Technical Standards, the surface water drainage strategy should seek to implement a SuDS hierarchy that aspires to achieve reductions in surface water runoff rates to greenfield rates. Where a reduction to the greenfield rate is not practicable, the proposed surface water drainage strategy should not exceed the existing runoff rate.

In addition, Building Regulations Part H (Ref. 22) requires that the first choice of surface water disposal should be to discharge to an adequate soakaway or infiltration system, where practicable. If this is not reasonably practicable then discharge should be to a watercourse, the least favourable option being to a sewer (surface water before combined). Infiltration techniques should therefore be applied wherever they are appropriate.

Key criteria and policies of both the 'West Sussex LLFA Policy for the Management of Surface Water' (Ref. 17) and 'Supplementary Requirements for Surface Water Drainage Proposals' (Ref. 18) have been considered.

9.2 Pre-development situation

The existing site area is 0.4ha and 18% impermeable.

The pro-rata IoH 124 method (Ref. 23) has been used to estimate the Greenfield surface water runoff for the site. Calculations are contained in **Appendix K**.

Table 9.1: IOH 124 surface water runoff (greenfield)

Return period	Peak flow (l/s)
QBar	0.9
1 in 1 year	0.8
1 in 30 year	2.1
1 in 100 year	2.9

As a developed site, the pre-development surface water runoff from the site has been calculated for a range of return periods using the Modified Rational method. The Modified Rational method uses the following equation to calculate peak runoff rate from an area:

$$Q = 2.78 C_v C_r i A$$

Where:

2.78 = Coefficient which accounts for the differences in units used for the inputs and the outputs of the equation.

C_v = Volumetric Runoff Coefficient - a co-efficient that describes the proportion of rainfall appearing in the surface water drainage system, assumed to be 0.95 for impermeable areas

C_r = Routing Coefficient - a routing co-efficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner, assumed to be 1.3 for urban areas

i = Rainfall Intensity (mm/hr) based on a 1 hour rainfall event

A = Area (ha)

Table 9.2: Modified Rational Method pre-development surface water runoff

Return period	Rainfall intensity (mm)	Peak flow (l/s)
QBar	15.15	4.0
1 in 1 year	11.68	3.1
1 in 30 year	35.46	9.4
1 in 100 year	45.33	12.0

Rainfall data has been taken from the Depth Duration Frequency rainfall calculator contained within the FEH 2013 web service, with the associated screenshots included in **Appendix K**.

9.3 Off site discharge options and limits

9.3.1 Infiltration

Infiltration should be considered as the primary option to discharge surface water from the developed site. The effectiveness of infiltration is completely dependent on the physical conditions at the site. Potential obstacles include:

- Local variations in permeability preventing infiltration – It is understood from the local geology and site investigations that the site is situated on an area of Raised Marine Deposits, which is not considered suitable for the use of soakaways due to its low permeability;
- Shallow groundwater table - For infiltration drainage devices, Building Regulation approved document H2 states that these “*should not be built in ground where the water table reaches the bottom of the device at any time of the year*”. The

Geoenvironmental Report ^(Ref. 7) indicates a high water table which potentially further limits soakage potential; and

- Source Protection Zones - As discussed in section 3.5, the site is not located within a Groundwater Source Protection Zone.

From the information available in the Geoenvironmental Report, infiltration is not considered a viable option as part of the drainage strategy.

Groundwater levels beneath the site are highly variable owing to the presence of a circa 2m tidal variation. As such, any variability in groundwater levels is likely to be controlled by daily tidal variations with seasonality likely to have little or no impact upon the shallowest depths at which groundwater will be recorded.

9.3.2 Discharge to watercourse

Given that infiltration is likely to be unsuitable for the site, the next option is to discharge surface water to a local watercourse. This is considered to be feasible as there is a ditch located approximately 5m to the northeast of the site with connectivity to the River Arun. As stated in Section 6.3, the site has previously received consent to discharge surface water into the ditch.

Due to the potential shallow groundwater and close proximity of the drainage ditch, it is proposed to discharge to this watercourse. As stated in Section 3.4, a previous discharge consent was historically present for the site, for discharge into this adjacent ditch, therefore a proposed watercourse connection would mimic the existing scenario.

Guidance given in the EA report, 'Rainfall Runoff Management' for Developers' ^(Ref. 24), states *"Small sites would require impractically small controls to achieve the required flow rates where these are calculated to be less than 5 l/s."*

As the QBAR Greenfield runoff rate has been calculated as 0.9l/s, this falls below this threshold and therefore it is reasonable to discharge at the existing QBAR rate of 4l/s, as the site has previously been developed.

As stated in Section 6.3, ADC have confirmed this is an acceptable discharge rate for the site. Correspondence with ADC is contained in **Appendix F**.

Access rights to cross the entrance road (which lies outside the red line boundary) will need to be negotiated in order to discharge into the existing ditch.

9.3.3 Discharge to surface water sewer

Due to the lack of surface water sewers within the immediate vicinity of the site, it is not considered feasible to discharge surface water to a sewer.

9.4 Post-development situation

The proposed development is approximately 66% impermeable, which will result in an increase in surface water across the site. It will therefore be necessary to manage surface water on-site in order to limit the discharge of surface water off-site to an agreed rate (as above), to provide sufficient on-site attenuation up to the 1 in 100 year climate change rainfall event and to provide improvements to water quality through appropriate source treatment.

9.4.1 Storage estimates

To determine the approximate volume of attenuation storage that would be required on the site, the WinDes 'Quick Storage' calculation has been used. WinDes 'Quick Storage' calculations provide a range of volumes as an approximation of the storage requirement. These volumes can be later revised at detail design stage by the introduction of specific flow control methods.

It is intended that surface water runoff from the proposed development will be discharged to the drainage ditch to the northeast. Calculations have been run using a discharge rate of 4l/s and an impermeable area of 2901m². No allowance is included in the calculations for infiltration and therefore the results illustrate a worst-case scenario. Calculations can be found in **Appendix K**.

Table 9.3: Quick storage estimates

Return period	Quick Storage volume (m ³)
1 in 30 year	63 - 99
1 in 100 year	92 - 138
1 in 100 year + 40% CC	142 - 214

The storage required on-site to accommodate the 1 in 100 year plus 40% climate change rainfall event is in the range of 142 - 214m³. This is further refined by producing a detailed model for the site, see below.

9.4.2 Proposed drainage strategy

In principle, the strategy contains the following features and criteria:

- It is considered likely that infiltration techniques will not be suitable on site due to the high groundwater and potential contamination on site;
- A modular storage tank has been located within the car parking area. It should be noted that in areas of high groundwater levels, these tanks may need to be lined to prevent groundwater ingress. Floatation issues should also be considered at the detailed design stage;
- Rainwater harvesting is not proposed as part of this development and therefore has not been included as part of any of the calculations. Green roofs are not considered viable due to the pitched roof proposals;
- The 'Surcharged Outfall' feature of MicroDrainage has been used in order to account for the tidal nature of the river Arun (to address tide locking). Tidal range figures have been supplied by the EA and it has been assumed that the tide is on a 12 hour cycle; and
- Petrol interceptors will be installed within the roads and parking areas in order to prevent hydrocarbon pollution.

The proposed SuDS strategy is to attenuate surface water within a 385mm deep modular storage tank (comprising two layers of Permavoid 150mm crates and one layer of Permavoid 85mm crates). This has been located based on the position of proposed buildings.

Groundwater levels for the site are known to be high. Therefore, Permavoid crates, which require a shallower build-up than other attenuation crates, have been used in order to increase the zone available to locate attenuation crates.

Crates have been utilised rather than permeable paving as the permeable paving sub-base would not be able to provide the volume of attenuation required in the available depth.

The proposed SuDS features are designed to provide approximately 151m³ of storage. This figure is based on a detailed MicroDrainage model and, as such, is lower than the maximum volume shown in Table 9.3, as 'Quick Storage' estimates generally provide a fairly conservative estimate of the volume required. The SuDS measures are outlined in the Indicative Surface Water Strategy as attached in **Appendix L**.

As the site is entirely located within the floodplain there is no viable alternative to store surface water runoff in an area outside the fluvial/tidal floodplain. The attenuation storage has been sited outside of the functional floodplain (1 in 20 year flood extent). It should be noted that, for many of the smaller return period rainfall events, tidal/fluvial floodwaters are unlikely to be present on site and therefore the surface water attenuation will operate as expected. The peak storm events and the peak fluvial/tidal flood events also don't necessarily coincide and therefore the majority of storm events will be adequately accommodated within the below ground storage before fluvial and tidal peaks. At times where the fluvial/tidal events do occupy the site, the relatively small surface water volumes from this 0.4ha site are considered negligible in comparison to the large fluvial/tidal water volumes and therefore considered unlikely to significantly impact on flood risk in the wider area.

The dimensions, volumes and location of the SuDS features will need to be revised during the detailed planning stage. Detailed design of individual features is not part of the scope of this report. Preliminary design criteria have been based upon guidance given in the CIRIA publication 'The SUDS Manual' (Ref. 25).

In line with the 'West Sussex LLFA Policy for the Management of Surface Water' (Ref. 17) and 'Supplementary Requirements for Surface Water Drainage Proposals' (Ref. 18), exceedance flow routes have also been considered, as shown in **Appendix L**. It has not been considered necessary to consider urban creep within any drainage calculations, due to the apartment block nature of the site and therefore the limited possibility of any future expansion of hard surfaces.

The SuDS features have a preliminary design to accommodate the outfall from all rainfall events up to the 1 in 100 year plus 40% climate change event.

Temporary drainage should be established for the construction phase of development to prevent silt mobilisation, potentially impacting on flow regimes and silt pollution downstream. The construction of SuDS should be considered in the early stages of site design.

9.4.3 Adoption and Maintenance

Maintenance of SuDS features should be undertaken in line with maintenance schedules outlined in the SuDS Manual (Ref. 25). An example of typical maintenance regimes for modular storage can be found in **Appendix M**. Full maintenance schedules should be confirmed at the detailed design stage in consultation with appropriate product suppliers.

An estate management company will be set up and SuDS maintenance will be part of their remit.

9.4.4 Water quality

The SUDS Manual contains guidance on how to assess water quality, stating *“Determining the hazard posed by the land use activities at a site and the extent to which underlying soil layers and/or proposed treatment components reduce the associated risk can be done using a variety of methods that vary in complexity and data requirements.”*

In accordance with Table 4.3 of the SuDS Manual, the proposed development for the site can be summarised with the following pollution hazard levels and management requirements for discharge to the receiving surface water (there will be no infiltration on site, therefore receiving groundwater is not considered here):

- Residential roofs – **Very Low** Pollution Hazard – Simple Index Approach; and
- Individual property driveways, roofs, residential car parks, low traffic roads, non-residential car parking with infrequent change (schools, offices) – **Low** Pollution Hazard – Simple Index Approach.

It is therefore considered appropriate to use the Simple Index Approach for the purpose of this assessment.

Table 26.1 of the SUDS Manual indicates that, for the Simple Index Approach, simple pollution hazard indices should be based on land use (eg, Table 26.2). An extract of Table 26.2 is replicated below, highlighting the relevant features applicable to this site:

Table 9.4: Extract of SuDS Manual Table 26.2: Pollution hazard indices for different land use classifications

Land use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, roofs, residential car parks, low traffic roads, non-residential car parking with infrequent change (schools, offices)	Low	0.5	0.4	0.4

In order to prevent hydrocarbons entering the watercourse, petrol interceptors will be installed within the roads and parking areas. No further SuDS features were feasible to include within the drainage strategy due to the site constraints including fluvial/tidal floodplains, high groundwater levels and lowered ground levels.

10 FLOOD MITIGATION MEASURES

Given the site's position within the floodplain, it is considered prudent to incorporate a variety of flood mitigation measures to ensure the development does not have a detrimental impact on flood risk to the site and wider environment, whilst also making sure that the intended users are safe for the lifetime of the development.

10.1 Overland flood flow

No further overland flow control measures are proposed as all surface water runoff up to the 1 in 100 year climate change storm will be stored on site and discharged to the nearby drainage ditch. Surface flows may be generated due to drainage capacity exceedance, which can be conveyed into the SuDS features.

10.2 Finished floor levels

Proposed finished floor levels for the lower ground floor will be set below the 1 in 100 year plus climate change design flood level. Therefore, its use will be restricted to refuse and cycle storage, car parking and void space only. All space on this floor will allow water to pass through in the event of a flood, except the stairwells, which will be constructed to be flood resistant.

In addition, the finished floor levels for all residential accommodation will be set at the first floor at 5.3mAOD, which is 1.18m above the 1 in 100 year plus climate change designed flood level.

As per the correspondence contained within **Appendix D**, the EA have confirmed this is acceptable.

In terms of the construction of the development, reference should be made to "Preparing for Floods" a DEFRA publication ^(Ref. 26), CIRIA guidance C624 "Development and flood risk" ^(Ref. 27) and the CLG document "Improving the flood performance of new buildings" ^(Ref. 28).

10.3 Watercourse easements and consents

Under the Water Resources Act 1991 and associated byelaws, works in, over, under or adjacent to Main Rivers require the consent of the EA and works in, over, under or adjacent to Ordinary Watercourses will require IDB, Local Authority or LLFA consent. This is to ensure that they neither interfere with the IDB/EA/LPA/LLFA's work nor adversely affect the environment, fisheries, wildlife and flood defence in the locality.

Off-site watercourses

Due to the presence of the Ordinary Watercourses within the vicinity of the site, it is likely that the EA/LLFA will require consent for any works within the proximity of the watercourse and may also require specific easements for these watercourses.

The 'Supplementary Requirements for Surface Water Drainage Proposals' document provided by the Local Authority (ADC) confirms *"Land Drainage Consent must be sought from the Lead Local Flood Authority (West Sussex County Council), or its agent (Arun District Council – land.drainage@arun.gov.uk), prior to starting any works (temporary or permanent) that affect the flow of water in the watercourse" and "Ditches and watercourses (including culverts) should retain a three metre easement with access that allows for its future maintenance"*.

With regards to the Spring Ditch, IDB ditch and "backflow" ditch, these features are considered to be within the EA's remit and the EA's guidance states *"Any works within 5m of these watercourses will require a Flood Defence Consent from the Environment Agency."*

The development proposals are more than 5m from each of these watercourse features. Therefore, the only works likely to require formal Flood Defence Consent are any new outfall works for the site's proposed surface water drainage strategy.

Any consent works usually take place post planning, prior to construction, however, the principals of any development within the appropriate easements should be agreed at the planning stage.

Existing culvert on-site

Correspondence with Arun DC has concluded that the watercourse should be left in place or diverted (with permission) with an associated 3m easement provided, unless conclusive evidence is submitted that it is no longer in use. The EA have confirmed they would agree with this ADC advice.

The drainage survey contained in **Appendix H**, appears to show the upstream drain is redundant as the pipe appears to be capped just beyond the last point of survey upstream. It is therefore proposed the existing feature should be abandoned and will not need to be diverted through the proposed development.

Further detailed investigation works may be required to ensure no current function of this feature and if any intentional inflows are found, further works may be required to divert such as part of the development.

The presence of the River Arun (Main River) local to the site, would also require any works within 8m to be formally approved by the EA. Given the distance from the River Arun is in excess of this, no formal consent is likely to be required relating the River Arun.

10.4 Flood compensation

The EA pre planning response states *"We would expect to see floodplain compensation for the fluvial 1% AEP event plus 45%, 3.64mAOD"*. This will need to be provided on a level-for-level basis.

Level for level analysis of the existing and proposed site layouts has been undertaken to ensure that there is no net loss of floodplain compensation storage up to the 1 in 100 year plus 45% climate change flood level of 3.64mAOD. All floodplain compensation will provide level-for-level storage (for every 200mm slice of floodplain, in line with the latest

EA advice) and connectivity will be available from the floodplain to all the allocated compensatory storage areas. This is in line with the standard approach and guidance provided by the EA.

The results of this exercise are shown in **Appendix N**. The proposed floodplain compensation extents plan shown on **Appendix N** indicates that by considering the existing elevated features (concrete platform, spoil heap and electricity substation) and the proposed flattening and lowering of the site, in effect, more floodplain storage will be available post-development. The tables on **Appendix N** demonstrate this floodplain compensation calculation balances to within a reasonable margin.

In essence, the plan shows:

- The 1 in 100 year plus 45% climate change flood is shown in light blue;
- The areas to be protected from floodwaters at the lower ground level are those shown in dark blue (including the wall volumes), amounting to 69.5m³ (Table 1). The remaining areas at lower ground floor (parking, void areas, cycle and refuse storage) will all be allowed to flood. This lower ground floor will be designed with wall openings and grilles to allow floodwater to flow freely, shown on the compensation drawing;
- The two existing raised areas (concrete platform and spoil heap) and existing substation slab are shown in green, which when removed back to existing ground levels (~3mAOD), will amount to 222m³ of recoverable volume (Table 2);
- The proposed areas of floodplain that will be gained as a result of changing levels are shown in pink, offering additional compensatory storage of 89.7m³ (Table 3).

The analysis shows that the existing structures (recoverable volumes) and the small areas of reprofiled levels accommodate a volume that is in excess of the proposed displaced volumes, and this is demonstrated for each 200mm slice.

As indicated in **Appendix D**, the EA have confirmed acceptance of the above approach on floodplain compensation.

As the proposed residential units are raised to upper ground floor level to mitigate the risk of flooding to properties, a large proportion of the lower ground flood will be designed as undercroft. The proposed design includes grille entrances to allow free flowing water to flow beneath the structure in large storm events. The voids will be constructed as per standard EA guidelines indicating the following requirements:

- Fully open void space underneath the building;
- Void opening heights should be at least the height of the 1% plus additional relevant climate change allowance;
- Void openings should be a minimum of 1m wide;
- At least one void opening should be located in every 5m of wall section;
- Bars can be incorporated at 100mm intervals for security reasons if needed; and
- Typically require a legal agreement/planning condition/maintenance plan to ensure they remain open for the lifetime of the development.

As stated in Section 6.1.2, the EA have indicated concerns about the use of 'voids' due to the risk of blockage. The proposals have been maximised to incorporate as much open space within the undercroft areas, consisting mostly of refuse/cycle stores, central cores and as much open car parking as considered possible for tracking and access

purposes. The remaining areas will be enclosed with a mixture of large grille openings and openings within structural walls to allow floodwaters to pass freely across the floodplain. It is worth noting that, of the undercroft areas, more than 50% will be utilised for other accessible uses. The undercroft/‘void’ areas are not utilised for the purpose of compensating any loss of floodplain, as this is shown to be offset by existing built footprint areas and minor proposed land reprofiling (see **Appendix N** and details above).

Voids would be maintained in perpetuity by a management company, to ensure compliance. The Management company will be set up for the site to manage the external works and drainage features. A management plan should be developed for approval by the planning authority, detailing all elements of the works to be carried out and their frequency.

10.5 Safe access/egress

In the event of a fluvial or tidal flood event, site users will be afforded dry access onto Ford Road via the raised access deck connecting the two blocks. Residential units are only located from first floor upwards and are therefore considered at a lower risk.

The EA’s flood map, as reproduced in **Figure 7.1**, shows that the vast majority of land to the south is within the floodplain associated with the River Arun, however, Ford Road remains within an area of lower risk (Flood Zone 1). In the event of a major flood, site users would simply need to exit the site onto Ford Road and turn left (southwest) following Ford Road to higher ground.

Safe access and egress routes should be assessed in accordance with the guidance document ‘FD2320 Flood Risk Assessment Guidance for New Developments’ (Ref. 29). As the proposed lower ground floor has a ground level of approximately 2.8mAOD, the predicted 1 in 100 year (45%) climate change flood level of 3.64mAOD would indicate flood depths on site up to approximately 0.84m. Even assuming a low velocity of floodwater of between 0 and 0.5m/s in the vicinity of the site, according to Table 13.1 in FD2320 (Ref. 29), this will still represent “danger for most”.

Site users at lower ground floor level can escape to the access deck at first floor level via an internal staircase. The central access cores will be protected by flood doors installed to prevent water entering. Standard flood doors mainly have designs to protect up to 600mm, whereas flood depths in such areas would likely exceed this in large flood events. Whilst not fully protecting the lower ground level against the extreme events, this would protect against the lower return period events up to the 1 in 100 year plus 20% climate change (3.33mAOD).

Therefore, in the event of a flood there should be no increased impact on potential emergency services. In addition, the proposed buildings have raised finished floor levels and upper floor refuge. Appropriate signage will be incorporated into the new development warning people of the flood risk and identifying areas of floodplain.

10.6 Flood management plan

The site is located within Flood Zone 3. As it is shown that the site is at high risk of fluvial, tidal and groundwater flooding, it is considered prudent to consider the implementation of a flood management plan.

The SFRA mapping shows that the site is located within the Flood Warning Area 065FWF5005. The EA charter is to provide a minimum 2 hours advance warning, which would provide sufficient time for site users within the development to be evacuated to an area of safe refuge (Ford Road).

However, it is recommended that future users of the site ensure they are registered with the EA's Flood Warning system (Floodline Warning Direct) to provide adequate forewarning in the event of a predicted flood in the neighbourhood in order to decrease the overall risk to a 'safe' level.

If deemed necessary by the Local Authority a Flood Management Plan and a flood evacuation plan should be developed for future users, which should highlight the extent of the floodplains surrounding the site and highlight the safest route of escape in the event of extreme flooding occurring. It should also include the contact details of the relevant emergency services

10.7 Flood resistance and resilience measures

As stated within Section 10.5 above, the lower ground floor level will be set below the 1 in 100 year plus climate change fluvial and tidal flood levels. Therefore, as a precautionary measure, during the detailed design process, it would be prudent to consider the use of flood resistant and resilient techniques such as those described below where possible. This would ensure that the future residential dwelling is resistant to flooding.

- Flood Resistant measures – methods to prevent floodwater reaching or entering properties
 - As mentioned above, flood doors to be installed at central access cores;
 - Demountable flood barriers to be installed across airbricks and doorways;
 - Bespoke flood skirts to be installed surrounding the property walls;
 - Permanent low bunds may provide restricted flow towards buildings acting as an effective local flood defence, subject to approval from planning authority and the EA;
 - Using external waterproof wall render for external walls;
 - Provision of non-return valves for all private connections points into the public combined sewer system to minimise the risk of backflows entering the property during overloading of the public sewer system following extreme rainfall events; and
 - Temporary airbrick covers and airbrick membrane covers can be manually installed in advance of flood events or periscope (raised) airbricks used where feasible.
- Flood Resilient measures – methods to minimise damage caused by floodwaters
 - Raised services - advisable to install electrical wall sockets and domestic appliances at elevated wall levels, above flood levels;
 - Internal doors may be replaced with water resistant plastic or acrylic doors;

- Internal waterproof wall render and internal waterproof coating for any ground level fixings;
- A Damp Proof Membrane would reduce the turnaround time for returning the property to full operation after a flood event; and
- The ground floor could be concrete in order to minimise damage and reduce the turnaround time for returning the property to full operation after a flood event.

In terms of the construction of the development, reference should be made to “Preparing for Floods” a DEFRA publication (Ref. 26), CIRIA guidance C624 “Development and flood risk” (Ref. 27) and the CLG document “Improving the flood performance of new buildings” (Ref. 28).

It should be noted that, as part of the development proposals, the electricity substation has been relocated to an area of higher ground, off Ford Road. **Appendix N** indicates this area is above the realigned fluvial floodplain and therefore considered at minimal risk. Therefore, no additional flood mitigation measures are required for the substation.

With regards to the lift shafts, which extend down to the lower ground floor, the following features have been incorporated into the proposal:

- Appropriate equipment to prevent the lift from going to lower ground in the event of a flood;
- Electrical equipment to be located at ground floor level or above (above flood levels): and
- A sump pump may be required for the lower ground lift shaft, in order to drain/pump water out in the aftermath of a flood.

