A/144/17/OUT

ctp consulting engineers

10 March 2017

A3992/1/PNH/DA

Planning Department
Arun Civic Centre
Maltravers Road
Littlehampton
West Sussex
BN17 5LF

ARUN DISTRICT COUNCIL
13 MAR 2017

Your ref PP-05859070

Dear Sirs

Land west of Brook Lane, Rustington and south of A259

We enclose 3 copies of the Flood Risk Assessment as requested.

Yours faithfully

[redacted]

Peter N Hawkins
For and on behalf of CTP

Cc Serena Page – DWD LLP
Ross Moyles – Store Property

Enc

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Project Name: Land west of Brook Lane, Rustington and south of A259

Flood Risk Assessment

Date: March 2017

Project Number: A3992

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Appendix B – Topographic Survey

Appendix C – Architects Proposals

Appendix D – Environment Agency Modelled Flood Levels

Appendix E – Modelled Floodplain Extension

Appendix F – Surface Water Drainage Calculations

Appendix G – Schematic Surface Drainage Layout Drawing – to follow



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# Document Status and Signatures

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| Signed on behalf of CTP | |
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## Executive Summary

This Flood Risk Assessment has been undertaken for the proposed demolition of existing buildings on site and the erection of a mixed use development comprising residential units and care home (Use Class C2 and C3) and ancillary facilities including railway crossing together with associated access, car parking and landscaping at land to west of Brook Lane and south of A259, Rustington, West Sussex, BN16 3JL. This assessment has been prepared in compliance with guidance given in the National Planning Policy Framework (NPPF) and Technical Guidance (March 2012).

The Environment Agency Flood Risk maps indicate that the proposed development site is partly situated in Flood Zone 1 and partly in Flood Zone 2 and 3. It is required that the Local Planning Authority apply the sequential test. In accordance with Table 2 and Table 3 of the NPPF the new construction are considered as "More Vulnerable". This type of construction is appropriate in Flood Zone 1 and 2 and the Exception Test is not required.

Environment Agency flood modelling for the tributary of the River Arun in the vicinity of the site has been obtained. The 0.5% (2110) design flood level for the site is 2.740mAoD. Based on this a minimum floor level of 3.040mAoD is recommended in the Environment Agency's standing advice. If this level is not possible, even though the site is not recorded as being previously affected by flooding it is recommended that flood resilient construction up to 300mm above the design flood level is provided. Residents of the new development shall be signed up to the Environment Agency's flood warning system for the tributary of the River Arun.

The risk of flooding from the different possible key sources has been assessed. This assessment has deemed that the risk of flooding from other sources at the site is low.

An initial assessment of the risk of flooding from the different possible key sources from the NPPF lists which could potentially affect the development site has been undertaken based on presently available information. According to the available information, this assessment has deemed that the risk of flooding from other sources at the site is low.

The proposals result in an increase of the impermeable areas and to mitigate the increase in surface water discharge rate, attenuation methods have been proposed. These measures would result in the peak surface water flows being limited to the greenfield run-off rates for all storm return periods up to a 1 in 100 year storm event plus an allowance of 40 % for climate change.



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Shallow infiltration measures, such as permeable paving, are required to achieve these run-off rates. It is proposed that the houses fronting hard landscaping and parking areas will be constructed from permeable paving blocks overlaying a permeable sub-base with infiltration into the ground. Also Arun District Council seeks to the implementation of ponds within developments where there are suitable areas. There are suitable areas for new open water features within the site located in Flood Zone one and outside the floodplain area. Attenuation of rain water in ponds and open water features will then be considered further.

Due to the ground water table it is possible that in some areas it will not be possible to use permeable paving or it will not be able to discharge to the proposed pond, and attenuation tanks may need to be provided. The proposed attenuation volumes have been sized to adequately convey storm events up to and including the 100 year storm events including an allowance of 40% for climate change using Microdrainage Windes software. These calculations are included in Appendix F. The surface water drainage proposals have been provided in the schematic drainage layout drawing included in Appendix G.



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# 1 Introduction

1.1 CTP have been engaged by Store Property Investments Ltd to prepare a site specific flood risk assessment as part of the planning application for the proposed works at the land west of Brook Lane and south of A259, Rustington, Littlehampton, West Sussex, BN16 3JL.

1.2 The flood risk assessment has been prepared in compliance with guidance given in the National Planning Policy Framework (NPPF) and Technical Guidance (March 2012).

1.3 The assessment covers the identification of all sources of flooding, their impact on the development, their residual risk and mitigation. A strategy for surface water drainage has also been included.

1.4 CTP Consulting Engineers are appropriately qualified professionals with the skills and experience to design surface water drainage systems to incorporate Sustainable Drainage (SuDS) and to carry out Flood Risk Assessments.

1.5 CTP has no responsibility to any other parties to whom this report may be circulated, in part or in full, and any such parties rely on the contents of this report solely at their own risk.

1.6 All copyright and other intellectual rights in and over this report and its contents shall remain vested in CTP. Store Property Investments Ltd and any person authorised by them is granted an irrevocable royalty free licence to use and reproduce this report for all purposes relating to the property but CTP shall not be liable for any use of the report for any purpose other than that for which it was originally prepared.



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# 2 Development Description and Location

## 2.1 Description of Existing Site

2.1.1 The proposed development is situated off Brook Lane, Rustington, Littlehampton, West Sussex, BN16 3JL. The site lies adjacent to the A259 running north and west of the site. A railway line delimits the south boundary of the site and the east is delimited by Brook Lane which provides access to the existing site. A watercourse collecting water from the east passes through the area and discharges to the Black Ditch on the other side of the A259. A shallow ditch also crosses the site. The site location is shown in Figure 1 and Figure 2.