10.8 Groundwater flooding mitigation

Given the potential for elevated and variable groundwater levels, the following mitigation measures should be considered and incorporated where feasible:

- Best practice should be followed for all new pipes/sewers to prevent the ingress of groundwater into the drainage systems;
- Non-return valves could also be fitted to prevent flooding within properties;
- Additional jointing/sealing should be incorporated in manholes, in areas potentially at risk;
- Consider use of groundwater interception systems to divert groundwater flows around below ground level obstructions; and
- As stated above, raised building FFLs and local land-re-profiling have been incorporated to mitigate against groundwater flood risk as well as fluvial flood risk.

10.9 Foul drainage provision

Foul drainage will be connected into the public foul network at Manhole 2701, as shown in **Appendix L**. Detailed foul drainage work is outside the scope of the assessment and full details should be confirmed at the detailed design stage, in liaison with Southern Water.

11 CONCLUSIONS AND RECOMMENDATIONS

This FRA complies with the NPPF and Planning Practice Guidance and demonstrates that flood risk from all sources has been considered in the proposed development. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

The proposed development site lies in an area designated by the EA as Flood Zone 3, and is outlined to have a chance of flooding of greater than 1 in 100 for fluvial sources and 1 in 200 for tidal sources in any year.

NPPF sets out a Sequential Test, which states that preference should be given to development located within Flood Zone 1. This flood risk assessment demonstrates that the Sequential Test does not need to be satisfied as the site has been selected as an Allocated Site. As the site falls within Flood Zone 3, the FRA also demonstrates that the requirements of the Exception Test could be met.

This flood risk assessment has concluded that:

- The proposed development is located within Flood Zone 3, and as such is at high risk of flooding from fluvial and tidal sources;
- Flood risk from groundwater is considered moderate at the site;
- Flood risk from other sources – surface water, sewers, reservoirs and artificial sources – is demonstrated to be low;
- The development will have no impact on other forms of flooding;
- Appropriate flood mitigation is included in the form of raised finished floor levels, provision of floodplain compensation storage, safe access and flood management plan; and
- The proposals will follow best practice regarding site drainage to ensure that any surface water runoff from the development is managed, ensuring flood risk is not increased elsewhere. The proposed development will increase the impermeable area on site resulting in an increase in surface water runoff if unmanaged. Therefore, surface water from the proposed development will be attenuated (up to the 1 in 100 year plus climate change rainfall event) and discharged directly to the adjacent IDB drain at a restricted rate of 4l/s.

Redevelopment at the site should be possible with the suggested additional flood mitigation measures and surface water controls implemented, thus reducing the flood risk to properties downstream. Overall, taking into account the above points, the development of the site should not be precluded on flood risk grounds.

12 REFERENCES

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27. CIRIA, 'Development and Flood Risk guidance for the construction industry' C624, 2004.
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APPENDIX A

RSK GROUP SERVICE CONSTRAINTS

1. This report and the drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for Oakford Homes Ltd (the "client") in accordance with the terms of a contract between RSK and the "client" dated April 2018. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable civil engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the appropriate location. Such features should not be used for setting out and should be considered indicative only.



APPENDIX B

TOPOGRAPHIC SURVEY



NOTES

APPENDIX C

PROPOSED PLANS

RIVER ARUN

BOUNDARY EDGE SOFTENED BY HEDGE AND TREE PLANTING

EXISTING TREES PROTECTED

+2.00 FGL

EXISTING PUBLIC FOOTPATH

AMENITY SPACE

EXISTING TREES PROTECTED

DENSE PLANTING TO ACT AS A SCREEN TO SOFTEN THE VIEW INTO THE SITE

THE PROPOSED BUILDING FORMS AN ACTIVE FRONTAGE OVERLOOKING THE EXISTING PUBLIC FOOTPATH

+2.80 FGL

AMENITY DECK

AMENITY SPACE

+3.60 FGL

PROPOSED VEHICULAR ACCESS ROAD AND JUNCTION ONTO FORD ROAD

2.4M X 57.4M PRIMARY DIRECTION VISIBILITY SPLAY

2.4M X 74.4M SECONDARY DIRECTION VISIBILITY SPLAY

FORD ROAD

PROPOSED PEDESTRIAN ACCESS POINT ONTO FORD ROAD

THE FRONTAGE TO COMPRISE METAL RAILINGS AND MANAGED HEDGING TO FIT WITH THE CHARACTER OF THIS PART OF FORD ROAD

THE PROPOSED DEVELOPMENT FOLLOWS THE LINEAR FORM OF THE ADJACENT PROPERTIES AND SET BACK AN EQUIVALENT DISTANCE FROM FORD ROAD

A1

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ARCHITECTURE | TOWN PLANNING | URBAN DESIGN

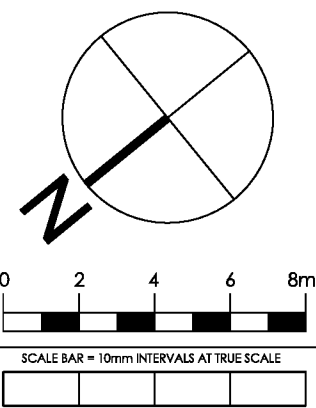
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RESIDENTIAL DEVELOPMENT
FORD ROAD
ARUNDEL
FOR OAKFORD HOMES

SITE PLAN SHOWING
ROOF PLAN

SCALE 1:200 DATE APRIL 2019 AUTHOR AC CHECK DP DRAWING NO. PP1249/101-04 REVISION P4

PRELIMINARY ISSUE



FGL - FINISHED GROUND LEVEL

S/S - ELECTRIC SUBSTATION

《 - UNDERCROFT PARKING

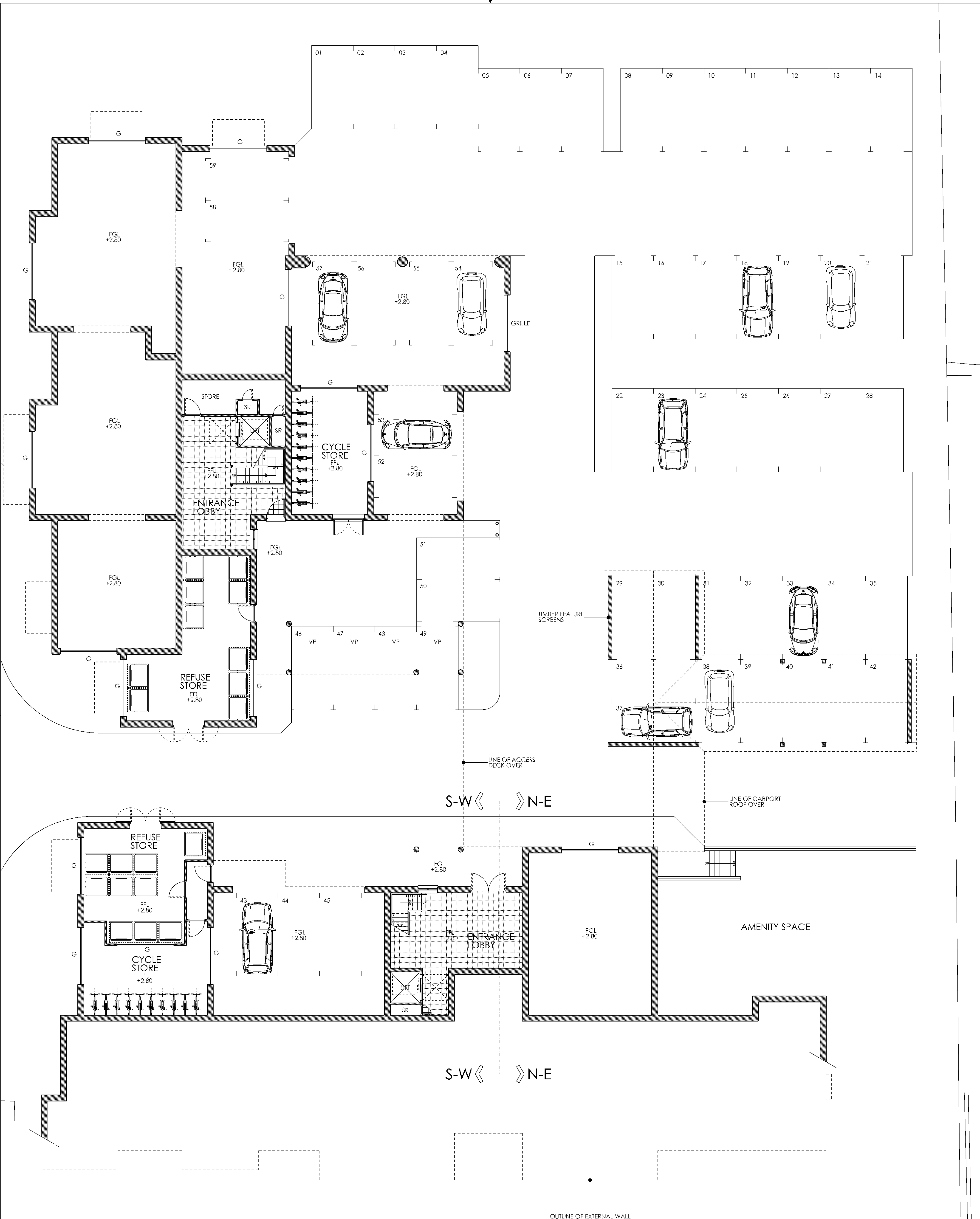
○ - EXISTING TREE

⬡ - PROPOSED TREE

⬢ - PROPOSED SHRUB PLANTING

⬢ - PROPOSED HEDGING

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LOWER GROUND FLOOR PLANS

POPE PRIESTLEY ARCHITECTS

ARCHITECTURE | TOWN PLANNING | URBAN DESIGN

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RESIDENTIAL DEVELOPMENT

FORD ROAD

ARUNDEL

FOR OAKFORD HOMES

SCALE: A1

DATE: FEB 2019

ARTIST: AC

CHECK: DP

DRAWING NO: PP1249/110-01

REVISION: P3

PRELIMINARY ISSUE

VP - VISITOR PARKING
G - GRILLED OPENINGS
FGL - FINISHED GROUND LEVEL
FFL - FINISHED FLOOR LEVEL

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RESIDENTIAL DEVELOPMENT

FORD ROAD

ARUNDEL

FOR OAKFORD HOMES

SCALE: A1

DATE: FEB 2019

ARTIST: AC

CHECK: DP

DRAWING NO: PP1249/110-01

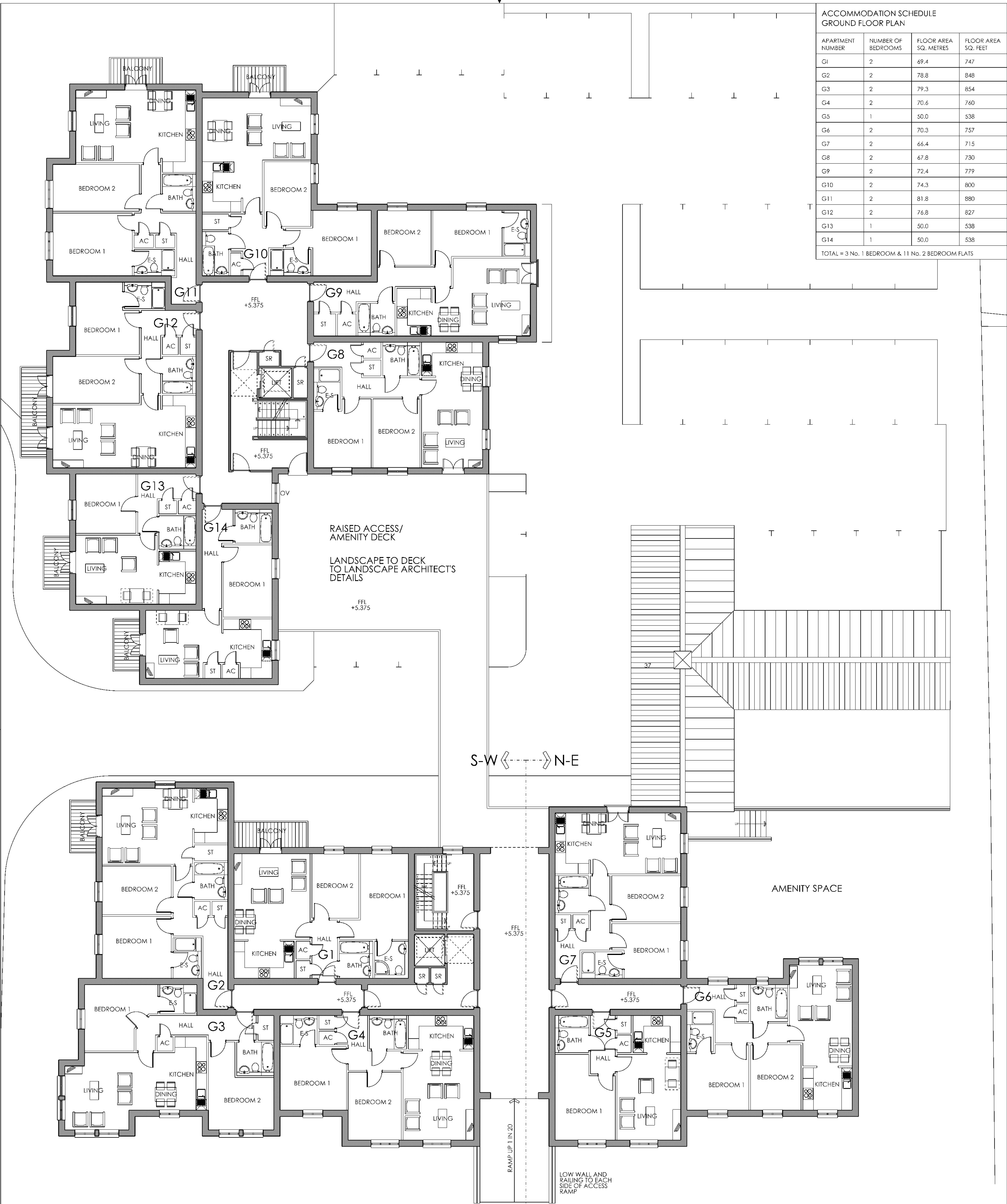
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PRELIMINARY ISSUE

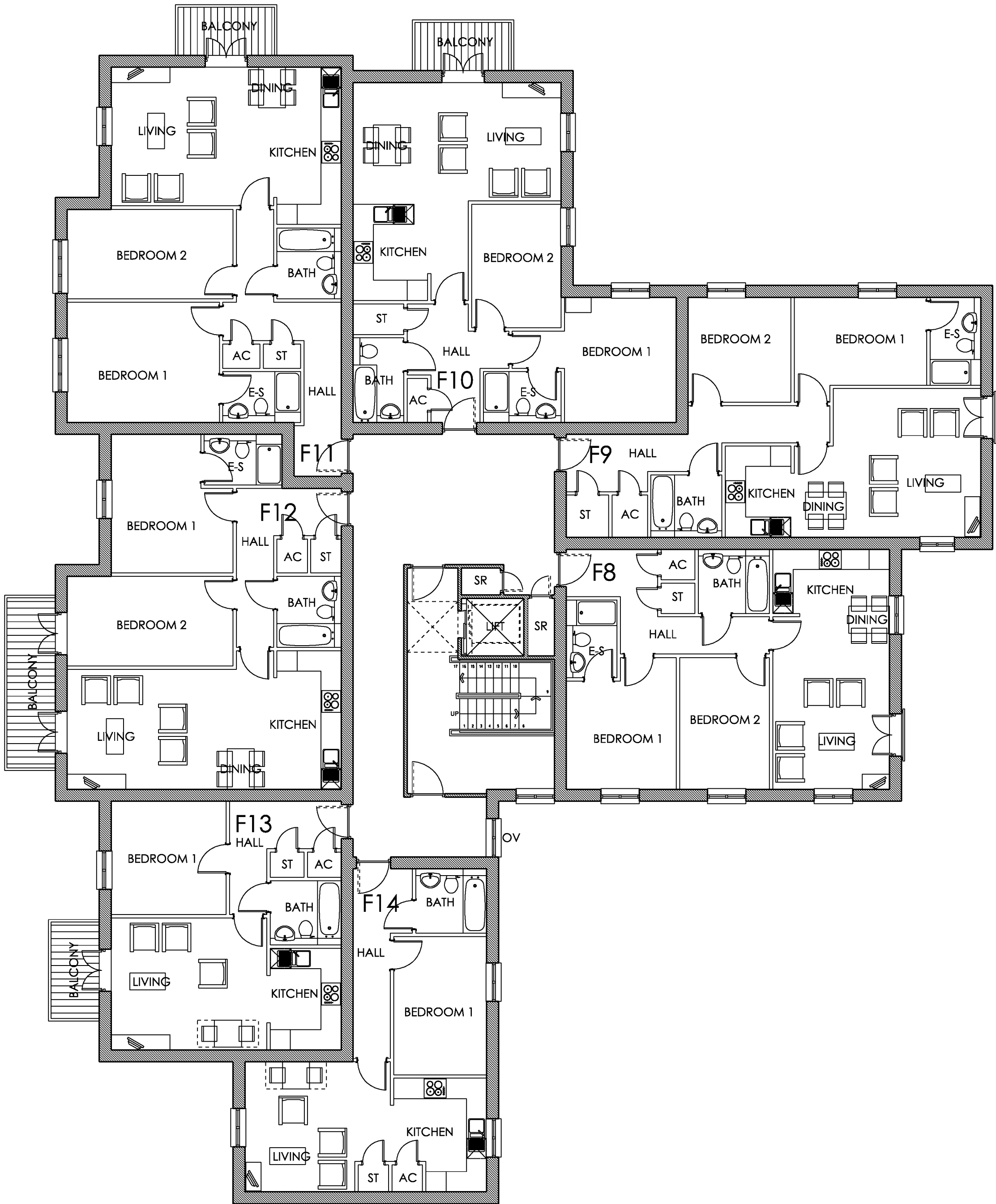
VP - VISITOR PARKING
G - GRILLED OPENINGS
FGL - FINISHED GROUND LEVEL
FFL - FINISHED FLOOR LEVEL

ARUNDEL DISTRICT COUNCIL, ARUNDEL

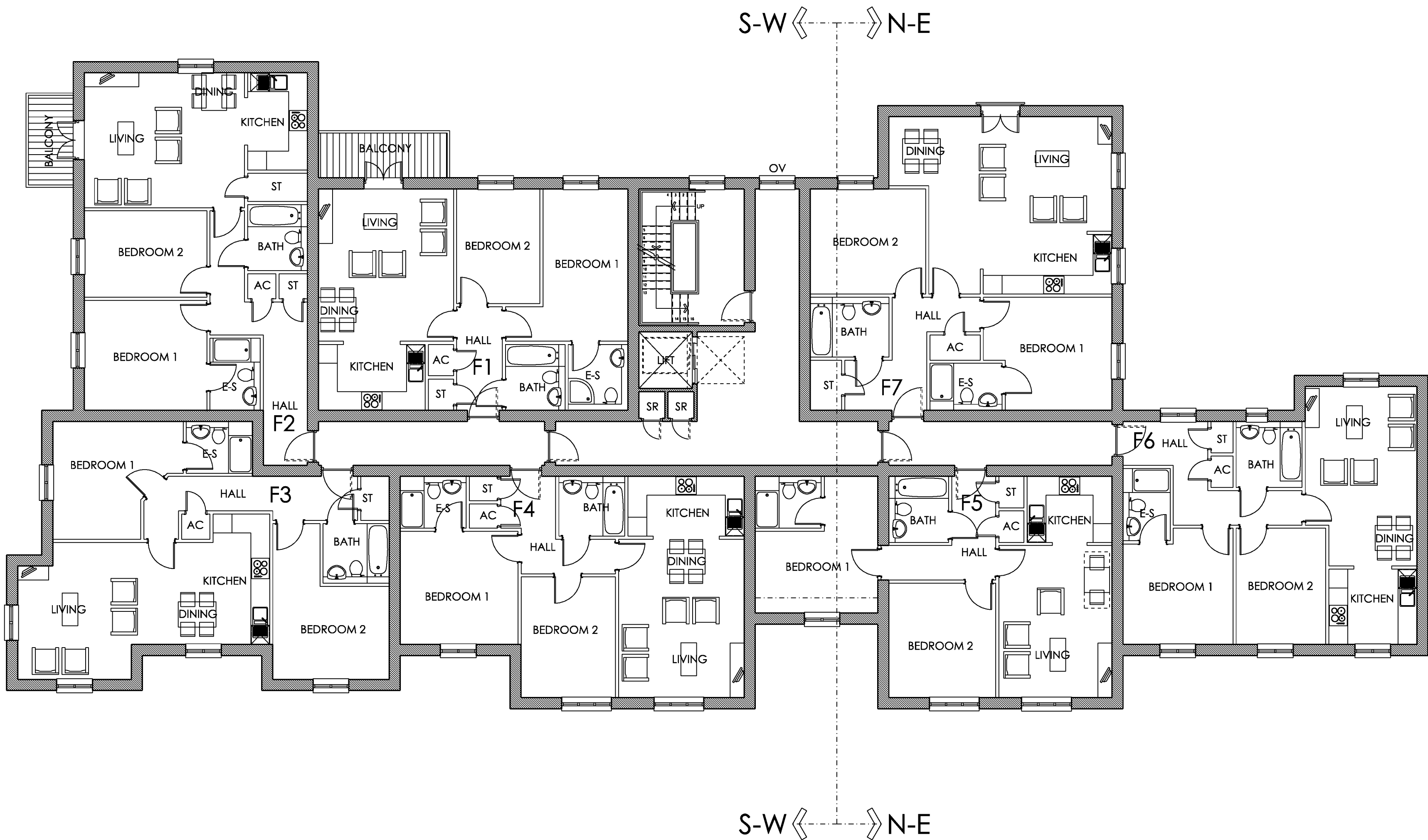
ACCOMMODATION SCHEDULE GROUND FLOOR PLAN			
APARTMENT NUMBER	NUMBER OF BEDROOMS	FLOOR AREA SQ. METRES	FLOOR AREA SQ. FEET
G1	2	69.4	747
G2	2	78.8	848
G3	2	79.3	854
G4	2	70.6	760
G5	1	50.0	538
G6	2	70.3	757
G7	2	66.4	715
G8	2	67.8	730
G9	2	72.4	779
G10	2	74.3	800
G11	2	81.8	880
G12	2	76.6	827
G13	1	50.0	538
G14	1	50.0	538
TOTAL = 3 No. 1 BEDROOM & 11 No. 2 BEDROOM FLATS			



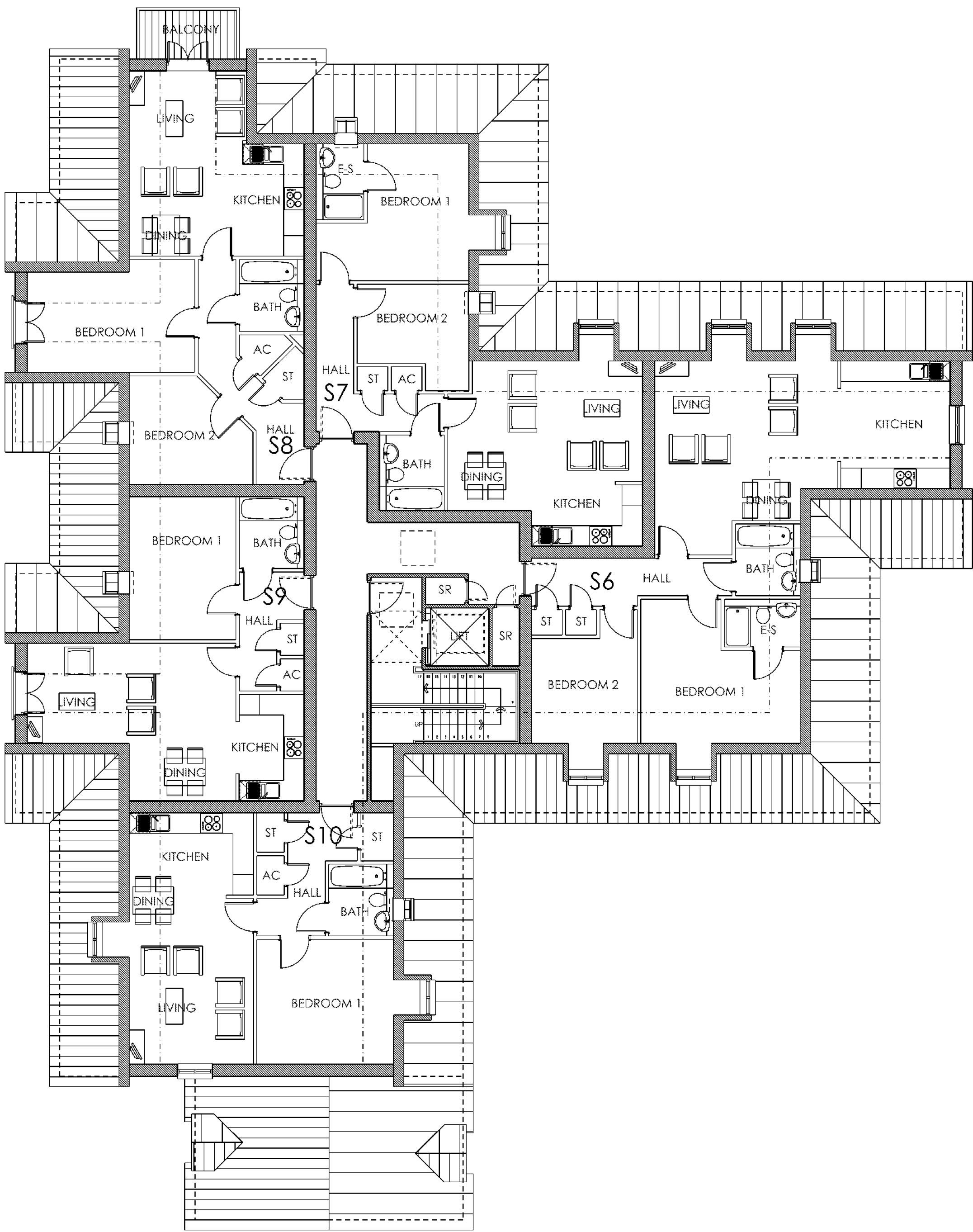
UPPER GROUND FLOOR PLANS



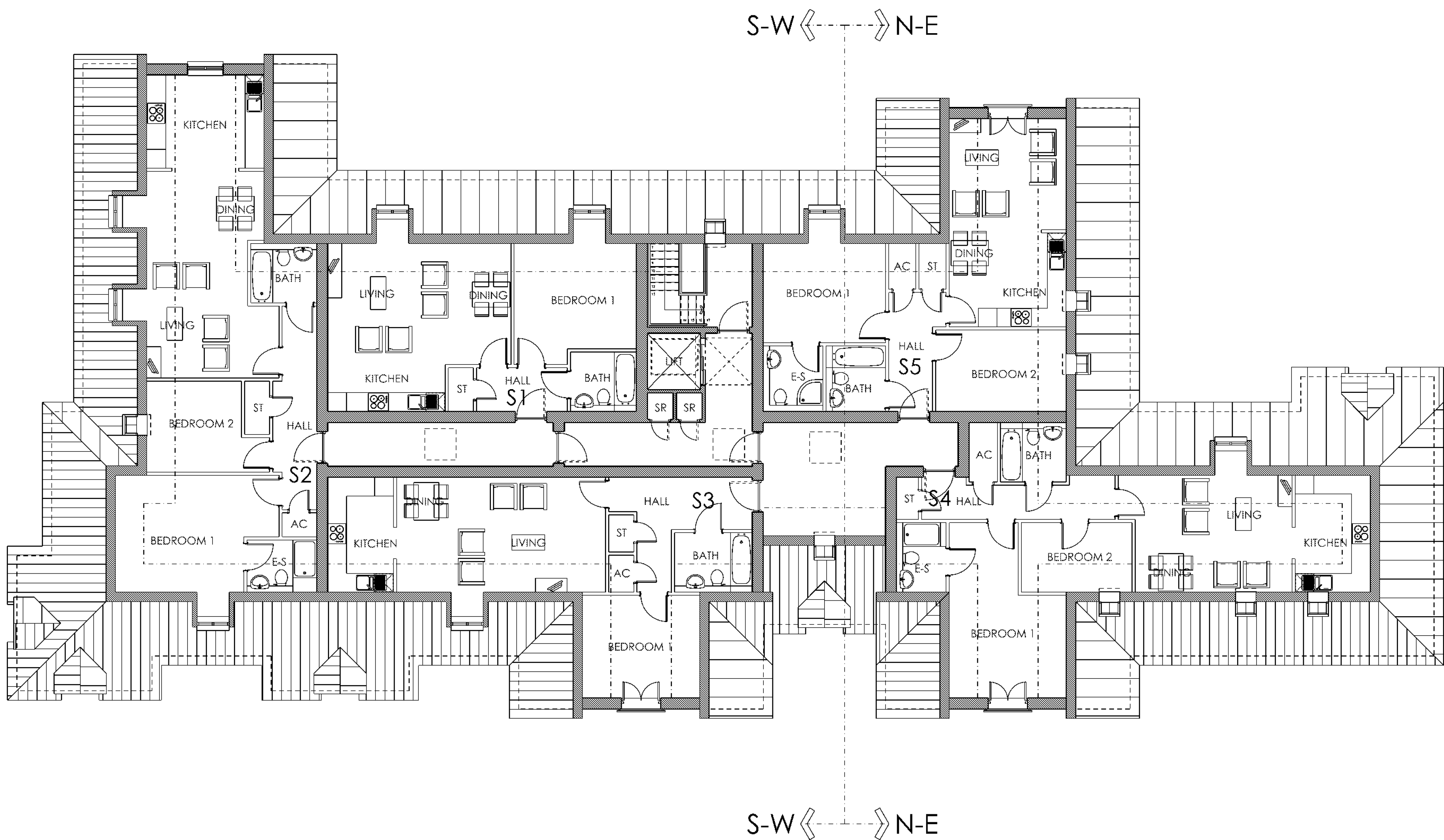
ACCOMMODATION SCHEDULE FIRST FLOOR PLAN			
APARTMENT NUMBER	NUMBER OF BEDROOMS	FLOOR AREA SQ. METRES	FLOOR AREA SQ. FEET
F1	2	69.4	747
F2	2	78.8	848
F3	2	79.3	854
F4	2	70.6	760
F5	2	68.5	737
F6	2	70.3	757
F7	2	84.0	904
F8	2	67.8	730
F9	2	72.4	779
F10	2	74.3	800
F11	2	81.8	880
F12	2	76.8	827
F13	1	50.0	538
F14	1	50.0	538
TOTAL = 2 No. 1 BEDROOM & 12 No. 2 BEDROOM FLATS			



FIRST FLOOR PLANS



ACCOMMODATION SCHEDULE SECOND FLOOR PLAN			
APARTMENT NUMBER	NUMBER OF BEDROOMS	FLOOR AREA SQ. METRES	FLOOR AREA SQ. FEET
S1	1	54.5	587
S2	2	86.6	932
S3	1	63.1	679
S4	2	74.9	806
S5	2	67.6	728
S6	2	86.9	935
S7	2	70.9	763
S8	2	67.0	721
S9	1	54.3	584
S10	1	58.5	630
TOTAL = 4 No. 1 BEDROOM & 6 No. 2 BEDROOM FLATS			



SECOND FLOOR PLANS



SOUTH-EAST ELEVATION



CARPORT

SOUTH-EAST ELEVATION

SCHEDULE OF MATERIALS - all to LA approval

- WALLS**
- RED MULTI-SANDFACED BRICKWORK.
 - COMPOSITE WEATHER BOARDING - COLOUR DARK GREY.
 - FLUSH DIAPER PATTERN BRICKWORK - SMOOTH BLUE HEADERS.
 - PROJECTING BRICK PLINTH.
- ROOFS**
- PLAIN BROWN TILES WITH MATCHING HIP AND RIDGE TILES.
 - DECORATIVE CRESTED RIDGE TILES AS SHOWN.
 - PLAIN TILED PITCHED ROOF DORMER WITH LEAD CHEEKS.
 - BLACK PVC-U RAINWATER GOODS.
 - CONSERVATION STYLE ROOFLIGHT.
 - GRP ROOF CUPOLA FEATURE.
- EAVES, VERGE & SOFFIT**
- PROJECTING EAVES AND SOFFIT WITH DECORATIVE BARGEBOARD DETAIL TO VERGES AS SHOWN - COLOUR LIGHT GREY.

- WINDOWS, DOORS, WINDOW HEAD & SILLS**
- PVC-U DOUBLE GLAZED WINDOWS, PATTERN / STYLE AS SHOWN - COLOUR LIGHT GREY.
 - PAINTED METAL JULIETTE BALCONY GUARDING WITH GLAZED BALUSTRADE.
 - RECONSTITUTED DECORATIVE STONE ENTRANCE FEATURE.
 - RECONSTITUTED STONE MILLION.
 - PROFILED METAL FRAMED BALCONIES WITH GLAZED BALUSTRADE - COLOUR BLACK.
 - FACE BRICKWORK JACK-ARCH HEADERS - PLAIN RED SANDFACED.
 - FACE BRICKWORK CURVE-ARCH HEADERS - PLAIN RED SANDFACED.
 - RECONSTITUTED STONE SILLS.
 - PAINTED METAL GRILLE - COLOUR BLACK.

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SCALE BAR - 10mm INTERVALS AT TRUE SCALE

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SECTIONAL SOUTH-WEST ELEVATION



SOUTH-WEST ELEVATION

SCHEDULE OF MATERIALS - all to LA approval

WALLS	
1.	RED MULTI-SANFACED BRICKWORK.
2.	COMPOSITE WEATHER BOARDING - COLOUR DARK GREY.
3.	FLUSH DIAPER PATTERN BRICKWORK - SMOOTH BLUE HEADERS.
4.	PROJECTING BRICK PLINTH.

ROOFS	
10.	PLAIN BROWN TILES WITH MATCHING HIP AND RIDGE TILES.
11.	DECORATIVE CRESTED RIDGE TILES AS SHOWN.
12.	PLAIN TILED PRCHED ROOF DORMER WITH LEAD CHEEKS.
13.	BLACK PVC-U RAINWATER GOODS.
14.	CONSERVATION STYLE ROOFLIGHT.
15.	GRP ROOF CUPOLA FEATURE.

EAVES, VERGE & SOFFIT	
20.	PROJECTING EAVES AND SOFFIT WITH DECORATIVE BARGEBOARD DETAIL TO VERGES AS SHOWN - COLOUR LIGHT GREY.

WINDOWS, DOORS, WINDOW HEAD & SILLS	
30.	PVC-U DOUBLE GLAZED WINDOWS, PATTERN / STYLE AS SHOWN - COLOUR LIGHT GREY.
31.	PAINTED METAL JULIETTE BALCONY GUARDING WITH GLAZED BALUSTRADE.
32.	RECONSTITUTED DECORATIVE STONE ENTRANCE FEATURE.
33.	RECONSTITUTED STONE MULLION.
34.	PROFILED METAL FRAMED BALCONIES WITH GLAZED BALUSTRADE - COLOUR BLACK.
35.	FACE BRICKWORK JACK-ARCH HEADERS - PLAIN RED SANFACED.
36.	FACE BRICKWORK CURVE-ARCH HEADERS - PLAIN RED SANFACED.
37.	RECONSTITUTED STONE SILLS.
38.	PAINTED METAL GRILLE - COLOUR BLACK.

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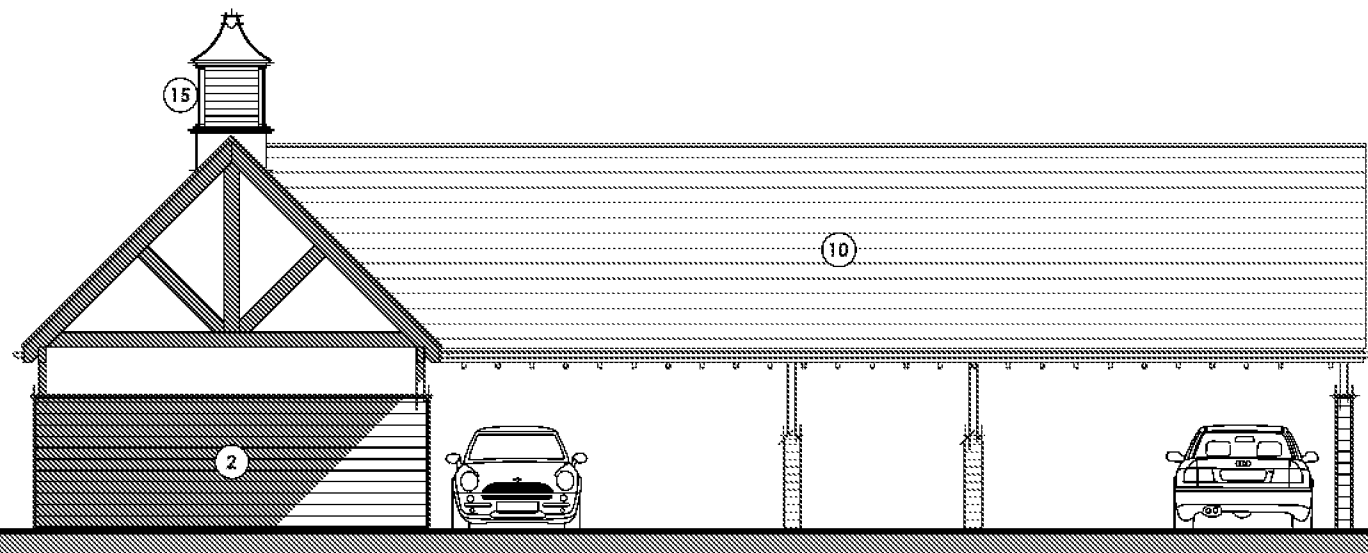
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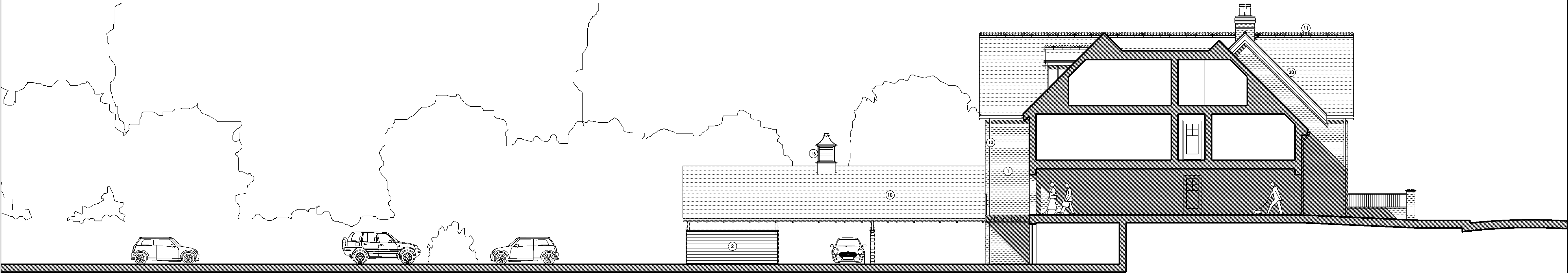
POPE PRIESTLEY ARCHITECTS	
ARCHITECTURE TOWN PLANNING URBAN DESIGN	
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RESIDENTIAL DEVELOPMENT GAS WORKS SITE ARUNDEL FOR OAKFORD HOMES	SOUTH-WEST ELEVATIONS
SCALE: 1:100 DATE: MAR 2019 AUTHOR: AC CHECK: DP	DRAWING NO: PP1249/110-12 VERSION: P2



NORTH-WEST ELEVATION TO
ACCESS ROAD



CARPORT (SECTIONAL)



CARPORT

NORTH-EAST ELEVATION
(SECTIONAL)

SCHEDULE OF MATERIALS - all to LA approval

- WALLS**
- RED MULTI-SANFACED BRICKWORK.
 - COMPOSITE WEATHER BOARDING - COLOUR DARK GREY.
 - FLUSH DIAPER PATTERN BRICKWORK - SMOOTH BLUE HEADERS.
 - PROJECTING BRICK PLINTH.
- ROOFS**
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 - DECORATIVE CRESTED RIDGE TILES AS SHOWN.
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 - GRP ROOF CUPOLA FEATURE.
- EAVES, VERGE & SOFFIT**
- PROJECTING EAVES AND SOFFIT WITH DECORATIVE BARGEBOARD DETAIL TO VERGES AS SHOWN - COLOUR LIGHT GREY.

- WINDOWS, DOORS, WINDOW HEAD & SILLS**
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 - PAINTED METAL JULIETTE BALCONY GUARDING WITH GLAZED BALUSTRADE.
 - RECONSTITUTED DECORATIVE STONE ENTRANCE FEATURE.
 - RECONSTITUTED STONE MULLION.
 - PROFILED METAL FRAMED BALCONIES WITH GLAZED BALUSTRADE - COLOUR BLACK.
 - FACE BRICKWORK JACK-ARCH HEADERS - PLAIN RED SANFACED.
 - FACE BRICKWORK CURVE-ARCH HEADERS - PLAIN RED SANFACED.
 - RECONSTITUTED STONE SILLS.
 - PAINTED METAL GRILLE - COLOUR BLACK.

IMPORTANT NOTE FOR USE OF THIS DRAWING: THIS DRAWING HAS BEEN PRODUCED SPECIFICALLY FOR USE ON THIS PROJECT. POPE PRIESTLEY ARCHITECTS IS NOT BE HELD RESPONSIBLE FOR REUSE OF THIS INFORMATION BY OTHERS FOR ANY PURPOSE OTHER THAN FOR WHICH IT IS SPECIFICALLY INTENDED. THIS DRAWING REFLECTS STANDARDS AGREED FOR THIS PROJECT AND CURRENT AT THE TIME OF PRODUCTION AND WILL NOT BE UPDATED IN ACCORDANCE WITH CHANGING LEGISLATION AND/OR OTHER REQUIREMENTS.

SCALE: 1:100 (SEE INTERIORS AT TRUE SCALE)

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PRELIMINARY ISSUE		RESIDENTIAL DEVELOPMENT FORD ROAD ARUNDEL FOR OAKFORD HOMES		NORTH-EAST & NORTH-WEST SECTIONAL ELEVATIONS	
SCALE: 1:100	DATE: MAR 2019	AUTHOR: AC	CHECK: DP	DRAWING NO: PP1249/110-13	VERSION: P2



APPENDIX D

ENVIRONMENT AGENCY CORRESPONDENCE

Emma Rowlands
Rsk
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Our ref: SSD85765
Your ref:
Date: 06/06/2018

Dear Emma Rowlands,

Enquiry Regarding Product 4 for Flood Risk Assessment for Site Address

Thank you for your enquiry which was received on 09 May 2018.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004. The information is attached.

The information on Flood Zones in the area relating to this address is as follows:

The site is in an area located within Flood Zone 3 as shown on our Flood Map for Planning (Rivers and Sea).

Note - This information relates to the area that the above named property is in and is not specific to the property itself as it is influenced by factors such as the height of door steps, air bricks or the height of surrounding walls. We do not have access to this information and is not currently used in our flood modelling.

Flood Zone definitions can be [REDACTED]

Flood Defences

There are flood defences in the form of an embankment. The estimated standard of protection is 1 in 75 years (1.3% AEP). The asset is maintained by the Environment Agency.

Model Information

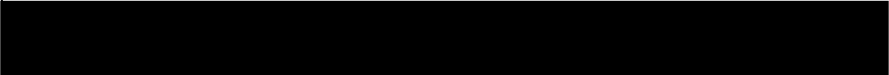
The model used was the Lower Tidal River Arun Strategy Study which was completed by Atkins in 2010 .

Flood History

We hold no record of previous flooding events affecting this site, although we are aware of localised surface water/groundwater issues in the vicinity of the site.

Please note our records are not comprehensive and may not include all events. I recommend contacting the Lead Local Flood Authority, **West Sussex County Council** or the Local Authority, **Arun District Council** for a more comprehensive flood history check.

FRA advisory text

Name	Product 4
Description	Detailed Flood Risk Assessment Map for Gas Works Site ford Road, Arundel, BN18 9DX.
Licence	<u>Open Government Licence</u>
Information Warnings	The majority of our models will not have the new climate change allowances for <u>fluvial</u> flood risk. +20% is not suitable for the majority of planning purposes and the new allowances to use should be checked here: 
Information Warning - OS background mapping	<i>The mapping of features provided as a background in this product is © Ordnance Survey. It is provided to give context to this product. The Open Government Licence does not apply to this background mapping. You are granted a non-exclusive, royalty free, revocable licence solely to view the Licensed Data for non-commercial purposes for the period during which the Environment Agency makes it available. You are not permitted to copy, sub-license, distribute, sell or otherwise make available the Licensed Data to third parties in any form. Third party rights to enforce the terms of this licence shall be reserved to OS.</i>
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. Contains Ordnance Survey data © Crown copyright 2017 Ordnance Survey 100024198.