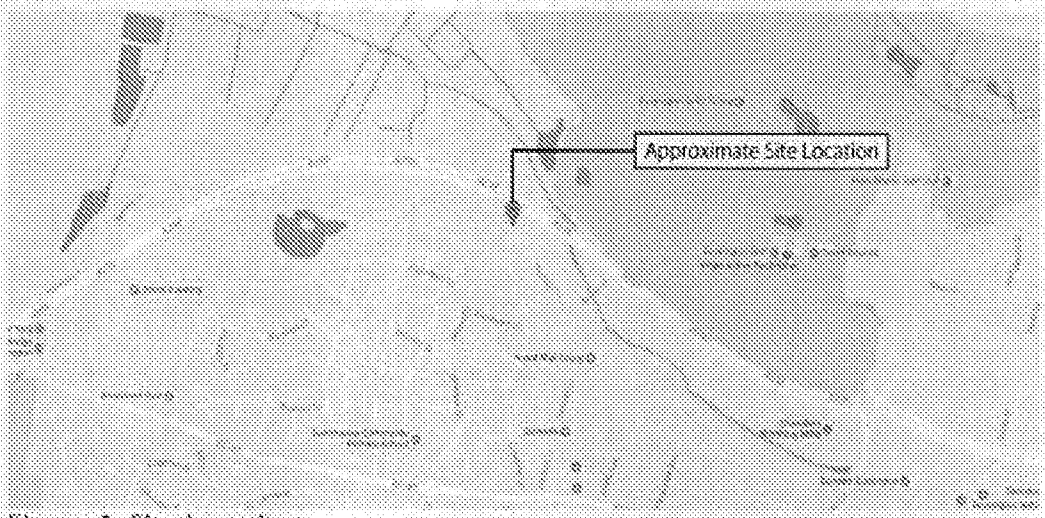



Figure 1: Site Location

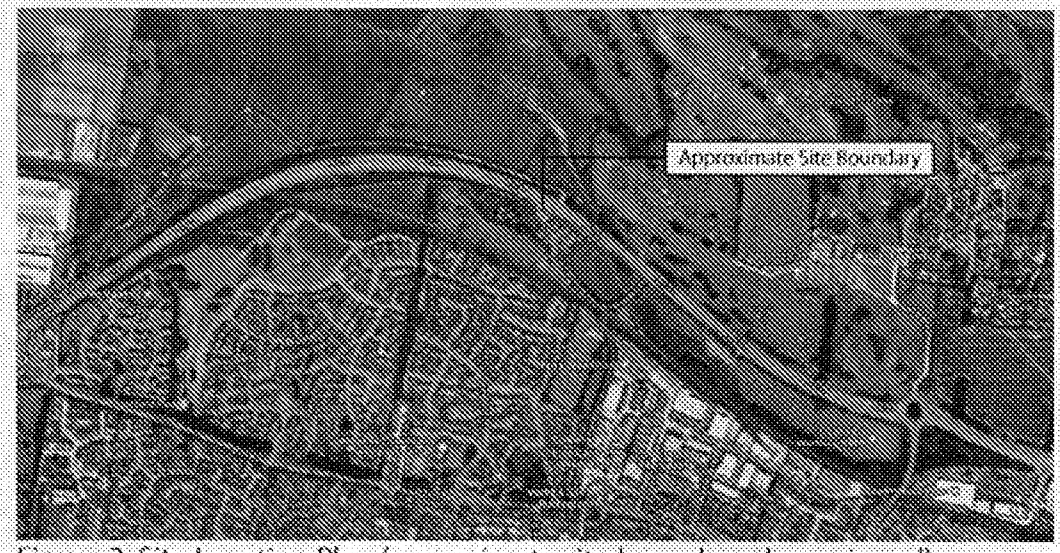



Figure 2: Site Location Plan (approximate site boundary shown in red)



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## 2.2 Permeable and Impermeable Areas

2.2.1 The existing site consists mainly of grazing land and comprises a residential property and stables with associated landscaped areas, car parking areas, access roads and storage buildings. With reference to the existing area plan included in Appendix A of this document a summary of the existing site areas is as follows:

| | |
|---|---|
| Site Application Boundary Area: | 59,211 m² |
| Existing Soft Landscaped Area | 54,930 m² |
| Existing Building Area: | 1,411 m² |
| Existing Hard Landscaping Area: | 1,029 m² |
| Existing Highway Area: | 1,841 m² |

## 2.3 Topographical Information

2.3.1 A topographic survey of the existing site has been undertaken. The survey shows that the site slopes from southwest to northeast, with a small peak in the centre of the south side. The levels range between 4.90m and 1.00 AOD approximately. The levels over the majority of the site are no lower than 1.60m AOD.

2.3.2 The topography also shows a shallow depression on the west corner connected to a pond located in the site across the railway through a 230mm diameter culvert pipe. The location map doesn't show any trace of a pond so this shallow depression is likely just an infiltration area with an overflow to the neighbouring pond via the culvert.

2.3.3 The topographic survey of the site is included in Appendix B.

## 2.4 Existing Drainage

2.4.1 The topographic survey of the existing development site indicates that there are some manholes within the site, therefore a drainage system is located at the site to serve the existing buildings. This survey also indicates a possible cesspit position inside the property.



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2.4.2 There is no visible evidence of surface water attenuation within the site and given the location of the infrastructure, it can be assumed that all surface water discharge is either unrestricted or discharges into a soakaway system. Also the existing access road has no visible drainage system and the water follows the topography to lower adjacent lands.

2.4.3 Sewer records from Southern Water for adjacent sites have been obtained and they do not show any sign of existing public sewers, reinforcing the likelihood that existing building discharges into a cesspit and to the existing watercourse or infiltration system. Further investigation of the existing drainage network is recommended to assess its condition and to confirm the outfall.

## 2.5 Soil Investigation

2.5.1 The British Geological Survey map for this area indicates that the development site is superficial sand and gravel – Raised Beach Deposit formation overlaying New Pit Chalk Formation. This map is shown in Figure 3.

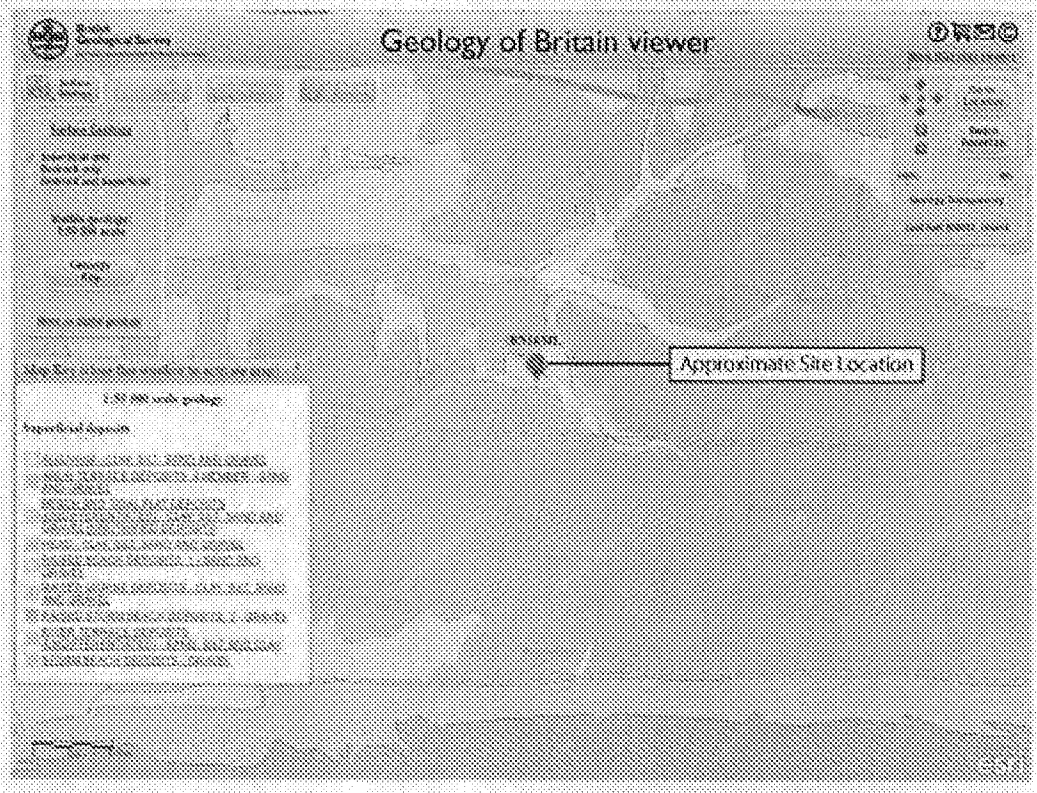



Figure 3: British Geological Survey



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2.5.2 The permeability of chalk, sand and gravel would suggest that the permeability of the soil is likely to be high to very high. The onsite soil condition should be confirmed by a site investigation.

## 2.6 Proposed Development

2.6.1 The proposed development involves the demolition of existing buildings on site and the erection of a mixed use development comprising residential units and care home (Use Class C2 and C3) and ancillary facilities including railway crossing together with associated access, car parking and landscaping. Some alterations are also proposed to the existing access road and landscaped areas. The proposals are shown in the architect's layout included in Appendix C.

2.6.2 With reference to the proposed area plan included in Appendix A of this document a summary of the proposed site areas is as follows:

| | |
|---|---|
| Site Application Boundary Area: | 59,211 m² |
| Proposed Soft Landscaping Area: | 39,297 m² |
| Proposed Public Highway Area: | 7,552 m² |
| Proposed Hard Landscaping Area: | 6,139 m² |
| Proposed Building Roof Area: | 6,223 m² |
| Total Proposed Impermeable Area: (Excluding Public Highway) | 12,362 m² |



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# 3 Flood Zones

## 3.1 Introduction

3.1.1 The Environment Agency uses Flood Zones to determine the vulnerability of every new development. These Flood Zones refer to the probability of river or sea flooding affecting the proposals. An interactive Flood Zone map is accessible on the Environment Agency website.

3.1.2 It can be seen from an extract from this interactive map (Figure 4) that the proposed site is partially located in Flood Zone 1, Flood Zone 2 and Flood Zone 3. Flood Zone 1 is designated as low probability of flooding. Land in this zone is assessed as having a less than 1 in 1000 annual probability of flooding. Flood Zone 2 is designated as medium probability of flooding. Land in this zone 2 has between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 year and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year. Flood Zone 3 is designated as high probability of flooding. Land in this zone is assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