Data Available Online

Many of our flood datasets are available online:

- Flood Map For Planning (Flood Zone 2, Flood Zone 3, Flood Storage Areas, Flood Defences, Areas Benefiting from Defences)
- Risk of Flooding from Rivers and Sea
- Historic Flood Map
- Current Flood Warnings

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Yours sincerely,

Eleonora Pilla
FCRM Officer - PSO West Sussex

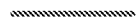


Environment
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N



Legend

Main River



Node_Points

Scale: 1:1,000

00.02250.045

Kilometers

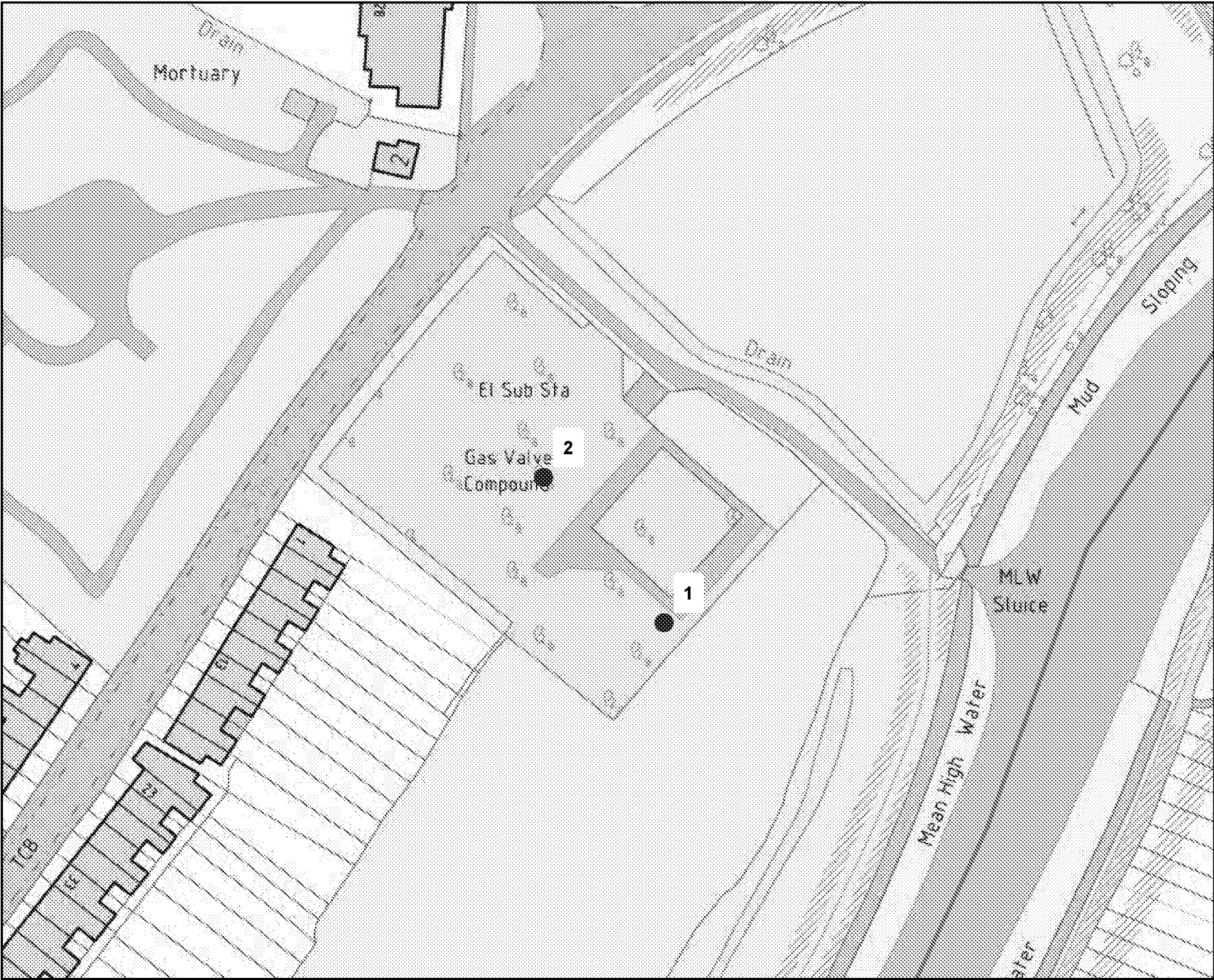


Table 5: Water Depth: Fluvial Undefended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Undefended Annual Exceedance Probability			
	Eastings	Northings	5%	1%	1% +CC	0.1%
1	501315	106709	0.25	0.42	1.34	0.66
2	501292	106736	-	-	0.18	-

Table 6: Water Depth: Fluvial Defended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Defended Annual Exceedance Probability			
	Eastings	Northings	5%	1%	1% + CC	0.1%
1	501315	106709	0.06	0.51	0.83	0.78
2	501292	106736	-	-	-	-

Table 7: Water Depth: Tidal Undefended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Undefended Annual Exceedance Probability			
	Eastings	Northings	5%	0.5%	0.5% (2115)	0.1%
1	501315	106709	0.67	0.93	1.59	0.99
2	501292	106736	-	-	0.53	-

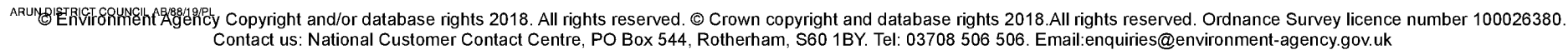
Table 8: Water Depth: Tidal Defended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Defended Annual Exceedance Probability			
	Eastings	Northings	5%	0.5%	0.5% (2115)	0.1%
1	501315	106709	-	-	2.03	-
2	501292	106736				

All levels taken from: Lower Tidal River Arun Strategy Study

Produced on: 06/06/2018

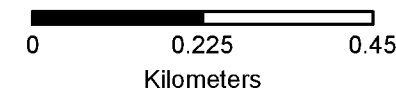
There is no additional information or health warnings for these levels/depths or the model from which they have been produced.

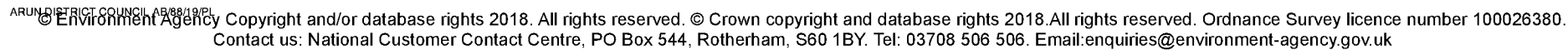


 5% AEP (Undefended Fluvial)
 1% AEP (Undefended Fluvial)
 0.1% AEP (Undefended Fluvial)
 1% AEP Plus Climate Change (Undefended Fluvial)

Climate Change (CC) for fluvial models is based on an increase in river flows of 35, 45 & 105% for undefended scenarios.

Scale: 1:10,000

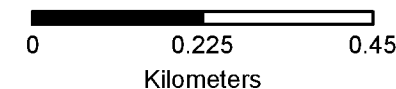


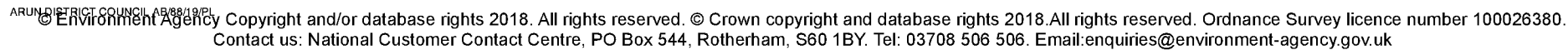


 5% AEP (Defended Fluvial)
 1% AEP (Defended Fluvial)
 0.1% AEP (Defended Fluvial)
 1% AEP Plus Climate Change (Defended Fluvial)

Climate Change (CC) for fluvial models is based on an increase in river flows of 35, 45 & 105% for undefended scenarios.

Scale: 1:10,000

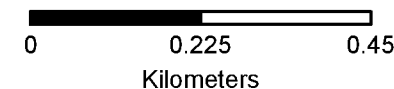


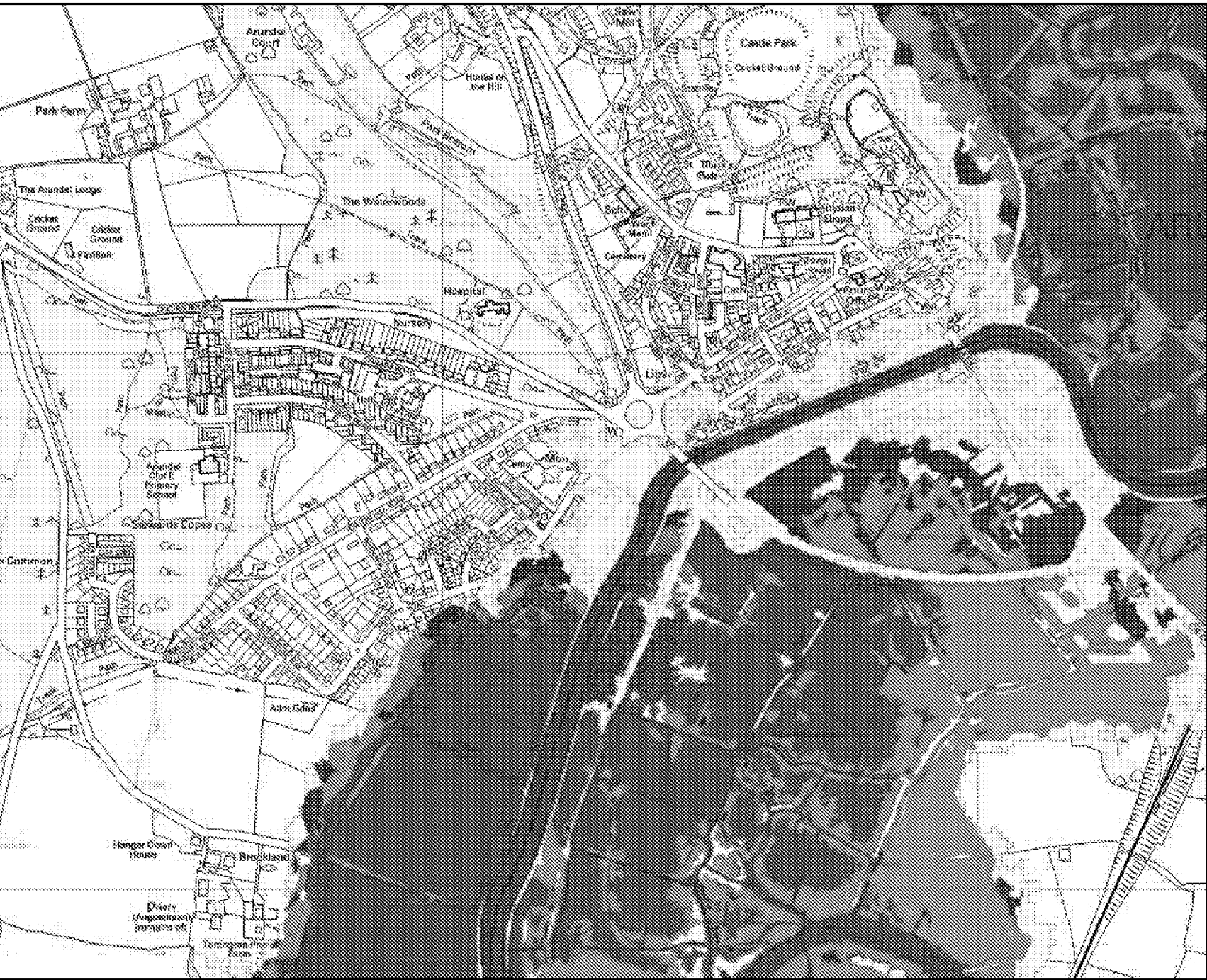


 5% AEP (Undefended Tidal)
 0.5% AEP (Undefended Tidal)
 0.1% AEP (Undefended Tidal)
 0.5% AEP (2110) (Undefended Tidal)

Climate Change (CC) for fluvial models is based on an increase in river flows of 35, 45 & 105% for undefended scenarios.

Scale: 1:10,000







Environment
Agency

N
▲

Legend

- 5% AEP (Defended Tidal)
- 0.5% AEP (Defended Tidal)
- 0.1% AEP (Defended Tidal)
- 0.5% AEP (2110) (Defended Tidal)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Climate Change (CC) for fluvial models is based on an increase in river flows of 35, 45 & 105% for undefended scenarios.

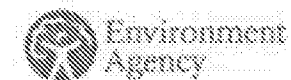
Defended scenarios only show the superseded 20% increase in flows

Scale: 1:10,000

00.2250.45

Kilometers

Flood Map for Planning (Rivers and Sea)



Scale 1: 10,000



Flood Map for Planning (Rivers & Sea)

- Sealed Main Rivers
- Defences
- Flood Storage Areas
- Areas benefiting from flood defences
- Flood Zone 3
- Flood Zone 2

Flood Map Areas (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Risk of flooding from Surface Water



Scale 1:10,000



Likelihood of flooding from Surface Water

-  High ($\geq 3.3\%$)
-  Medium (3.3% - 1%)
-  Low (1% - 0.1%)
- Very Low

Likelihood of flooding from Surface Water

- High:** Greater than or equal to 3.3% (1 in 30) chance in any given year
- Medium:** Less than 3.3% (1 in 30) but greater than or equal to 1% (1 in 100) chance in any given year
- Low:** Less than 1% (1 in 100) but greater than or equal to 0.1% (1 in 1,000) chance in any given year
- Very Low:** Less than 0.1% (1 in 1,000) chance in any given year

This information is shown on the Risk of Flooding from Surface Water map on our website.

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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). E-mail: enquires@environment-agency.gov.uk

Flood defences

Legend

Statutory Main Rivers
Defences (EA maintained)

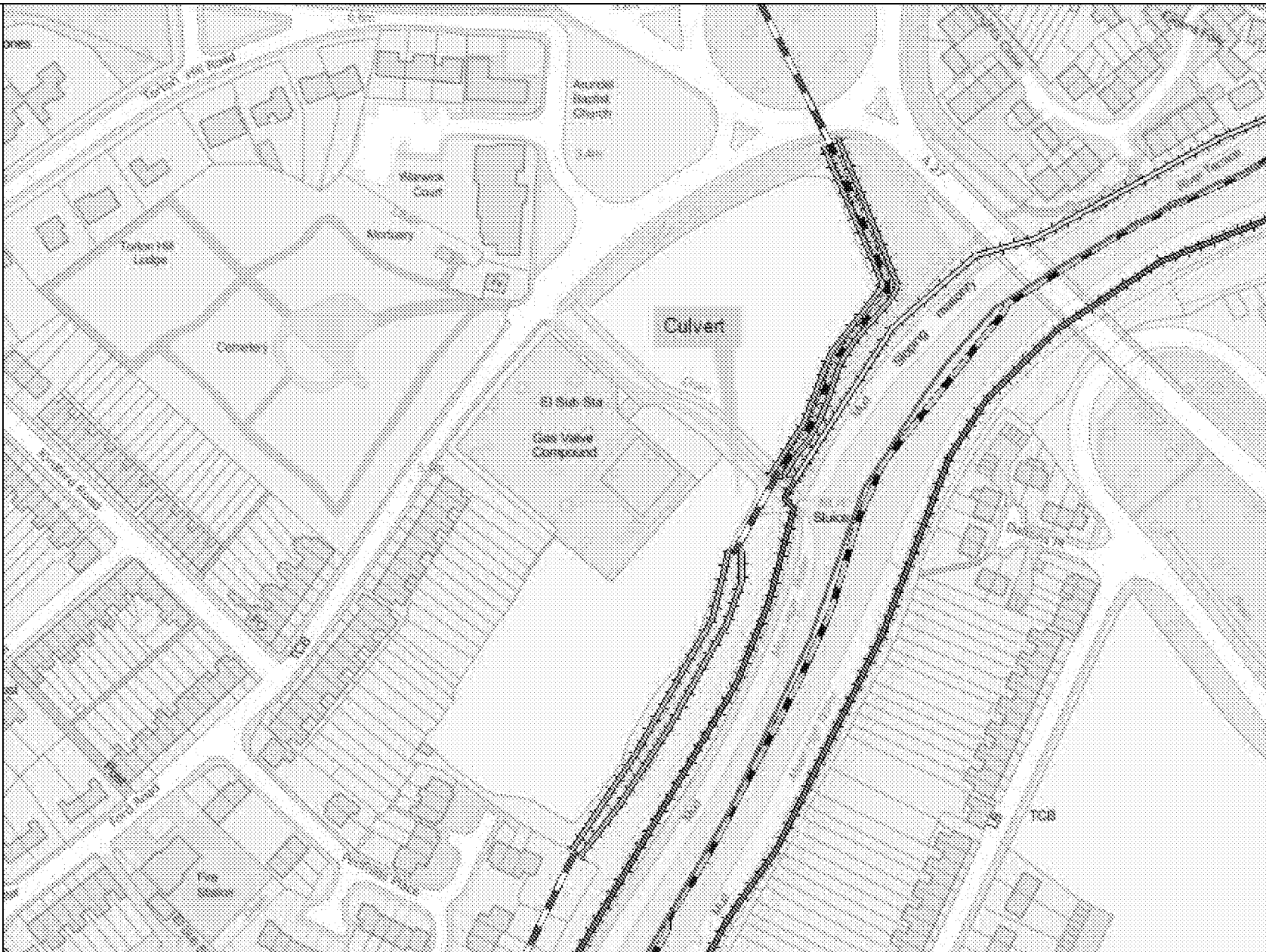
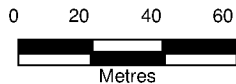
- | | |
|--|------------------------|
| | Asset type not defined |
| | Embankment |
| | Wall |
| | Flood Gate |
| | Demountable Defence |
| | Bridge Abutment |
| | High Ground |
| | Beach |
| | Barrier Beach |
| | Promenade |
| | Quay |
| | Cliff |
| | Dunes |

Defences (3rd party maintained)

- | | |
|---|------------------------|
|  | Asset type not defined |
|  | Embankment |
|  | Wall |
|  | Flood Gate |
|  | Demountable Defence |
|  | Bridge Abutment |
|  | High Ground |
|  | Beach |
|  | Barrier Beach |
|  | Promenade |
|  | Quay |
|  | Cliff |
|  | Dunes |

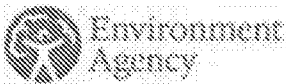
Channels (EA maintained)

- Asset type not defined



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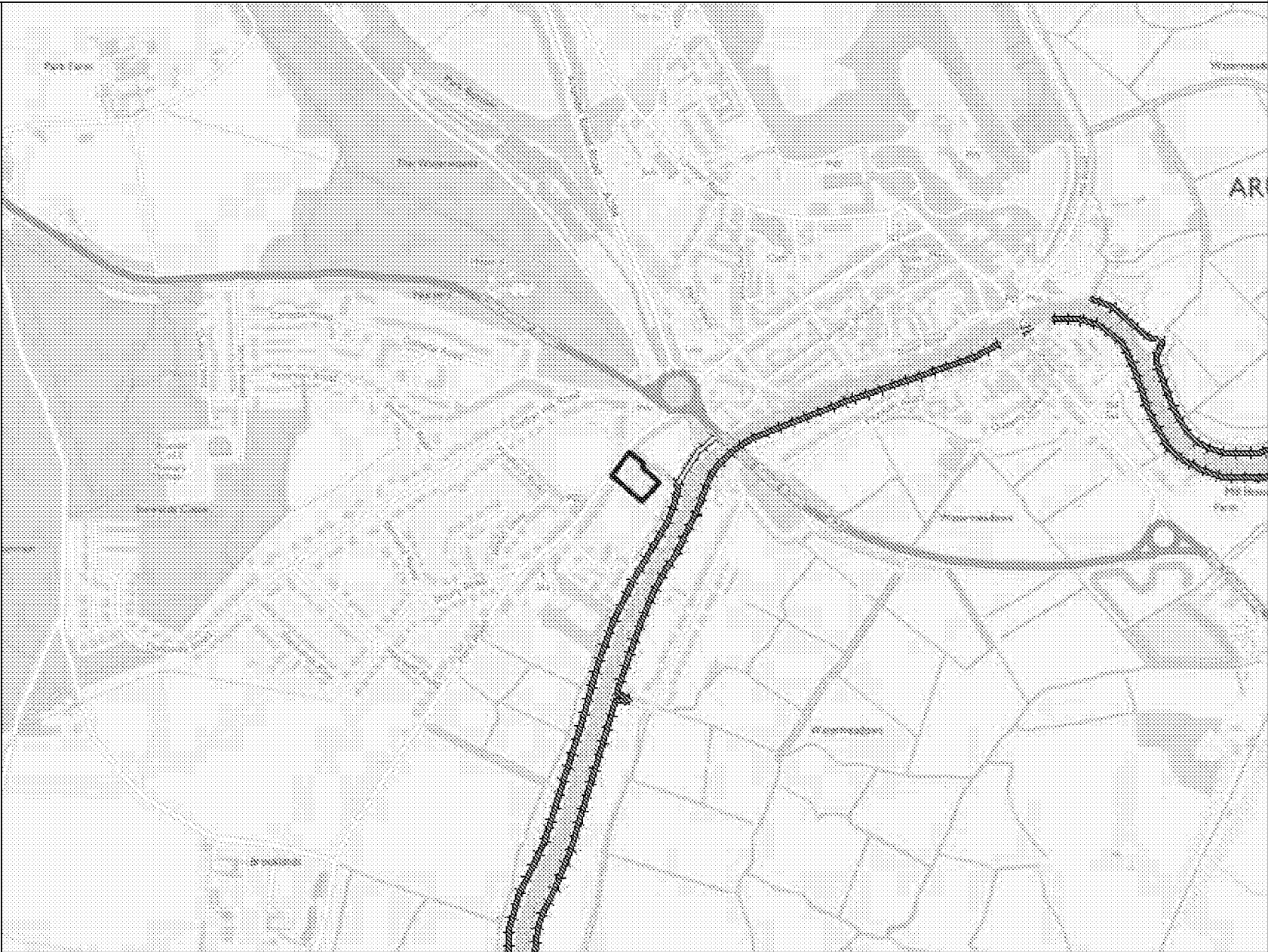
AIMS Flood Defence Map (EA Maintained). Centred on BN18 9DX. Created



Legend

Defences (EA maintained)

- Asset type not defined
- Embankment
- Wall
- Flood Gate
- Demountable Defence
- Bridge Abutment
- High Ground
- Beach
- Barrier Beach
- Promenade
- Quay
- Cliff
- Dunes



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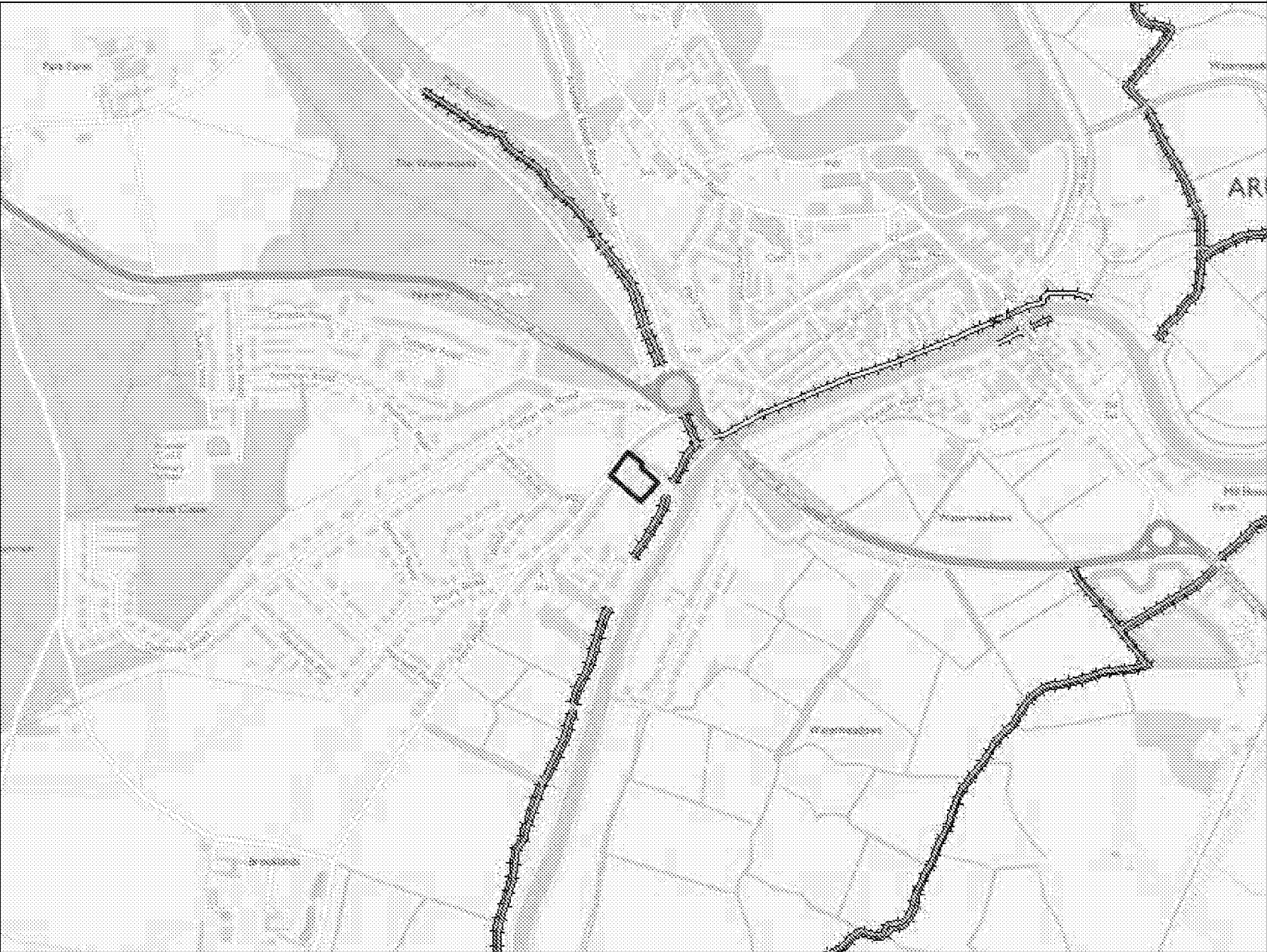
AIMS Flood Defence Map (3rd Party Maintained). Centred on BN18 9DX.