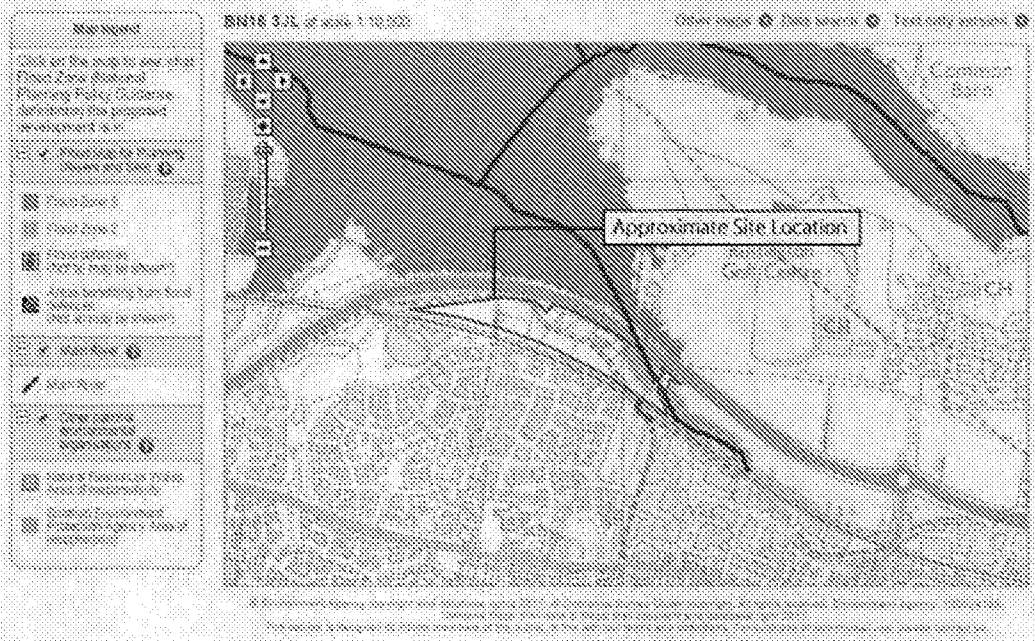



Figure 4: Extract from Environment Agency.



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## 3.2 Sequential Test

3.2.1 Parts of the Brook Lane grounds are located in Flood Zones 1, 2 and 3. With reference to Figure 4 the existing and the proposed buildings are located entirely within Flood Zone 1 and 2 and out of Flood Zone 3. The existing road layout allows safe egress to Flood Zone 1 to the south of the site from the proposed new construction. It is not proposed to undertake any new development in Flood Zone 3 apart from some alterations to existing landscaping.

3.2.2 Since the site is partially located within Flood Zone 2 and Flood Zone 3 the NPPF requires that the Local Planning Authority apply the sequential test to ensure that the development is located in the most appropriate area in terms of use and flood risk.

## 3.3 Appropriate Uses

3.3.1 With reference to Table 2 of the NPPF this proposed residential development and residential care homes uses would be classified as "More Vulnerable".

3.3.2 With reference to Table 3 of the NPPF "More Vulnerable" development in Flood Zone 1 and 2 is appropriate. Therefore, the proposals are appropriate for Flood Zone 1 and Flood Zone 2, and an Exception Test is not required.



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# 4 Site Specific Flood Risk Assessment

## 4.1 Sources of Flooding

4.1.1 The NPPF lists the key sources of flooding which could potentially affect the development site. An assessment of how these forms of flooding may affect the site and details on how they will be managed safely within the development are considered in the following sections:

1. Flooding from Rivers and the Sea
2. Groundwater
3. Flooding from Sewers and Drainage
4. Overland flows
5. Water Infrastructure
6. Flooding from Development Drainage

## 4.2 Flooding from Rivers and the Sea

4.2.1 As shown in Figure 3 the Environment Agency Flood Risk Map indicates that the proposed development site is partly located within Flood Zone 1 (low risk of flooding), Flood Zone 2 (medium risk of flooding) and Flood Zone 3 (high probability of flooding). The areas located in flood zones 3 are away from the existing and proposed buildings and are in landscaped areas.

Environment Agency Modelled Flood Levels

4.2.2 A request was made to the Environment Agency for the issue of modelled flood levels for the tributary of the River Arun in the vicinity of the development site (EA Order Reference: 5SD/37767) This information is provided in full in Appendix D.

4.2.3 A Flood Map Report for the site has been received from the Environment Agency. It also shows that the site is located in an area benefitting from the Arun East Bank Tidal Walls Flood Defences. The report states that the sites lies in an area with a 0.5% chance of flooding in 2110 from the sea considering the presence of flood defences.

4.2.4 Modelled flood levels for a number of nodes within the vicinity of the development site have been taken from the Lower Tidal River Arun Strategy Study (2010) of the site up to the year 2110 and are included in the flood map report. The defended flood levels have been produced for annual exceedance probability of between 0.5% tide and 1% plus climate change fluvial and 5% tidal and 20% fluvial.