Legend

Defences (3rd party maintained)

- Asset type not defined
- Embankment
- Wall
- Flood Gate
- Demountable Defence
- Bridge Abutment
- High Ground
- Beach
- Barrier Beach
- Promenade
- Quay
- Cliff
- Dunes



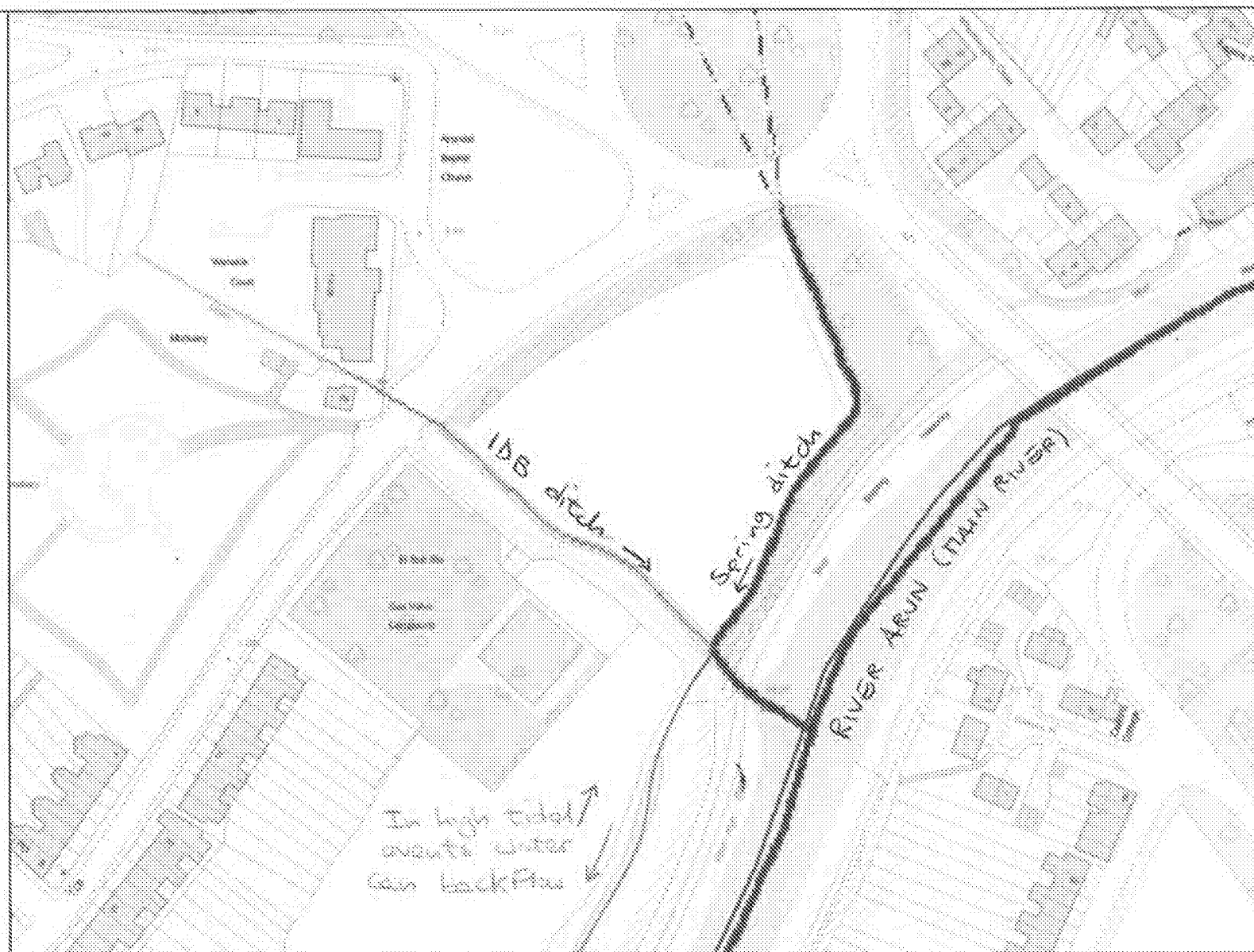
Legend

Sealed Main Rivers

Detailed River Network

- Primary River
- Secondary River
- Tertiary River
- Lake / Reservoir
- Canal
- Canal Tunnel
- Extended Culvert
- Multiple Channel Culvert
- Underground River (potential sewer)
- Underground River (inferred)
- Underground River (local knowledge)
- Uninferred

Offline Drainage features



Jemma Looney

From: PSO West Sussex <P [REDACTED]>
Sent: 07 May 2019 11:12
To: Jemma Looney
Subject: RE: 190417 SSD124287 - Action by 10 May Product 7 for Gas Works Site Arundel BN18 9DX
Attachments: Watercourses map.pdf

Dear Jemma,

Thanks for your email. Apologies for the confusion. Please find attached a map of the watercourses we referred to in our previous email.

We are not aware of the culverted watercourse indicated with the letter B in your attachment. Could that be a surface water drainage? Did you ask Southern Water?

I can confirm that 'A' is the IDB watercourse we were referring to in our email.

There is some local history of flooding associated to the watercourse (**Watercourse 1 - IDB ditch in attached map**) – Arun DC's drainage department may have some more information.

This watercourse is within the IDB. This watercourse is not a watercourse which we permissively maintain on behalf of the IDB annually however we have undertaken some works in the past to alleviate flood risk (ad-hoc).

The main flow paths are listed below.

1. Your site borders the main Ford Road – **Watercourse 1 (IDB ditch in attached map)** will take flow from Ford Road and further West towards Torton Hill.
2. The inflow from the North East at the confluence of the outfall is known locally as Spring Ditch (**Watercourse 2 in attached map**) – this is the main inflow from a spring based supply rising from the Downs and partly controlled by Chalk Spring Fishery.
3. The other inflow is a ditch network which runs South from the confluence of the outfall chamber heading adjacent to the flood bank (**Watercourse 3 on the attached map**) for several miles into farmland closer to Ford to the South of your site: this ditch also discharges through tidal outfalls further South, BUT in high tidal events water will backflow from that farmland and head Northwards back towards the confluence of the outfall so this needs to be counted for in any calculation.

I hope it's a bit clearer now.

Please get in touch if you have further questions.

Kind regards,
Ele

Eleonora Pilla

Flood and Coastal Risk Management Officer | Partnership & Strategic Overview | West Sussex
Environment Agency | Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD



From: Jemma Looney [mailto:JLooney@rsk.co.uk]

Sent: 03 May 2019 17:28

To: [REDACTED]
Subject: RE: 190417 SSD124287 - Action by 10 May Product 7 for Gas Works Site Arundel BN18 9DX

Good Afternoon,

Many thanks for your email response on this.

In relation to your comments highlighted in yellow below, please can you provide a marked-up plan of the watercourses showing the inflows/outfalls/confluences you refer to. The reason being, our query was in relation to a culvert crossing the site itself.

To assist, please find attached a plan distinguishing the 2 features we are aware of.

We have been in contact with your planning department separately about what mitigation measures are required i.e. easements, and we need to establish if there are any specific requirements for the culvert (shown B on plan). Please confirm that only feature 'A' would be considered a watercourse under the EA/IDB remit.

I would very grateful if you could please confirm in the next couple of days.

Many thanks for your assistance.

Kind regards,

Jemma Looney (née Cooling)
Principal Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire. HP3 9RT, UK

[REDACTED]

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Registered number: 4723837

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From: PSO West Sussex <PS [REDACTED]>

Sent: 01 May 2019 08:53

To: Jemma Looney <[REDACTED]>

Cc: SSD Enquiry <[REDACTED]>

Subject: RE: 190417 SSD124287 - Action by 10 May Product 7 for Gas Works Site Arundel BN18 9DX

Dear Jemma,

Thanks for your email. Please see our response in red below.

Can you please confirm if you have any information such as the following:

1. a. Do you have any detailed plans/information on the upstream/downstream flaps for this feature?
b. What is the capacity of this sluice and in particular the river side flap you refer to below. From your text below we understand the upstream flap is always open but to enable us to establish any flow capacity within this ditch, we need to gain an idea of the downstream pipe outfall.

The outfalls through the raised embankments were mostly installed in the late 1960's and were of a standard design ranging in diameter. The outfall at the location specified is 940mm diameter according to our records.

2. Do you have any details on the condition of this sluice?

The latest asset inspection of the sluice and the embankment has been assessed as 'Fair' in accordance with our assessment process. The flap valve is subject to a twice yearly inspection and maintenance regime. The rear 'flood gate' is maintained in the very same way, however the operation winding spindle was replaced a few years ago to ensure operational needs.

At some stage this year we will be undertaking a confined space CCTV inspection of the outfall itself.

Please be mindful that we do not own the sluice nor the land it sits upon, but we undertake control as a maintainer and operator.

Existing culvert

We have also recently become aware of an existing culvert feature crossing beneath the site, as shown on the attached survey extract. We have requested information on this from Arun DC as the local planning/drainage department and they have stated *"The watercourse is within the IDB area and therefore is within the EA's jurisdiction. Please get in touch with them."*

There is some local history of flooding associated to the watercourse – Arun DC's drainage department may have some more information.

As stated by Arun DC, the watercourse is within the IDB. This watercourse is not a watercourse which we permissively maintain on behalf of the IDB annually however we have undertaken some works in the past to alleviate flood risk (ad-hoc).

The main flow paths are listed below.

1. Your site borders the main Ford Road – the watercourse you have mentioned will take flow from Ford Road and further West towards Torton Hill.
2. The inflow from the North East at the confluence of the outfall is known locally as Spring Ditch – this is the main inflow from a spring based supply rising from the Downs and partly controlled by Chalk Spring Fishery.
3. The other inflow is a ditch network which runs South from the confluence of the outfall chamber heading adjacent to the flood bank for several miles into farmland closer to Ford to the South of your site: this ditch also discharges through tidal outfalls further South, BUT in high tidal events water will backflow from that farmland and head Northwards back towards the confluence of the outfall so this needs to be counted for in any calculation.

The attached CCTV survey extract indicates a small drain run (225mm diameter pipe) from the southwest corner crossing the site towards the northeast. At the downstream end, there is a short stretch where this opens out into a 900mm diameter brick culvert. This mainly lies beneath the access track which is outside our site boundary. We have tried to investigate whether there is any potential for incoming flow at the upstream end, indicating if the pipe continues to serve a purpose or whether this is purely a historic remnant of the now-redundant gas works and can be fully abandoned. We would very grateful for any additional information you could provide on this.

We have no knowledge on this drainage system within your proposed site, but you may want to contact the owner of the adjacent field who may be able to supply some local information.

Tidal levels

Finally, please can you provide the maximum tide levels and tidal range for this stretch of the River Arun, both in winter and summer.

We could provide a whole dataset of tidal ranges, but typical levels for Winter are High 2.158m AOD Low -0.197m AOD, and Summer High 2.366m AOD Low -0.092m AOD.

Please note that for Arundel the tidal range is also influenced by the fluvial flow. Sometimes the outfalls cannot fully discharge due to the high fluvial flows. Incoming high tides can also be affected by tidal surge, wind, etc.

The data provided above is taken from a river level gauge just upstream of the old Arundel road bridge in Queens Street.

I hope we interpreted your questions correctly, and you find the information useful.

Please do not hesitate to contact us if you have further questions.

Kind regards,
Ele

Eleonora Pilla
Flood and Coastal Risk Management Officer | Partnership & Strategic Overview | West Sussex
Environment Agency | Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD

PSOWestSussex@environment-agency.gov.uk
National Customer Contact Centre: 03708 506506



From: Jemma Looney [REDACTED]
Sent: 16 April 2019 17:31
To: PSO West Sussex <[REDACTED]>
Cc: SSD [REDACTED]
Subject: RE: 180912 SSD99316 - Product 7 for Gas Works Site Arundel BN18 9DX

Good Afternoon,

I just wanted to check if my email below had been received as I realised the attachments were quite large? Please can you confirm.

I have removed the photographs from this email, and can send separately if required.

I would be grateful if you could perhaps let me know when we're likely to receive a response.

Many thanks for your assistance.

Jemma Looney (née Cooling)
Principal Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

Switchboard: +44 (0)1442 437500

<http://www.rsk.co.uk>

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Registered number: 4723837

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From: Jemma Looney
Sent: 12 April 2019 16:22
To: PSO West Sussex <[REDACTED]>
Cc: SSD Enquiries <[REDACTED]>
Subject: RE: 180912 SSD99316 - Product 7 for Gas Works Site Arundel BN18 9DX

Good Afternoon,

As a follow up from our enquiries last year (see below email chain), I would be grateful for your assistance with the following queries.

Sluice gate

Further to our previous correspondence below, we are trying to establish further information about the sluice just downstream from our site. For info, I have reattached our topographic survey showing the site location in red and the sluice in blue. I have also attached photographs of the sluice feature (upstream and downstream).

Can you please confirm if you have any information such as the following:

3. Do you have any detailed plans/information on the upstream/downstream flaps for this feature?
4. What is the capacity of this sluice and in particular the river side flap you refer to below. From your text below we understand the upstream flap is always open but to enable us to establish any flow capacity within this ditch, we need to gain an idea of the downstream pipe outfall.
5. Do you have any details on the condition of this sluice?

If you do not hold this information, please can you advise where we can obtain this information? We're just going off the EA signage at this location, indicating its an EA asset.

Existing culvert

We have also recently become aware of an existing culvert feature crossing beneath the site, as shown on the attached survey extract. We have requested information on this from Arun DC as the local planning/drainage department and they have stated *"The watercourse is within the IDB area and therefore is within the EA's jurisdiction. Please get in touch with them."*

The attached CCTV survey extract indicates a small drain run (225mm diameter pipe) from the southwest corner crossing the site towards the northeast. At the downstream end, there is a short stretch where this opens out into a 900mm diameter brick culvert. This mainly lies beneath the access track which is outside our site boundary. We have tried to investigate whether there is any potential for incoming flow at the upstream end, indicating if the pipe continues to serve a purpose or whether this is purely a historic remnant of the now-redundant gas works and can be fully abandoned. We would very grateful for any additional information you could provide on this.

Additionally, please can you provide any particular requirements you would wish to see accommodated within the proposal. It is essential to our development plan that we are able to divert this whole run if we are unable to abandon it completely.

Tidal levels

Finally, please can you provide the maximum tide levels and tidal range for this stretch of the River Arun, both in winter and summer.

Many thanks for your assistance.
Kind regards,

Jemma Looney (née Cooling)
Principal Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

Please note, I have recently changed my email address. Emails sent to my previous address will be redirected for some time, however please update any contact details for future reference.

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From: PSO West Sussex <[REDACTED]>
Sent: 17 September 2018 09:12
To: Emma Rowlands <[REDACTED]>
Cc: SSD Enquiries <[REDACTED]@environment-agency.gov.uk>
Subject: RE: 180912 SSD99316 - Product 7 for Gas Works Site Arundel BN18 9DX

Dear Emma,

Thank you for your Products 5, 6 and 7 for the Gas Works Site, Arundel, BN18 9DX.

Please read the attached covering letter with the licence information. Below is the link to download the Lower Tidal River Arun Strategy (LTRAS) model. This will expire after 30 calendar days.

<https://ea.sharefile.com/d-s3b4b55a9a6e47858>

With regard Spring Ditch outfall I have spoken with our Field Team. There are two flaps here. The one which you have the photo of is always open. The spindle is there just in case the one on the river side were to fail, then the spindle could be used to close the gate, should an emergency situation occur.

Please do not hesitate to contact us if you have any further queries at psowestsussex@environment-agency.gov.uk.

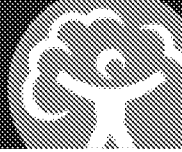
Kind regards,
Ele

Eleonora Pilla

Flood and Coastal Risk Management Officer | Partnership & Strategic Overview | West Sussex



Creating a better place
for people and wildlife



From: Emma Rowlands [REDACTED]
Sent: 10 September 2018 16:06
To: PSO West Sussex <[REDACTED]>
Subject: RE: GE3433 SSD85765 P4 Gas Works Site Arundel BN18 9DX

Hi Leanne,

Thank you for your response. We visited the site recently and noticed that there was a sluice gate adjacent to the site (please see attached topographic survey and photo showing its grid reference TQ 01368 06729). Please could you provide any information you may have on this?

In addition, please could you provide the model data files for the site?

Kind Regards,
Emma

From: PSO West Sussex [REDACTED]
Sent: 02 July 2018 14:32
To: Emma Rowlands [REDACTED]
Cc: SSD Enquiries [REDACTED]
Subject: RE: GE3433 SSD85765 P4 Gas Works Site Arundel BN18 9DX

Dear Emma,

The tidal levels, depths and outlines all have the current climate change allowances. For fluvial, we only have (and therefore can only provide) the superseded 20% allowances for this model. Guidance on climate change allowances and how to use them in Flood Risk Assessments can be found [here](#).

Advice on finished floor levels would have to go to our planning team. We highly recommend using pre-application service. If you do decide to use this service I would forward this email (with the P4 attachments) onto PlanningSSD@environment-agency.gov.uk with your enquiry.

I have provided two separate Flood Defence Maps, and we will ensure this is made clearer in the future. The pink and white line was showing a simple culvert, however this layer was meant to have been turn off as it is not regarded as a defence.

The flood defence referred to in the covering letter is the Embankment which is shown in brown on the map. We do not keep records of the height of the defences as these are EA maintained and not EA owned. Information on Flood and Coastal Risk Management asset information, and details of all planned maintenance activities can also be viewed using the [Asset Management Service](#).

I hope this helps, and if you have any other questions about this request please let us know.

Kind regards,

Leanne Prentice

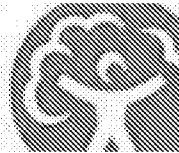
FCRM Officer, Partnerships & Strategic Overview Team West Sussex

Environment Agency | Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD



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From: [REDACTED]
Sent: 27 June 2018 16:58
To: PSO West Sussex <[REDACTED]>
Cc: SSD Enquiries <[REDACTED]>
Subject: 180527: GE3433 - Ini - SSD85765: Pr4 and surface water flood map Arundel BN18 9DX:

Hi Ele,

Thank you for sending across the Product 4 data for the above site. We are in the process of advising our client on proposed mitigation measures to the site and need to establish what flood level to use. We therefore have the below questions about the data:

1. Tidal levels and Flood outlines:

- Please could you confirm whether these levels/outlines already include the new climate change allowances (superseded 20%). It appears that some levels may include the new levels and some don't, please can you make this clear in the levels and depths tables.
- Please advise on which level should be used for the purpose of assessing flood risk on site. We need to ensure we provide adequate advice back to the client on what finished floor levels should be raised to, if floodplain compensation is required, to what level and if any additional mitigation is required. We appreciate the EA's planning team may need to input on required mitigation, however at this stage we need to establish the levels for discussion.

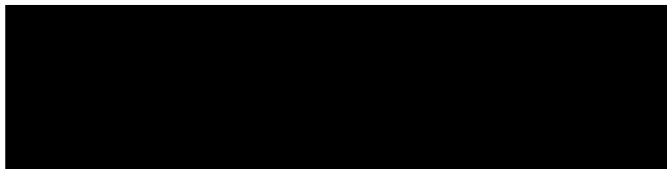
2. Flood Defence Map:

- Please could you clarify what the pink and white line is.
- How do we tell the difference between EA maintained defences and 3rd Party maintained defences as the key shows the same colour scheme for both?
- Please could you provide information on the height of the defences. – i.e. do the defences defend both the tidal and fluvial events?
- The cover letter states that the defences provide protection up to the 1 in 75 year event. Please could you clarify which defences this relates to, or whether it is all of them?

Kind Regards,
Emma

Emma Rowlands
Graduate Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



<http://www.rsk.co.uk>



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From: PSO West Sussex [mailto:
Sent: 06 June 2018 14:51
To: Emma Rowlands
Cc: SSD Enquiries
Subject: RE: 180514:SSD85765: Pr4 and surface water flood map Arundel BN18 9DX:Due by 31 May

Dear Emma,

Thank you for your Product 4 request for **Gas Works Site, Ford Road, Arundel, BN18 9DX**. Please find attached the flood risk data.

For information on flooding from other sources such as surface water please contact the Lead Local Flood Authority, West Sussex County Council.

For FRA and pre-planning advice please see attached FRA Advisory Text and Planning Advice from the Environment Agency.

Please be aware that in February 2016 the Environment Agency updated its guidance on climate change allowances. The standard allowance of adding 20% to peak flows – as per previous guidance in the National Planning Policy Framework, may not be applicable for the purposes of informing development proposals. It is possible that our current modelling has under estimated flood risk when taking climate change into consideration. This does not however have an effect on Flood Zone 2 or 3. Guidance on climate change allowances and how to use them in Flood Risk Assessments can be found [here](#).

For future reference, detailed flood information and maps can be viewed using the [Long Term Flood Risk Information](#) service and [Flood Map for Planning](#) service. Flood and Coastal Risk Management asset information, and details of all planned maintenance activities can be viewed using the [Asset Management Service](#).

If you have any further queries about this request, please do not hesitate to contact us at

Kind regards,

Ele

Eleonora Pilla

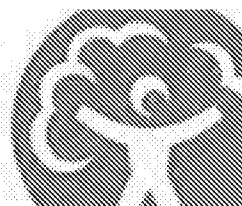
Flood and Coastal Risk Management Officer | Partnership & Strategic Overview | West Sussex
Environment Agency | Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD

Defra are consulting on minor changes to the Environmental Permitting Regulations for Flood Risk Activities. The [consultation](#) will run for 10 weeks from 10 April - 20 June 2018.



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From: ERowlands@rsk.co.uk

Sent: 09 May 2018 11:47

To: Enquiries, Unit

Subject: Site at Arundel - Request for Product 4 data and surface water flood maps

Dear External Relations,

Please could we request a **Product 4 (Detailed FRA/FCA Map)** and **the surface water flood maps** for the following site:

Gas Works Site
Ford Road

Arundel
BN18 9DX

OS Grid ref: 501282, 106746

I have also attached a map with the site highlighted.

Please can we obtain **flood levels and flows** for all available return periods for the watercourses within this area i.e. the River Arun (EA Main River) and any other watercourses.

Please can we also obtain any surface water flooding maps if available.

Please can you also provide any details of further constraints such as culverts etc and any historical flood mapping.

If you require any additional information, please do not hesitate to contact me.

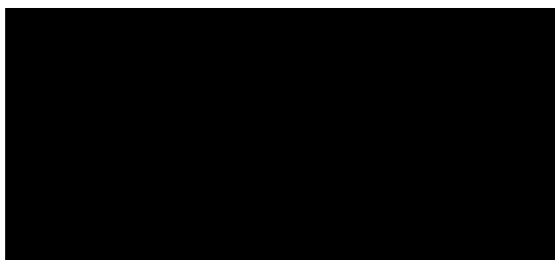
Many thanks.

Kind Regards,

Emma

Emma Rowlands
Graduate Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



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Ms E Rowlands
RSK LDE
18 Frogmore Road Industrial Estate
Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Our ref: HA/2018/120530/01-L01
Your ref: 133309
Date: 28 August 2018

Dear Ms Rowlands

Detailed Advice

35 residential units in 2 apartment blocks. Any comments on this site, particularly regarding flood risk and drainage and questions.

Gas Works Site, Ford Road, Arundel, BN18 9DX

Thank you for accepting our offer to provide detailed planning advice.

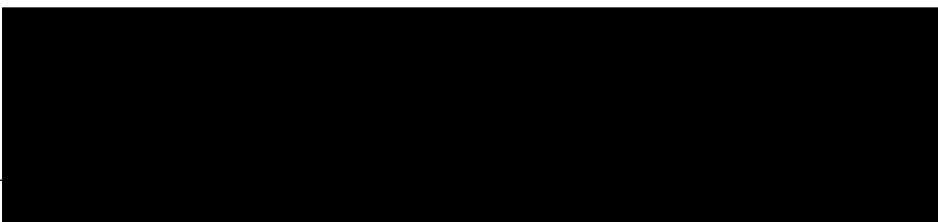
We are providing this advice under Agreement No. ENVPAC/1/SSD/00030. Please note we have taken 4 hours to review and provide our advice on these documents which is as estimated in our Programme of Works. The total will now be £400 plus VAT which is payable on receipt of our invoice.

Environment Agency Advice

We have reviewed the submitted information in relation to the proposed development and have the following detailed comments

According to our Flood Map for Planning (Rivers and the Sea) the site is located in Flood Zone 3, and is at risk from both tidal and fluvial sources. Furthermore according to Arun Strategic Flood Risk Assessment (2016) the site is partially within Flood Zone 3b (functional flood plain, defined as the defended case 1 in 20-year annual probability - 5% Annual Exceedance Probability - event).

As stated in Table 1 (Flood Zones) of the Planning Policy Guidance (PPG) to the National Planning Policy Framework (NPPF) this zone comprises land where water has to flow or be stored in times of flood. In line with Table 3 (Flood Risk Vulnerability) of the PPG only Essential Infrastructure and Water Compatible uses are permitted in this zone, and only if the Exception Test has been passed.



The proposed residential accommodations fall under the More Vulnerable classification as per Table 2 (Flood Risk Vulnerability Classification).

Therefore the proposed development would be against the national policy if it is proposed to build within the Flood Zone 3b.

If this Policy issue could be overcome, and after the Sequential Test has been successfully applied, then the Exception Test will have to show how you will manage flood risk on and off the site.

In regards to other sources of flooding (e.g. surface water, groundwater, ordinary watercourses, drainage, etc.) we would advise to contact the Lead Local Flood Authority West Sussex County Council and the Local Authority Arun District Council.

There are two IDB watercourses nearby the site. Any works in, over, under or within 5 metres will require a Flood Defence Consent from the Environment Agency, as the Internal Drainage Board.

1. Please can you confirm the new climate change allowance (%) which should be included within our assessment of flood risk. Please can you also confirm the acceptable technical methodology for applying this new allowance.

The higher central (45%) and upper (105%) peak flow allowances should be used for this type of development (taken from Table 1 peak river flow allowances by river basin district).

For further guidance on how climate change could affect flood risk to new development please visit: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

In order to account for flood risk impacts due to climate change, in major development proposals, we would expect a detailed hydraulic modelling, through either re-running EA hydraulic models or construction of a new hydraulic model by the developer.

You can request one of our flood risk product to SSDenquiries@environment-agency.gov.uk

2. Please could you confirm which levels we should use for the purpose of assessing flood risk on site (ie. Whether to use fluvial, tidal, defended or undefended levels).

You will have to design your mitigation measures to mitigate for the design flood plus an allowance for climate change, which will be the worst case scenario between fluvial (1% AEP plus climate change), tidal (0.5% plus climate change), defended and undefended levels.

3. Please could you outline your requirements for FFLs and floodplain compensation (i.e. what level of mitigation would be expected).

Finished floor levels for habitable room should be set at least 300mm above the design level plus an allowance for climate change.

Loss of flood plain storage will need to be assessed within the Flood Risk Assessment (FRA), and adequate flood plain compensation will be required. As stated in the NPPF (Paragraph 155), development should be directed away from the areas of highest flood risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

You must therefore ensure that there is no loss of flood flow or flood storage capacity for floods up to the design flood as a result of the proposed development, including an appropriate allowance for climate change, and should seek to create a net flood risk benefit wherever possible.

Furthermore the location of the compensation works must relate hydraulically and hydrologically to the location of the site.

Other basic requirements for compensatory floodplain storage are as follows:

- A volume of floodplain equal to or larger than that lost to the proposed development must be created
- The volume must apply at all levels between the lowest point on the site and the design flood level including climate change. Normally this is calculated by comparing volumes taken by the development and the volume offered by the compensatory storage for a number of horizontal 'slices' through the range defined above.
- The thickness of a vertical slice should typically be 0.2 metres. In the case of large flat sites or very steep sites this may be varied, for example for flat sites to 0.1 or even 0.05 metres. The slice thickness should be set to provide between ten and fifteen slices for such unusual sites.

There is currently an existing substation on the site which may be retained as part of the proposals. As part of your response, please could you provide some advice on this (ie. whether any mitigation measures are required).

We would recommend that a desk study and site investigation is undertaken along with a remediation strategy. In terms of drainage, soakaways would not be allowed in contaminated ground unless you have undertaken sufficient remediation in those areas. Groundwater is likely to be shallow there though the site lies on Raised Terrace deposits over Chalk. The site is not in a source protection zone. The biggest risk here is to the River Arun from contamination. If you are likely to want to pile, we may need to recommend conditions for piling.

I hope the above advice is helpful. Should you have any further queries please do not hesitate to contact me.

Yours sincerely

Miss Hannah Brothwell
Sustainable Places Advisor



Disclaimer

Our opinion is based on the information available to us at the time of the enquiry. When the formal planning application is submitted, our position may change if there have been changes to environmental risk or evidence, and/or planning policy.

End

Jemma Looney

From: Brothwell, Hannah [REDACTED]
Sent: 28 September 2018 09:46
To: Emma Rowlands; Jemma Looney
Subject: RE: Cost recovered detailed advice - Gas Works Site Arundel

Hello Emma and Jemma

Thank you for your email, we have the following comments to make:

I can confirm we consider the work done using the intermediate approach to estimate the design flood level allowing from climate change acceptable and so detailed modelling is not required. This would set the 1%AEP (1in100) event plus 45% at 3.64mAOD and the 1%AEP (1in100) event plus 105% at 4.12mAOD. Using the conservative approach of taking the 105% level to set the minimum FFL at 4.42mAOD would be acceptable. It is encouraging to see that the development proposal include residential accommodation set at the upper ground floor level of 5.3mAOD.

We would not expect to see floor levels raised for non-residential areas such as cycle and refuse storage. We would expect to see floodplain compensation for the fluvial 1%AEP event plus 45%, 3.64mAOD.

The FRA needs to show that the development is not increasing flood risk to any existing infrastructure on the site such as electricity substations. However, it would not be expected to actively reduce the risk of flooding to the substation.

The Lower Tidal River Arun Strategy recommended that the defences in Arundel are improved to sustain the current level of protection. We are not currently at a stage where we know when a scheme for the area will be delivered.

I hope this is helpful but please let me know if you require any further information.

Many thanks
Hannah

Hannah Brothwell | Planning Advisor | Sustainable Places | Solent and South Downs Area | Environment Planning and Engagement
Environment Agency | Romsey Depot | Canal Walk | Romsey | Hampshire | SO51 7LP
[REDACTED]

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Our [Flood Risk Standing Advice](#) has been updated



Planning for the
future of water



From: Emma Rowlands [mailto:emma.rowlands@environment-agency.gov.uk]
Sent: 10 September 2018 16:49
To: Brothwell, Hannah <hannah.brothwell@environment-agency.gov.uk>
Cc: Jemma Looney <JLooney@rsk.co.uk>
Subject: RE: Cost recovered detailed advice - Gas Works Site Arundel

Dear Hannah,

Many thanks for your response. Please see our comments below:

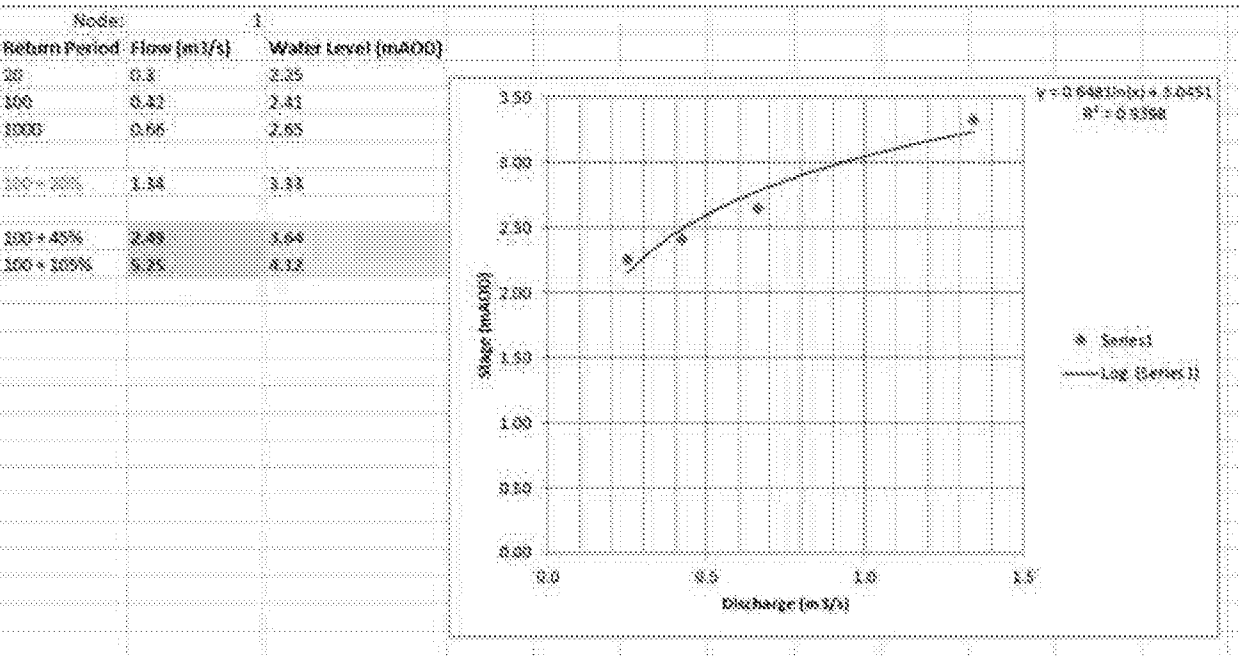
Please can you confirm the new climate change allowance (%) which should be included within our assessment of flood risk. Please can you also confirm the acceptable technical methodology for applying this new allowance.

We have used the Intermediate approach to calculate the fluvial 1 in 100 year climate change levels with the higher central (45%) and upper (105%) allowances.

The stage-discharge relationship was extrapolated at EA node 1. The stage-discharge relationship yielded the following flood levels:

- 1 in 100 year plus 45% climate change – 3.64m AOD
- 1 in 100 year plus 105% climate change – 4.12m AOD.

See below screenshot for calculation details. Please let us know if this method is sufficient.



Given that this calculated worst case fluvial flood level of 4.12m AOD is close to the worst case defended tidal flood level of 4.02m AOD, we would consider this reasonable grounds to base our Flood Risk Assessment on. In addition, the latest development proposals include residential accommodation set at the upper ground floor level of 5.3m AOD and above, which is significantly (more than 1m) above the above 1 in 100 year plus 105% CC flood level (4.12m AOD). We would suggest this is sufficient reason that detailed flood modelling would not be required for this proposal, however we look forward to your confirmation.

Please could you outline your requirements for FFLs and floodplain compensation (i.e. what level of mitigation would be expected).

Based on the calculated levels above, we would assume that a minimum finished floor level of 4.42m AOD would be considered appropriate (300mm above worst case flood level as recommended). As stated above, the development proposals provide an even better solution as the proposed residential accommodation is set at the upper ground level of 5.3m AOD and above. We would therefore consider this to be appropriate, however please can you confirm. The current proposals include a lower ground floor (set at approximately 2.8m AOD), which would be solely used for parking, cycle/refuse storage and void spaces, and therefore we consider it appropriate that floor levels do not need to be raised here, however please can you confirm.

Based on recent experience, we anticipate that floodplain compensation would need to be provided for the fluvial 1 in 100 year plus 45% climate change event (3.64m AOD) only. Please confirm that this is acceptable.

There is currently an existing substation on the site which may be retained as part of the proposals. As part of your response, please could you provide some advice on this (ie. whether any mitigation measures are required).

Your latest response did not provide any comment on the potential mitigation required for a substation, simply reference to the need for Site Investigation data. At present it is undecided whether this substation will stay in its current location or be moved elsewhere within the site. Please could you therefore provide advice regarding what mitigation measures would be required for either option, so that this can be considered within the development proposal.

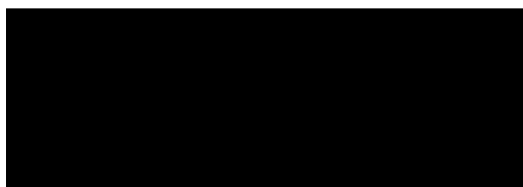
Finally, we are aware of the Lower Tidal River Arun flood risk management scheme proposed for the wider area, as described on your website [here](#). Please can you provide an update on the progress of this scheme, and provide details of the latest proposals for any upgrade to defences in the site area.

We look forward to receiving your confirmation on the detailed points above, however should you require any further information, or feel it necessary to discuss further via phone call or in a meeting, please do let us know.

Kind Regards,
Emma

Emma Rowlands
Graduate Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



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From: Brothwell, Hannah [mailto:[\[redacted\]](#)]
Sent: 29 August 2018 09:54
To: Emma Rowlands <[E.\[redacted\]](#)>
Subject: Cost recovered detailed advice - Gas Works Site Arundel

Dear Ms Rowlands

Please find attached our cost recovered detailed advice regarding the site: Gas Works Site Arundel

Kind regards
Hannah

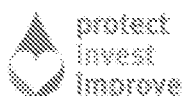
Hannah Brothwell | Planning Advisor | Sustainable Places | Solent and South Downs Area | Environment Planning and Engagement

Working in partnership to enable sustainable growth and create better places for people and wildlife

We offer a cost recovery service for bespoke pre-application advice. For more information go to: [gov.uk](https://www.gov.uk) or [email us](#)

Have a look at '[Building a Better Environment](#)', our guide for developers

Our [Flood Risk Standing Advice](#) has been updated



Planning for the
future of water



We are currently experiencing a high level of workload and dealing with a large volume of incident work due to the extended dry weather.

Whilst we will endeavour to respond to your consultation/enquiry we anticipate that there may be a delay in our response. We apologise for any inconvenience this may cause.

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Ms Jemma Looney
RSK LDE
18 Frogmore Road Industrial Estate
Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Our ref: HA/2018/120530/04-L01
Your ref: ENVPAC/1/SSD/00030
Date: 30 April 2019

Dear Ms Looney

DETAILED ADVICE

GAS WORKS SITE, FORD ROAD, ARUNDEL, BN18 9DX

Thank you for accepting our offer to provide detailed planning advice. We have reviewed the further information and questions submitted

We are providing this advice under Agreement No. ENVPAC/1/SSD/00030. Please note we have taken 5 hours to review and provide our advice which is slightly less than we estimated in our offer letter. The revised total will now be £500 plus VAT which is payable on receipt of our invoice.

Environment Agency Advice

We have reviewed the submitted information in relation to the proposed development and have the following detailed comments in bold. These are based on the information available at the time of writing, namely emails and attachments from Jemma Looney dated 13/02/2019 and 09/04/2019.

Questions in email dated 13/02/2019.

- As the lower ground floor will be set at levels slightly lower (approx. 2.7/2.8mAOD) than existing ground levels (3.4mAOD), we assume the EA will have no objection to this, given the proposals at this level only include cycle, refuse storage, car parking, voids and access cores. This could potentially provide more flood storage volume than the existing scenario.



We would not normally support proposals for lowering ground levels in a fluvial flood zone 3 area, as this could increase the risk of flooding. In this case the ground floor will not have any habitable accommodation, therefore, on the basis of the information provided, we would have no objection to this being set at 2.8m AOD. We would advise to check groundwater levels on the site as these may be high.

- Our client is aware of the potential flood depths in these areas (up to 1.4m during the worst case 1 in 100 year plus 105%CC flood event) but would like confirmation the EA will not object to this element of the scheme. We should note that this proposed level of 2.8mAOD is close to the 1 in 20 year flood level of 2.67mAOD and therefore we would appreciate any advice you may have. Our client is proposing to incorporate flood doors, offering protection up to 600mm (equating to 3.4mAOD). Whilst not fully protecting the lower ground level against the extreme events, this would protect against the lower return period events up to the 1 in 100 year plus 20% climate change.

We would not expect you to fully protect the ground floor as this will not have any habitable rooms. Please be aware that voids as means of flood plain compensation are normally contrary to our guidance. Issues with voids include trapped debris and blockages under the building, and silt accumulations which is difficult to clean down after a flood event and can potentially lead to public health issues. Therefore we would suggest to assess the option to have the undercroft as car park, as long as this remains open with no barrier to the flow route of flood water. We would also encourage to retain the garden space, currently allocated to car park.

In regards to Flood Zone 3b, we would expect no development to take place within the extent of Flood Zone 3b.

- In addition, our client has an aspiration to 'infill' the front entrance to the site to create a more appealing entrance (highlighted in yellow on the attached plan). As this area is outside the 1 in 100 year plus 45% CC flood extent (as shown), we do not envisage any problems will infilling this area. Please can you confirm.

If this area is outside the fluvial climate change outline land raising should not be a problem.

Questions in email dated 09/04/2019 and attachment '133309 - 10-12 - Floodplain Compensation (P3)' (which supersedes email dated 29 March 2019)

Just to note, we have now updated our floodplain compensation calculations to incorporate a new layout, therefore please see attached for the latest version to be used for providing your advice. To update the info as below:

- This revision now takes into account the existing substation and proposed wall volumes, and shows the amended flood outline for the post-development scenario
- As before, the only areas to be protected from floodwaters at the lower ground level are those shown in dark blue (including the wall volumes) amounting to 69.5m³ (Table 1)
- The two existing raised areas (concrete platform and spoil heap) and existing substation slab shown in green amount to 222m³ of recoverable volume (Table 2), when removed back to existing ground levels.
- The proposed areas of floodplain that will be gained as a result of changing levels are shown in pink, offering additional compensatory storage of 89.7m³ (Table 3).

We agree with the principle of the flood plain compensation.

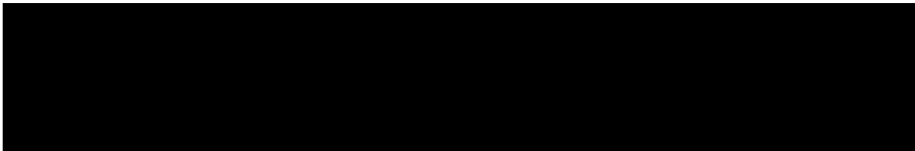
We would expect the Flood Risk Assessment to look at all sources of flooding. In particular the site might be vulnerable due to the effects of tide lock. During prolonged rainfall events considerable run off from three watercourses is reliant on discharging into the River Arun through the main sluice. When the adjoining River Arun water levels are above the sluice outfall inevitably backing up occurs and the adjoining sites get flooded.

The site is next to an Internal Drainage Board (IDB) ditch. Any works in under or over or within 5 metres of the watercourse bank tops will require the formal consent of the Environment Agency.

I hope the above advice is helpful. If there is any further work you anticipate needing our detailed advice on in relation to this project please contact me on the details below.

Yours sincerely

Miss Hannah Brothwell
Sustainable Places Advisor



Disclaimer

Our opinion is based on the information available to us at the time of the enquiry. When the formal planning application is submitted, our position may change if there have been changes to environmental risk or evidence, and/or planning policy.

Jemma Looney

From: Brothwell, Hannah <[REDACTED]>
Sent: 23 May 2019 13:31
To: Jemma Looney
Subject: FW: Detailed advice - Gasworks ENVPAC/1/SSD/00030

Hi Jemma

Apologies for the delay, please find below our answers to your questions in red text.

Kind regards
Hannah

From: Jemma Looney <[REDACTED]>
Sent: 10 May 2019 14:10
To: Brothwell, Hannah <[REDACTED]>
Cc: PSO West Sussex <[REDACTED]>
Subject: RE: Detailed advice - Gasworks ENVPAC/1/SSD/00030

Good Afternoon Hannah,

Many thanks for your response confirming the proposals and generally the floodplain compensation calculations are acceptable.

We have a few points that require further clarification, as follows:

Undercroft parking and voids

Whilst undercroft parking has been provided in some areas, it is not feasible to utilise all undercroft areas as parking spaces due to tracking of vehicles into those areas. In order to meet local parking standards, it is not considered feasible to remove parking spaces from the garden area; this area is required to meet the number of spaces needed for the development. The attached mark-up SK04 indicates how undercroft parking has been maximised (highlighted yellow), and you will note that other undercroft areas are either utilised for refuse/cycle stores, central cores or more inaccessible for tracking.

We should note that the void areas have been designed in accordance with standard EA criteria including:

- Fully open void space underneath the building
- Void opening heights are provided to the height of the 1% plus additional relevant climate change allowance
- Void openings will be a minimum of 1m wide
- At least one void opening is located in every 5m of wall section (shown on plan)
- Bars will be incorporated at 100mm intervals for security reasons/prevention of storage

As stated in our previous email, the EA would not normally support voids as means of flood plain compensation as this does not guarantee that the floodplain will be retained in the same way as a compensation scheme. An example of where stilts or voids could be considered appropriate is where a replacement dwelling of similar footprint is proposed either wholly within Flood Zone 3, or where space for a conventional scheme is limited due to land ownership. It will need to be demonstrated why a conventional scheme is not possible to be implemented, as well as a plan being agreed between the applicant and the local planning authority to ensure that the voids are managed and maintained for the lifetime of the development.

Also the interaction between overland flood flow routes and voids should be looked at, and how the voids will work under flooding circumstances.

Sources of flooding

In relation to your comment about addressing all sources of flooding, the FRA will assess the risk posed to the site from all sources of flooding including fluvial, tidal (including tide locking), surface water, groundwater, artificial drainage and reservoir flooding. Firstly, your response mentions 3 watercourses. We have been in separate contact with your

Partnership & Strategic Overview team who have marked up the attached watercourses map. Please can you confirm that the 3 watercourses you refer to in your letter are as shown i.e. IDB ditch, Spring Ditch and the backflow from the ditch to the south? For ease of reference and communication, I have attached the latest email correspondence from your PSO team and copied them in.

We are pleased to see that all sources of flooding will be assessed in the FRA, and confirm that the watercourses map attached to your previous email shows the most up to date records.

Regarding tide locking, we are currently in separate discussions with Arun DC (acting on behalf of West Sussex CC as LLFA) on how best to include this within the drainage strategy and model, as we understand they will be approving the surface water drainage strategy as part of the application.

Regarding watercourse easements and consenting, we understand the IDB ditch is within the EA's remit (please confirm), therefore any works in under or over or within 5m of this watercourse will require the formal consent of the EA (as stated in your letter). As this 5m offset mainly sits outside the boundary, this is likely only to impact on the proposed surface water drainage outfall.

Existing culvert

As a separate question (you will note this was stated in our email to the PSO team), we have also recently become aware of an existing culvert feature crossing beneath the site, as shown on the attached survey extract. Your PSO team have confirmed "We are not aware of the culverted watercourse indicated with the letter B in your attachment".

In the absence of any further information from the EA, we are proposing to refer to the advice from Arun DC, as included in the final attached email. This indicates that the watercourse should be left in place or diverted unless evidence indicates it is no longer in use, no buildings to be located over the watercourse and a 3m easement to be provided. Please confirm you would not have any further requirements for this feature.

We agree with the advice provided by Arun DC.

I look forward to hearing from you.

Kind regards,

Jemma Looney (née Cooling)
Principal Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

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From: Brothwell, Hannah <
Sent: 30 April 2019 17:10

To: Jemma Looney <[REDACTED]>
Subject: Detailed advice - Gasworks ENVPAC/1/SSD/00030

Hello Jemma

Please find attached our detailed advice following your emails under agreement reference ENVPAC/1/SSD/00030.

Should you have any further queries please do not hesitate to contact me.

Kind regards
Hannah

Hannah Brothwell | Planning Advisor | Sustainable Places | Solent and South Downs Area | Environment Planning and Engagement
Environment Agency | Romsey Depot | Canal Walk | Romsey | Hampshire | SO51 7LP
Tel: 02084 745865 Mobile: 07789747374
Hannah.brothwell@environment-agency.gov.uk

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APPENDIX E

WEST SUSSEX COUNTY COUNCIL

CORRESPONDENCE

Emma Rowlands

From: Alison Woodfield [mailto:alison.woodfield@arundel.gov.uk] on behalf of PL Planning Applications
Sent: 09 May 2018 16:58
To: Emma Rowlands
Subject: RE: Enquiry re. Local Flooding issues in Arundel area

This application needs to be sent to Arun District Council (planning@arun.gov.uk)

The Lead Local Flood Authority (LLFA) will not be respond until the applicant has a formal response from the EA.

Regards
Alison

From: ERowlands@rsk.co.uk [mailto:ERowlands@rsk.co.uk]
Sent: 09 May 2018 11:51
To: Flood Risk Management; Kevin Macknay
Cc: PL Planning Applications
Subject: Enquiry re. Local Flooding issues in Arundel area

FAO: Drainage and Flooding team

Good Afternoon,

We are Engineering Consultants acting for a Client who is considering development of a site within the Arundel area. We are in the process of producing a Flood Risk Assessment for the site and would be grateful for your input on the following points.

For reference, I have included a site plan.

The site is approximately 0.43ha in size and the proposals include the development of approximately 35 residential units across two apartment blocks (two storeys).

Flooding records/maps

Are the council aware of any local flooding issues within the Arundel area? As part of our Flood Risk Assessment we will be documenting any recorded incidents of flooding so any records/anecdotal evidence that the council may have, would be of great help. In particular we would be interested to hear of any reported incidents of surface water, highway or groundwater flooding.

Are there any surface water flood maps available and if so please can we obtain a copy?

We have recently submitted a request for data from the Environment Agency and are currently awaiting their response. We anticipate that they will be able to provide us with any relevant modelled fluvial/tidal flood levels for the site.

Flood Mitigation Measures

Can you provide information on any required flood mitigation measures you may suggest for development in this area, if deemed necessary.

Surface Water Drainage Strategy

We understand that there will no longer be a requirement for local authorities to set up SABs, as previously indicated under Schedule 3 of the Flood Water Management Act 2010, however we understand that West Sussex County Council are now a statutory consultee on all major planning applications and will be providing comments on the surface water drainage for new sites.

At this stage, a formal drainage strategy has not yet been produced, however the general principles will likely include:

- Sustainable drainage features (SuDS) where feasible
- Discharge to ground/watercourse/sewer
- Accommodate the 1 in 100 year plus climate change storm event on site

Therefore we would be grateful if you could please provide your pre-planning advice on the surface water drainage strategy for this site? Are there any particular local requirements that the council wish to raise, relating to the proposed drainage strategy for the area, such as:

- Any discharge restrictions
- Use of SuDS features – what types and level of adoption
- Level of drainage detail required at the planning stage
- Any interim guidance for proposed drainage on new developments in this area?

Following the recent publication of the new climate change allowances from the Environment Agency, please can you confirm what West Sussex County Council consider to be an appropriate climate change allowance for developments in this area.

If you have any formal pre-planning procedure i.e. forms, fees etc, please can you provide details.

The above information would be of great assistance in developing the masterplan, drainage strategies and designs for the project prior to planning submission.

Many thanks for your time.

I look forward to your reply.

Kind regards,

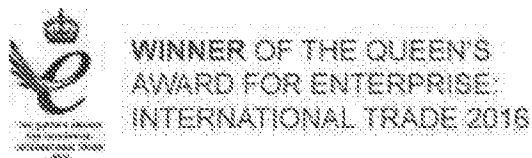
Emma

Emma Rowlands
Graduate Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



<http://www.rsk.co.uk>



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Emma Rowlands

From: Kevin Macknay [REDACTED]
Sent: 11 May 2018 16:40
To: Emma Rowlands
Subject: RE: Enquiry re. Local Flooding issues in Arundel area
Attachments: Ford Road, Arundel.docx

Emma,

Further to your recent enquiry. Many of the questions you have raised will be covered in the 'West Sussex LLFA Policy for the Management of Surface Water', which can be found on our web site.

[REDACTED]

This document has been adopted by all our partner borough and district councils, who take the lead with regards to the checking and discharge of drainage matters linked to new developments, and sets out what information is required at the planning stage of any development.

With regards to the site in question. I have attached a plan showing the local flood risk from both surface water and the rivers / sea. As you can see the development area is almost wholly within the EA's Flood zones 2/3 and therefore you will need to consult with them regarding this development.

A drainage strategy and flood risk assessment will be necessary for this development.

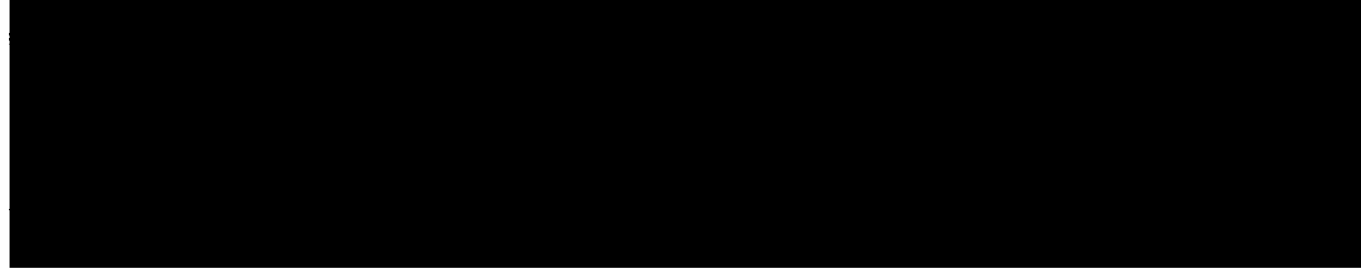
With regards to the other questions you have asked:

- Any discharge restrictions
Likely to be set by the EA, as the site is likely to discharge direct to the River Arun.
- Use of SuDS features – what types and level of adoption
Should be covered in our surface water policy. However, you may have issues with high ground water due to the proximity of the river.
- Level of drainage detail required at the planning stage
The more the better. Will be covered in our surface water policy
- Any interim guidance for proposed drainage on new developments in this area?
Will be covered in our surface water policy
- Following the recent publication of the new climate change allowances from the Environment Agency, please can you confirm what West Sussex County Council consider to be an appropriate climate change allowance for developments in this area.
Will be covered in our surface water policy

Hope this helps.

Regards,

Kevin Macknay
Flood Risk Management – Team Leader
Economy, Infrastructure and Environment
Highways and Transport
West Sussex County Council



From: [Redacted] <[Redacted]>

Sent: 09 May 2018 11:51

To: Flood Risk Management; Kevin Macknay

Cc: PL Planning Applications

Subject: Enquiry re. Local Flooding issues in Arundel area

FAO: Drainage and Flooding team

Good Afternoon,

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Are there any surface water flood maps available and if so please can we obtain a copy?

We have recently submitted a request for data from the Environment Agency and are currently awaiting their response. We anticipate that they will be able to provide us with any relevant modelled fluvial/tidal flood levels for the site.

Flood Mitigation Measures

Can you provide information on any required flood mitigation measures you may suggest for development in this area, if deemed necessary.

Surface Water Drainage Strategy

We understand that there will no longer be a requirement for local authorities to set up SABs, as previously indicated under Schedule 3 of the Flood Water Management Act 2010, however we understand that West Sussex County Council

are now a statutory consultee on all major planning applications and will be providing comments on the surface water drainage for new sites.

At this stage, a formal drainage strategy has not yet been produced, however the general principles will likely include:

- Sustainable drainage features (SuDS) where feasible
- Discharge to ground/watercourse/sewer
- Accommodate the 1 in 100 year plus climate change storm event on site

Therefore we would be grateful if you could please provide your pre-planning advice on the surface water drainage strategy for this site? Are there any particular local requirements that the council wish to raise, relating to the proposed drainage strategy for the area, such as:

- Any discharge restrictions
- Use of SuDS features – what types and level of adoption
- Level of drainage detail required at the planning stage
- Any interim guidance for proposed drainage on new developments in this area?

Following the recent publication of the new climate change allowances from the Environment Agency, please can you confirm what West Sussex County Council consider to be an appropriate climate change allowance for developments in this area.

If you have any formal pre-planning procedure i.e. forms, fees etc, please can you provide details.

The above information would be of great assistance in developing the masterplan, drainage strategies and designs for the project prior to planning submission.

Many thanks for your time.

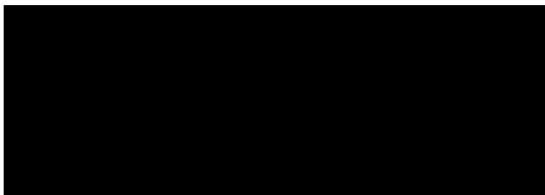
I look forward to your reply.

Kind regards,

Emma

Emma Rowlands
Graduate Hydrologist

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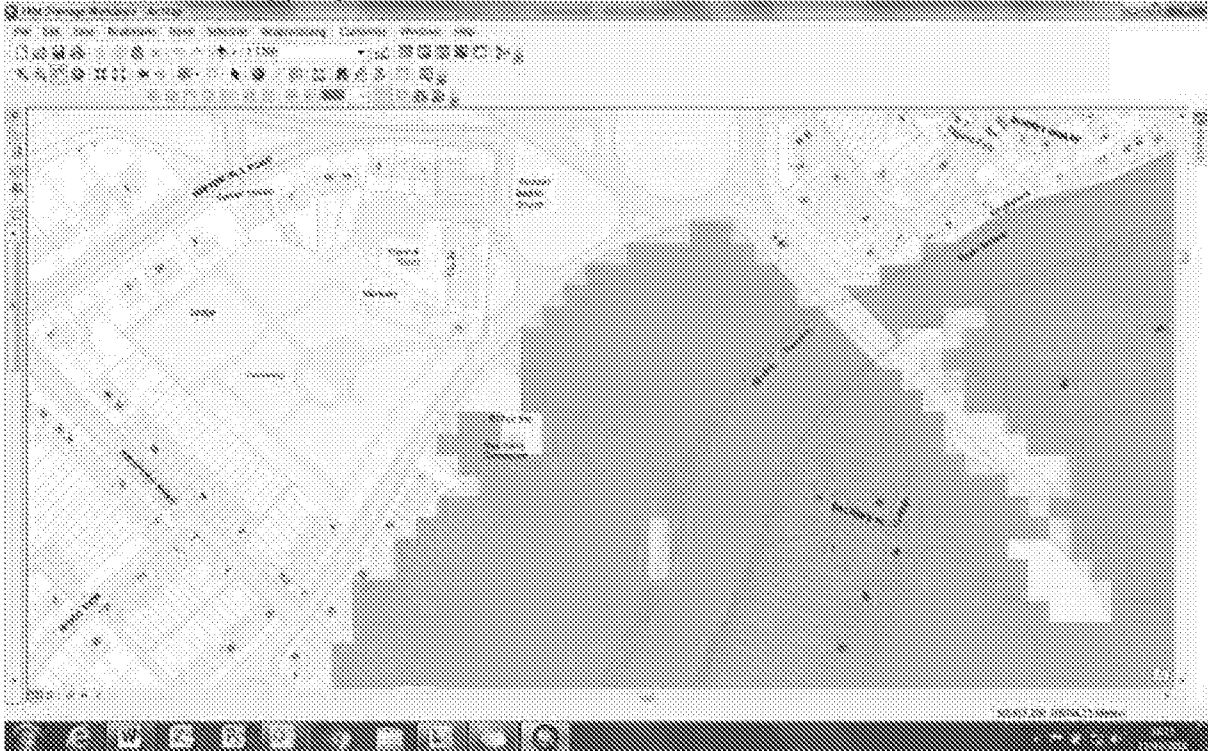
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Old gas valve compound, Ford Road, Arundel.

Flood mapping for surface water – 1 in 30 and 1 in 100 storm events.



EA Flood zone mapping – Flood Zones 2 and 3.





APPENDIX F

ARUN DISTRICT COUNCIL

CORRESPONDENCE

Jemma Looney

From: Laura Gibbons <[REDACTED]>
Sent: 02 October 2018 08:35
To: Jemma Looney
Cc: Emma Rowlands
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Jemma,

Sorry, I have been away on leave. The information you have provided is fine, happy for you to progress using this.

Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)



From: Jemma Looney [mailto:[REDACTED]]
Sent: 28 September 2018 16:34
To: Laura Gibbons
Cc: Emma Rowlands
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

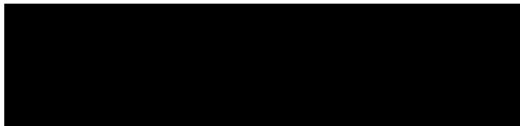
Hi Laura,

Please can you provide a response to our enquiry below.

Many thanks,

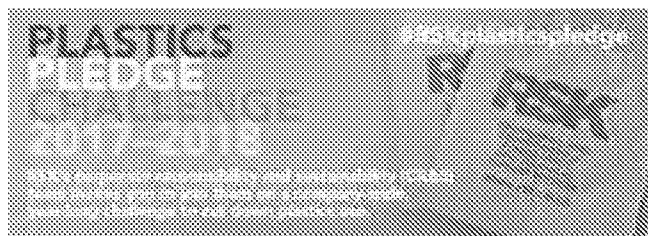
Jemma Looney (née Cooling)
Senior Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



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From: Emma Rowlands
Sent: 20 September 2018 13:40
To: Laura Gibbons <[REDACTED]>
Cc: Jemma Looney <JLooney@rsk.co.uk>
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Laura,

Please see the screenshot below of our workings for the modified rational method. I have also attached the FEH rainfall data screenshots.

2.2 Modified Rational Method - DEVELOPED SITE

$$Q = 2.78 C_v C_r i A$$

C_v = Volumetric Runoff Coefficient - a co-efficient that describes the proportion of rainfall appearing in the surface water drainage system, assumed to be 0.95

C_r = Routing Coefficient - a routing co-efficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner, assumed to be 1.3 for urban areas

i = Rainfall intensity (mm/h) based on a 1 hour rainfall event

A = Area (ha)

2.78 = Coefficient which accounts for the differences in units used for the inputs and the outputs of the equation (1000/360)

C_v	0.95		
C_r	1.3		
i (mm/hr)	15.15	QBAR	Rainfall data has been taken from the Depth Duration Frequency rainfall calculator contained within the FEH 2013 web service
	11.68	1 in 1 year storm	
	35.5	1 in 30 year storm	
	45.39	1 in 100 year storm	

Return Period	Peak Flow (l/s)	Limiting discharge of Predevelopment Qbar by percentage	
Qbar	3.9		
1 in 1 year storm	3.8	Proposed Limited Discharge:	l/s
1 in 30 year storm	9.1		
1 in 100 year storm	11.6		

Please let me know if you require anything else.

Many thanks,
Emma

Emma Rowlands
Graduate Hydrologist

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From: Laura Gibbons <l.gibbons@rsk.co.uk>
Sent: 20 September 2018 09:10
To: Emma Rowlands <ERowlands@rsk.co.uk>
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Emma,
Thanks for sending this through, if I could see the full work up, so I can see the values of coefficients used and check these.
Thanks,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

From: Emma Rowlands [<mailto:ERowlands@rsk.co.uk>]
Sent: 14 September 2018 14:13
To: Laura Gibbons
Cc: Jemma Looney
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Laura,

Apologies, those calculations are incorrect. Please find the correct calculations below for the existing rate, calculated using the modified rational method:

QBAR: 3.9 l/s
1 in 1 year: 3.0 l/s
1 in 30 year: 9.1 l/s
1 in 100 year: 11.6 l/s

Kind Regards,
Emma

Emma Rowlands
Graduate Hydrologist

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From: Emma Rowlands
Sent: 14 September 2018 12:18
To: Laura Gibbons <[redacted]>
Cc: Jemma Looney <[redacted]>
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Laura,

Please see the QBAR calculations below. I have also attached the loH124 screenshot.

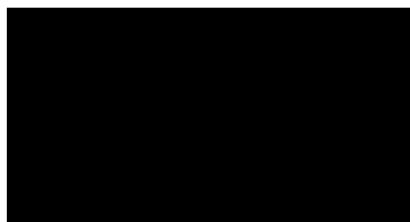
QBAR: 0.8 l/s
1 in 1 year: 0.7 l/s
1 in 30 year: 1.9 l/s
1 in 100 year: 2.7 l/s

Kind Regards,

Emma

Emma Rowlands
Graduate Hydrologist

RSK
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From: Laura Gibbons <[REDACTED]>
Sent: 14 September 2018 08:19
To: Jemma Looney <[REDACTED]>
Cc: Emma Rowlands <[REDACTED]>
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Jemma,

Sorry that there has been a delay in getting back to you, I have been out of the office on site and the emails have been piling up.

I look forward to seeing the details on the contamination. Groundwater data will be needed for me to review attenuation details to ensure there is no risk of flotation.

Could you please send through the calculations for QBar that you have completed. I will review these as a priority.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre, Maltravers Road, Littlehampton, BN17 5LF

Internal: 37818 | External: +44 (0) 1903 737818 | Fax: +44 (0) 1903 716018 | E-mail: laura.gibbons@arun.gov.uk

[REDACTED]

From: Jemma Looney [m [REDACTED]]
Sent: 06 September 2018 14:54
To: Laura Gibbons
Cc: Emma Rowlands
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Laura,

Please can you confirm when we may likely receive a response to our enquiry below. We're keen to establish the constraints for developing our drainage strategy for the site, and therefore request confirmation of the allowable discharge rate .

Many thanks,

Jemma Looney (née Cooling)
Senior Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

[REDACTED]

Please note, I have recently changed my email address. Emails sent to my previous address will be redirected for some time, however please update any contact details for future reference.

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From: Emma Rowlands
Sent: 10 August 2018 16:38
To: Laura Gibbons <[REDACTED]>
Cc: Jemma Cooling <[REDACTED]>
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

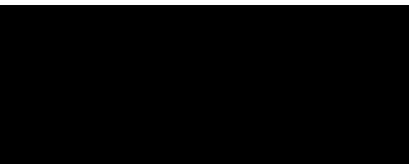
Hi Laura,

Please see my comments in red below. Please let me know if you require any more information.

Kind Regards,
Emma

Emma Rowlands
Graduate Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



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From: Laura Gibbons [mailto:l.gibbons@rsk.co.uk]
Sent: 07 August 2018 13:02
To: Emma Rowlands
Cc: emma.cooling@rsk.co.uk; Emma Cooling; Roger Spencer
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Emma,

I would like to understand further the justification for not using infiltration. How shallow is the groundwater? This information will be required when reviewing even attenuation schemes. We do not have any data for ground water levels however we are aware that there are contamination issues on the site -- there will be further evidence of this in our report.

We require that flows are controlled to a rate equivalent to QBar for the greenfield site. I have attached our further guidance notes for more information. The QBAR greenfield rate for the site is 0.8l/s which is not feasible to discharge at. Considering that we are discharging into a tidal watercourse (and would like to remove the runoff from site quickly) and the site has previously been developed, we can propose a rate of discharge rate of 4l/s (the existing QBAR rate, calculated using the modified rational method).

Should you have any additional questions please feel free to get in contact.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)



Save the environment - think before you print.

From: [REDACTED]
Sent: 03 August 2018 16:02
To: Roger Spencer
Cc: ks [REDACTED]
Subject: RE: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Hi Roger,

Thank you for your comments below. We are progressing our SuDS strategy and are proposing to discharge surface water into the drainage ditch to the north east of the site, which discharges into the tidal River Arun (please see attached map). Following the SuDS hierarchy, soakage is not considered feasible for the site due to potential contamination and shallow groundwater levels, and therefore discharge to watercourse is the next option (also replicating the existing site drainage regime).

Given the proximity of the site to the River Arun and the lack of other sensitive receptors in the area, we propose to discharge at a rate of 11.6 l/s (the existing 1 in 100 year storm) for all storm events up to and including the 1 in 100 year plus 40% climate change event. Please can you confirm that this is acceptable to you. Following confirmation, we will design our SuDS strategy accordingly.

To confirm, we are also in separate correspondence with the EA regarding fluvial flood risk and their requirements.

Kind Regards,
Emma

Emma Rowlands
Graduate Hydrologist

RSK
19 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

<http://www.rsk.co.uk>



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From: Roger Spencer [mailto:roger.spencer@arundel.gov.uk]
Sent: 24 May 2018 15:17
To: Emma Rowlands
Subject: FW: Enquiry re. Local Flooding issues in Arundel area - Rowlands - May18_25

Dear Emma,

Your request for information regarding a potential Arundel development site has been passed to me for a response.

I will address all of your points but as a precursor I would advise that Tom Callaway has left the Authority, so any future requests should be sent either Paul Cann or Laura Gibbons. They are both on leave at the moment hence you receiving a reply from me.

I would also say that part of the site (nearest the River) is within the River Arun Internal Drainage District and so the Environment Agency (acting as the IDB) will have an opinion besides their own flood risk views and advice.

A tiny portion of the site (2 to 4m² of the northern corner) is shown as being affected on our surface water flood map (unlike the site to the north which is almost all covered).

The area is susceptible to groundwater flooding and at risk of flooding from the river (high, medium & low zones across the site) and in Flood Zone 2 & 3. I believe all of this is available from the EA website but please do not hesitate to come back to me if this is not readily available.

The Council's mapping does not show any historic flooding on the site but it should be noted that this is not a definitive record. This may be due to flooding not having occurred due to relative levels or existing protection afforded to the current/previous gas equipment on the site. There has been flooding in other parts of Arundel; indeed to the site immediately adjacent is usually quite wet.

The Environment Agency produced a strategy for the Lower Tidal River Arun (LTRAS) and is currently looking at how best to provide a suitable level of protection to the Town.

There are public surface and foul sewers around the site on three sides. As well as the River Arun, the ditch to the north is also classed as main River.

A series of land drains and highway drains flow towards the river but I do think that they flow across the site, rather they discharge into the adjacent site and its peripheral ditches.

SABs were indeed a part of the Sch 3 of the Flood and Water Management Act – Sch 3 is yet to be brought into law and we understand that it will not be – the way that SuDS is dealt with on sites of more than nine units is now covered under Planning.

WSCC is the LLFA for this site and colleagues there will comment strategically; we (Arun Engineers) act as their agent and can usually give more specific advice and deal with any Land Drainage consenting, as well as advising Planning colleagues, here and at the South Downs National Park, on drainage matters relating to any development site in the District. The National Park boundary is to the other side of the main A27/Ford Rd roundabout and so the Park may have an opinion on what is appropriate in Planning terms in close proximity to the Park, if not in drainage terms.

The main issues will be dealing with surface water (in the hierarchical fashion of soakage, controlled discharge to a watercourse and then [again controlled] to a surface water sewer) - more information on this on our website at: <https://www.arun.gov.uk/download.cfm?doc=docm93ijjm4n11643.pdf&ver=11625>) and mitigating for the flood risk of zones 2 & 3. I am sure that the information you get from the Environment will assist greatly in establishing volumes and

depths of flood to be dealt with; it is not for the Council to suggest how to deal with this aspect especially not knowing what type, scale, etc. of development might be proposed for the site.

The obvious route for the discharge of surface water would be to the River Arun but you would need to allow for tide locking both now and into the future with climate change allowance

I would not wish to pre-empt my Planning colleagues views on pre-planning advice but I would like to see for a site such as this, a proper masterplanning exercise to prove its viability (in drainage terms) rather than conditioning any approval that may be given. I am sure they will also mention the sequential / exception testing within your FRA.

The advice given on our website (above link) implies that we do not adopt SUDS in new development but would require a comprehensive Management Plan (valid in perpetuity) – again all on the Council's website.

Again, not wishing to pre-empt colleague's comments but I foresee WSCC taking due note of the EA guidance in respect of climate change allowances.

I would stress that it is important to undertake groundwater monitoring over the winter period to ascertain worst case conditions and then to use that information to guide your percolation rate investigations, FRA & drainage strategy.

With regard to Pre-Planning Advice I would direct you to the third section of the following page on the Council's website <https://www.arun.gov.uk/pre-planning-advice>

Regards,

Roger Spencer



<http://www.arun.gov.uk>

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Emma Rowlands

From: Matthew Cheeseman
Sent: 11 May 2018 17:17
To: Emma Rowlands
Subject: FW: Enquiry re. Local Flooding issues in Arundel area
Attachments: Drainage - Supplementary Guidance Notes.pdf

From: Laura Gibbons [REDACTED]
Sent: 11 May 2018 12:04
To: Matthew Cheeseman
Subject: RE: Enquiry re. Local Flooding issues in Arundel area

Thanks for you enquiry.

Flooding Records

We hold no flooding records. I would advise you to look at the Arun District 2016 SFRA, which may provide more information, including surface water flood maps.

The Agency will certainly be able to provide you with historic flooding and flood maps following your presumably product 4 (or higher) data request.

Flood Mitigation Measures

The site is within the functional flood plain. I would think there would be more suitable localities in the district to develop. However, I would think you would need to provide compensatory flood storage, raised FFLs, and possibly more, at the EA's request. It is such a tricky site that I would think a site specific flood model utilising the existing model the EA holds would be of benefit to aid the design of mitigation measures. And obviously sufficient freeboard added to modelled flood levels. The EA will hopefully advise on all of this.

SuDS

I attach our standard guidance notes, I advise you get in contact with us as early as possible to discuss the design of the SuDS scheme.

Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

From: Nicola Spencer **On Behalf Of** Planning
Sent: 09 May 2018 17:58

To: 'ERowlands@rsk.co.uk'
Cc: Land Drainage
Subject: RE: Enquiry re. Local Flooding issues in Arundel area

Thank you for your email

If you require pre application advice you will need to make a planning pre application advice request and pay the fee of £700.00 as the development is for 35 units and a further £200.00 if you wish to have a meeting following the advice. Further information can be found here [\[REDACTED\]](#)

I have forwarded your email to our engineers section who may be able to give you some flooding information from their records

Yours sincerely

[REDACTED]

From: [REDACTED]
Sent: 09 May 2018 12:01
To: [REDACTED]nfomanagement; Planning
Subject: Enquiry re. Local Flooding issues in Arundel area

FAO: Drainage and Flooding team

Good Afternoon,

We are Engineering Consultants acting for a Client who is considering development of a site within the Arundel area. We are in the process of producing a Flood Risk Assessment for the site and would be grateful for your input on the following points.

For reference, I have included a site plan.

The site is approximately 0.43ha in size and the proposals include the development of approximately 35 residential units across two apartment blocks (two storeys).

Flooding records/maps

Are the council aware of any local flooding issues within the Arundel area? As part of our Flood Risk Assessment we will be documenting any recorded incidents of flooding so any records/anecdotal evidence that the council may have, would be of great help. In particular we would be interested to hear of any reported incidents of surface water, highway or groundwater flooding.

Are there any surface water flood maps available and if so please can we obtain a copy?

We have recently submitted a request for data from the Environment Agency and are currently awaiting their response. We anticipate that they will be able to provide us with any relevant modelled fluvial/tidal flood levels for the site.

Flood Mitigation Measures

Can you provide information on any required flood mitigation measures you may suggest for development in this area, if deemed necessary.

Surface Water Drainage Strategy

We understand that there will no longer be a requirement for local authorities to set up SABs, as previously indicated under Schedule 3 of the Flood Water Management Act 2010, however we understand that West Sussex County Council are now a statutory consultee on all major planning applications and will be providing comments on the surface water drainage for new sites.

At this stage, a formal drainage strategy has not yet been produced, however the general principles will likely include:

- Sustainable drainage features (SuDS) where feasible
- Discharge to ground/watercourse/sewer
- Accommodate the 1 in 100 year plus climate change storm event on site

Therefore we would be grateful if you could please provide your pre-planning advice on the surface water drainage strategy for this site? Are there any particular local requirements that the council wish to raise, relating to the proposed drainage strategy for the area, such as:

- Any discharge restrictions
- Use of SuDS features – what types and level of adoption
- Level of drainage detail required at the planning stage
- Any interim guidance for proposed drainage on new developments in this area?

Following the recent publication of the new climate change allowances from the Environment Agency, please can you confirm what West Sussex County Council consider to be an appropriate climate change allowance for developments in this area.

If you have any formal pre-planning procedure i.e. forms, fees etc, please can you provide details.

The above information would be of great assistance in developing the masterplan, drainage strategies and designs for the project prior to planning submission.

Many thanks for your time.

I look forward to your reply.

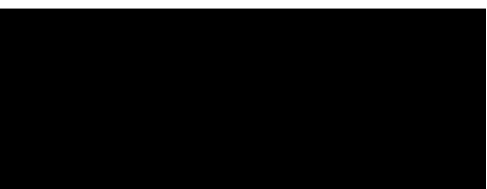
Kind regards,

Emma

Emma Rowlands
Graduate Hydrologist

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Supplementary Requirements for Surface Water Drainage Proposals

Any proposed surface water scheme must consider sustainable drainage principles.

SuDS Selection

The following destinations must be considered for surface runoff in order of preference:

1. Discharge into the ground (infiltration);
2. Controlled discharge to a surface water body;
3. Controlled discharge to a surface water sewer.

Surface water must not be discharged into the foul sewer system. Infiltration structures include soakaways, basins, swales and permeable paving. Discharge to surface water bodies and surface water sewers must be restricted to an agreed rate.

SuDS selection hierarchy based on:

CIRIA C753 - The SuDS Manual

BS8582:2013 – Code of Practice for Surface Water Management for Development Sites

Approved Document H of the Building Regulations

Infiltration Drainage Design

Infiltration rates for soakage structures are to be based on percolation tests undertaken in the winter period at the location and depth of the proposed structures. The percolation tests must be carried out in accordance with BRE 365, CIRIA R156 or a similar approved method, and cater for the 1 in 10 year storm event between the invert of the lowest entry pipe into the infiltration structure and the base. For the purpose of design, the percolation rate must be applied to the sides of the infiltration structure only and the rate for the base must be zero. This does not apply to infiltration basins or permeable pavements, whereby the percolation rate is applied to the base only. There must be provision to ensure that there is capacity in the system to contain the 1 in 100 year storm event plus 40% on stored volumes, as an allowance for climate change. The infiltration structure should also drain 50% of its total volume in 24 hours or less for both the 1 in 10 and 1 in 100 year (plus 40%) storm events, in order to provide spare capacity for subsequent storms.

Any infiltration drainage design must include adequate winter groundwater monitoring data to determine the highest winter groundwater table. Residential developments in excess of five properties will require ground water monitoring to be carried out between October and March inclusive. The extent of monitoring required for smaller developments will be subject to agreement with the Council's Engineers.

Adequate freeboard must be provided between the base of the soakaway structure and the highest recorded groundwater level identified in that location.

Restricted Discharge

Discharge to a watercourse or surface water sewer must be restricted to the estimated mean greenfield runoff rate (Q_{bar}) by means of a controlled outflow (or restricted to existing runoff rates for brownfield sites). This can be derived from IH124 or a similar approved method. Any storage design must be submitted with groundwater monitoring data where applicable to ensure there will be no detrimental effect on the structure or storage. Storage areas are preferred to be in an 'open' form such as ponds, rather than underground tanks.

Flow Exceedance Routes

The drainage design should show flow routes through the proposed development, demonstrating where surface water will be conveyed for three types of flow:

1. Low flow routes

Regular flow from source control features such as permeable pavements should travel in low flow channels through the development in a controlled way contributing to landscape quality.

2. Overflows

In the event of local blockages or surcharge a simple overflow arrangement should allow water to bypass the obstruction and return to the management train sequence until conditions return to normal.

3. Exceedance routes

When SuDS are overwhelmed by exceptional rainfall, then exceedance routes are required to protect people and property. These provide unobstructed overland flow routes from the development and should be considered for all drainage schemes. Exceedance routes should also be protected from future changes in land use.

Culverting a Watercourse

Culverting (piping) a watercourse is not advised unless there is no alternative. The resulting reduction in storage volume, flow capacity and habitat potential would be unacceptable. Culverted watercourses are also more difficult to maintain due to the limited accessibility.

Land Drainage Consent must be sought from the Lead Local Flood Authority (West Sussex County Council), or its agent (Arun District Council – land.drainage@arun.gov.uk), prior to starting any works (temporary or permanent) that affect the flow of water in the watercourse. Such works may include culverting, channel diversion and the installation of trash screens.

The development layout must take account of any existing watercourses (open or culverted) to ensure that future access for maintenance is not restricted.

See also:

Land Drainage Act 1991 (amended 1994)

Maintenance and Management

Ditches and watercourses (including culverts) should retain a three metre easement with access that allows for its future maintenance.

Details of the maintenance and management of the SuDS system are to be set out in writing in a site specific maintenance manual. This manual shall include details of the financial management and arrangements for the replacement of components at the end of the manufacturers recommended design life. This document is then to be submitted as part of the planning process.

References

The Building Regulations 2000
Drainage and waste disposal
Approved document H
ISBN: 1-859462-08-1

Building Research Establishment,
Soakaway Design – Digest 365 (BRE 365)
ISBN: 1 86081 604 5, 1991

Centre for Ecology and Hydrology
Flood Estimation for Small Catchments - IH Report 124
Marshall, D.C.W. & Bayliss, A.C.
ISBN: 0948540621, 1994

CIRIA
C697 The SUDs Manual
Woods-Ballard, B.; Kellagher, R. et al
ISBN: 978-0-86017-697-8, 2007

CIRIA
R156 Infiltration Drainage – Manual of Good Practice
Bettess, R.
ISBN: 0 86017 457 3

British Standards Institution
BS8582:2013 – Code of Practice for Surface Water Management for Development Sites
ISBN: 978 0 580 76700 5

Jemma Looney

From: Laura Gibbons [REDACTED]
Sent: 30 May 2019 14:42
To: Cham Ariyaratne
Cc: Jemma Looney
Subject: RE: Arundel gas works - surface water strategy

Hi Cham,

I have provided a suggestion of providing storage on the roof. We do not accept surface water storage being provided within the flood plain.

Thanks,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

From: Cham Ariyaratne [REDACTED]
Sent: 23 May 2019 16:05
To: Laura Gibbons
Cc: Jemma Looney
Subject: RE: Arundel gas works - surface water strategy

Laura,

The entire site is located within Flood Zone 3 and when you allow for the flood compensation with 100-years + 45% climate change allowance, this will not leave any areas outside the modelled flood extent to locate attenuation storage. The site is allocated for residential development through the local plan. Therefore, we would like to find a solution to allow the development to happen. The position you are taking below does not provide us with any options to proceed. We would try our best to maximise the storage onsite and reduce the discharge as far as possible. However, we are unable to locate any of this storage outside the modelled flood zone. Could you please advise whether this can be accepted as a potential solution to enable the site to be developed?

Kind regards,

Cham

Mobile: +44 7471 227313

From: Laura Gibbons <La [REDACTED]>
Sent: 22 May 2019 12:38
To: Cham Ariyaratne <CA [REDACTED]>
Subject: RE: Arundel gas works - surface water strategy

Hi Cham,

We would not allow storage within the predicted flood extents. Discharge rates must be restricted to QBar greenfield or 2l/s whichever is the greater.

Surcharging of outfalls would need to be modelled to flood levels.

Thanks,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)



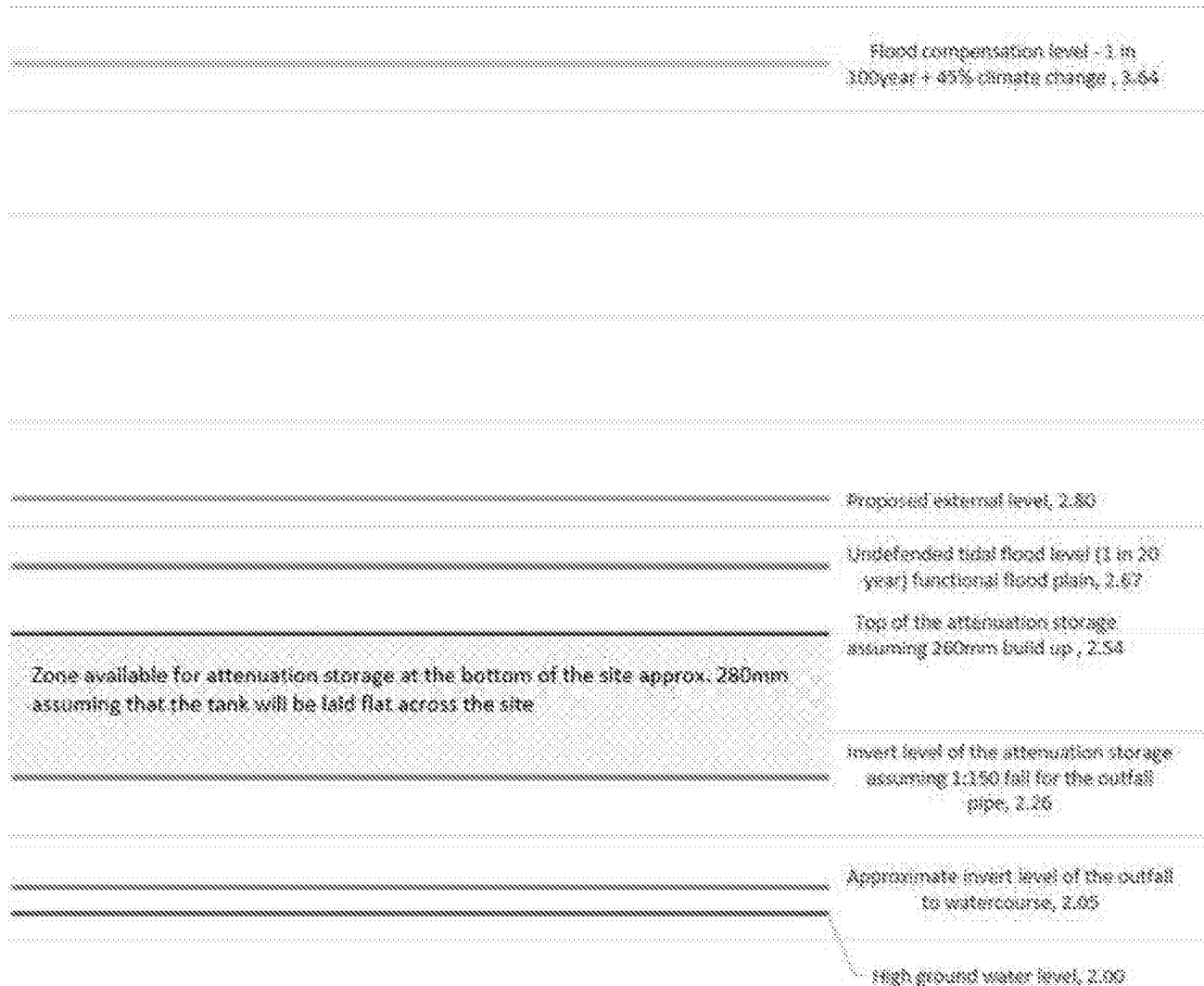
From: Cham Ariyaratne [mailto:cham.ariyaratne@arundel.gov.uk]
Sent: 10 May 2019 16:28
To: Laura Gibbons
Cc: Jemma Looney
Subject: RE: Arundel gas works - surface water strategy

Laura,

Thank you for your email on 24/04/2019. Please see below some further thoughts and queries. We would like to better understand our options and parameters before modelling the system in Windes.

Surface water attenuation

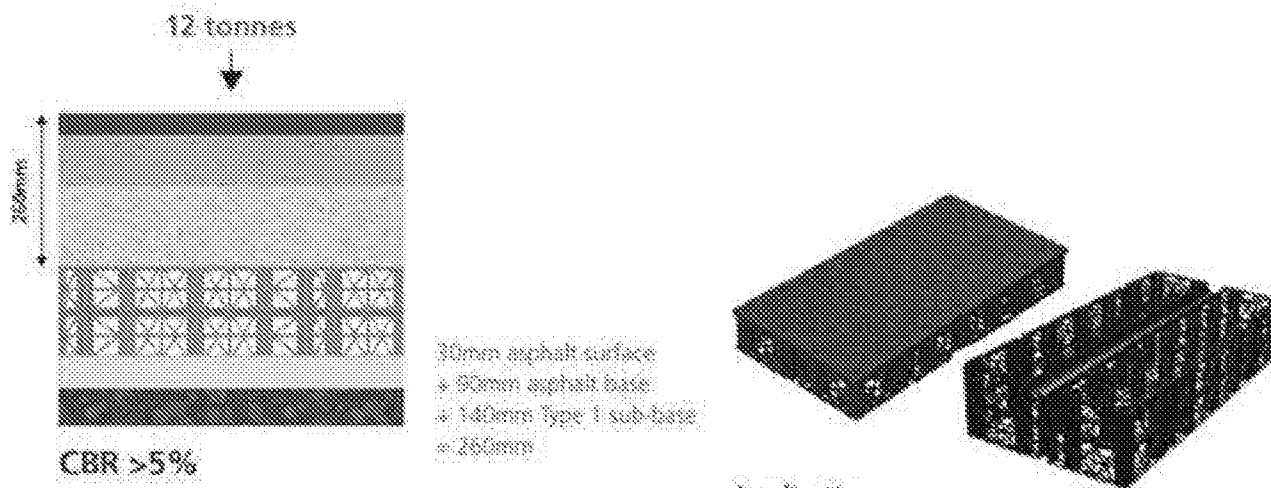
The following figure demonstrate the key levels affecting the design.



As shown above, there is only a limited space available between the pavement build-up and the proposed invert levels to accommodate any attenuation storage; 280mm at the bottom of the site. If you allow for a nominal fall of 1 in 300 across the site, at the top of the car park this zone will reduce further to around 140mm.

The storage invert levels cannot be lowered beyond 2.26 mAOD if we wish to have a gravity fed surface water drainage system. In any case, this will be located below the functional flood plain level of 2.67 mAOD as demonstrated above.

We have considered Permavoid as an option to provide the storage under the car park area. Please see some of the product details provided. The build up of 260mm is based on the manufacturer recommendation for a car park area.



Permavoid 85 and 150

Product code: PVPP85 and PVPP150

Permavoid is a geocellular interlocking system designed for shallow groundwater storage or infiltration, to be used in place of traditional aggregate sub-base. The system has an exceptionally high compressive and tensile strength and bending resistance with a proprietary jointing system to create a horizontal structural 'raft' within the pavement that is ideal for the shallow attenuation of surface water. The system can also be combined in layers using interlocking shear connectors to increase depth in 85mm and 150mm increments. This is particularly useful in designing infiltration systems, allowing flexibility in balancing the soil permeability/infiltration area of the Permavoid storage units and residual temporary attenuation.

The storage achievable with this solution is summarised below.

- Available footprint (in proposed car parking area) = 960m²
- Thickness of the storage unit = assume 200mm average across the site allowing for reduction at the top.
- Voids ratio = 92%
- Storage achievable = 176m³

The required storage to restrict the discharge to 4l/s is 214m³.

Whilst not considered feasible to restrict to 4l/s, if the restriction could be limited to the Q100 peak rate of 12l/s, the storage requirement would equate to 151m³, which can be accommodated within the available permavoid storage as shown above.

The site does not contain any flat roofs and therefore storing the rain water at roof level is not an option. We are therefore faced with limited other solutions to achieve the required storage based on your previously set out criteria.

Could you please advise whether we can consider a higher rate of discharge to work with the achievable storage for the site?

Storage requirements for tide locking

We would also like to check the criteria we would need to apply to understand the storage requirements for tide locking situation. Could you please advise the application rainfall event and the duration we need to use when modelling this situation?

Kind regards,
Cham

From: Laura Gibbons <[REDACTED]>
Sent: 26 April 2019 14:46
To: Cham Ariyaratne <[REDACTED]>
Cc: Jemma Looney <[REDACTED]>
Subject: RE: Arundel gas works - surface water strategy

Good Afternoon Cham,

Because of the site location you will not be discharging directly into the River Arun, but you will instead be discharging into an ordinary watercourse which we know has historic flooding issues upstream.

This watercourse becomes tidally locked. I would not support proposals to discharge to this watercourse un-attenuated as this will likely result in either your site flooding or the risk of flooding elsewhere being increased. Unless you can demonstrate this will not be the case I suggest we are at a sticking point.

Have you considered storing surface water on the roof?

Thanks,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)



From: Cham Ariyaratne [redacted]
Sent: 23 April 2019 16:08
To: Laura Gibbons
Cc: Jemma Looney
Subject: Arundel gas works - surface water strategy

Laura,

Further to our conversation last week, please find below some information about the latest layout and the existing constraints of the site.

- Proposed external level for the site as per the latest layout = 2.800 mAOD.
- The depth to the groundwater table measured by Atkins in 2011 was 2 mAOD (high tide)
- Flood compensation storage level for a in 100year event +45% climate change event = 3.640 mAOD (please find the flood compensation storage proposals attached)
- The Environment Agency modelled fluvial flood levels for node 1 referenced in the attached floodplain outline drawing is 2.41 mAOD for 1 in 100 year event and 3.33 mAOD for 1 in 100 year event + climate change. 1 in 1000 year level is 2.65 mAOD

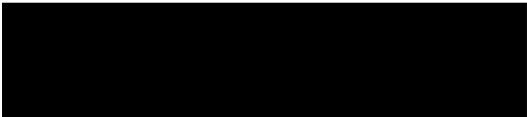
As discussed, if we are to discharge the water from the site at a restricted rate of 4 l/s, this will require approximately 221m³ of storage on site. We are currently struggling to locate this storage onsite due to the flood and ground water levels highlighted above. Any storage located within the external areas will be below flood compensation storage levels.

In light of this, we would like to further investigate the options for discharging the surface water at a unrestricted rate. As the surface water from this site and the vicinity is getting discharged to the tidal Rival Arun, we hope this would be acceptable from your point of view. This approach will also get rid of any surface water from the site as soon as possible, hence not compromising the flood compensation storage. Could you please advise whether you would be happy for us to use this as the basis for our drainage design?

Kind regards,

Cham Ariyaratne
Principal Civil Engineer

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK


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Jemma Looney

From: Laura Gibbons <[REDACTED]>
Sent: 05 April 2019 14:04
To: Jemma Looney
Subject: RE: Arundel gas works - site constraints

Hi Jemma,

Thank you for sending over the survey report. From looking at this report and our historic mapping we believe this drain is a culverted ordinary watercourse. The watercourse is within the IDB area and therefore is within the EA's jurisdiction. Please get in touch with them.

However, this IDB is likely to be disbanded in the relatively near future and passed to us. The EA may want to know our opinion. We would require the watercourse to be left in place or diverted (with permission) unless conclusive evidence is submitted that it is no longer in use. The possibility to divert will depend on levels. We would require no buildings to then be located over the watercourse and a 3m easement to be provided.

Supplementary guidance notes regarding surface water drainage are located here <https://www.arun.gov.uk/surfacewater> on Arun District Councils website. A surface water drainage checklist is available here <https://www.arun.gov.uk/drainagechecklist> on Arun District Councils website, this should be submitted with a Discharge of Conditions Application.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)



From: Jemma Looney [mailto:[REDACTED]]
Sent: 29 March 2019 10:14
To: Laura Gibbons
Subject: Arundel gas works - site constraints

Hi Laura,

Many thanks for your time on the phone last week.

As discussed, we would be grateful for your assistance in establishing any constraints associated with the existing drain beneath the site.

Please find attached the CCTV survey we have commissioned for the site. You will note (from the site plan on the final page) that there appears to be a small drain run (225mm diameter pipe) from the southwest corner crossing the site towards the northeast. At the downstream end, there is a short stretch where this opens out into a 900mm diameter brick culvert. This mainly lies beneath the access track which is outside our site boundary.

We have tried to investigate whether there is any potential for incoming flow at the upstream end, indicating if the pipe continues to serve a purpose or whether this is purely a historic remnant of the now-redundant gas works and can be fully abandoned. We would be very grateful for any additional information you could provide on this.

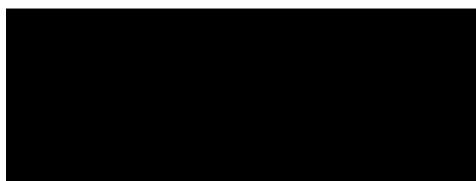
Additionally, as discussed, please can you provide any particular requirements you would wish to see accommodated within the proposal. As you will note from the attached development proposal (please just note that the North Point is incorrectly pointing South), it is essential to our development plan that we are able to divert this whole run if we are unable to abandon it completely.

I look forward to hearing from you.

Kind regards,

Jemma Looney (née Cooling)
Principal Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK



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