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4.2.5 With reference to Modelled Flood Levels the nodes relevant to the site are the shown on Figure 4.

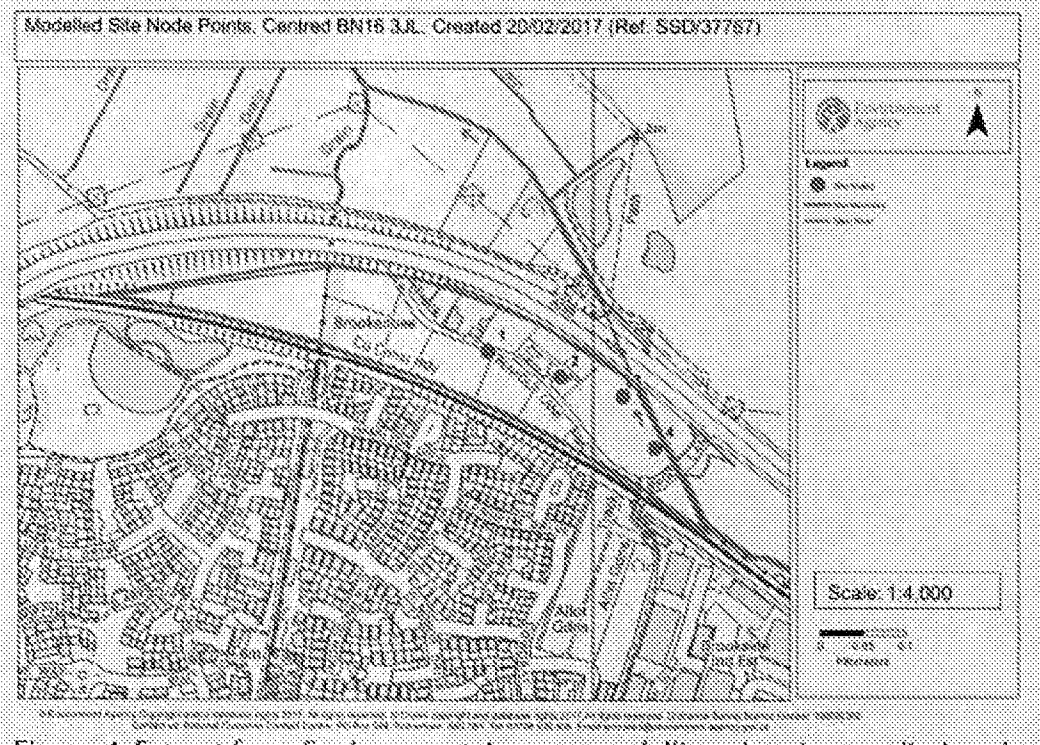



Figure 4: Extract from Environment Agency modelling showing studied nodes along the site.

4.2.6 The flood report states that the defended scenarios include the beach profile and show flooding from wave overtopping of defences. The undefended scenarios do not include any wave overtopping. As such, it can be seen that there are greater flood extents for the defenced scenarios rather than the undefended.

4.2.7 Environmental Agency's Littlehampton Arun East Bank-Tidal Walls Flood Defence Scheme (2013) states that the risk of a breach will be present if no works are undertaken to maintain the flood defences along the east bank due to deterioration. The scheme states that the Environmental Agency and Arun District Council should ensure that the Tidal Walls defences are regularly inspected and essential safety works are carried out.

4.2.8 In the very unlikely event of a breach it is likely that this will not be a sudden event. Regular inspection is likely to highlight any damage which could have the potential to cause flooding in the vicinity of the defences prior to a breach occurring. This would provide the opportunity for the evacuation of residents within the flood extents area prior to the breach occurring.



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4.2.9 Due to this the Environmental Agency report result of the Tidal undefended model is not relevant in this case and it can be ignored.

4.2.10 The flood levels for the site for the different annual exceedance probabilities for the defended and undefended scenarios are as follows:

| Undefended | | Defended | |
|---|---|---|---|
| Fluvial - 1% plus Climate Change | Tidal – 0.5% (2110) | Fluvial - 1% plus Climate Change | Tidal – 0.5% (2110) |
| 1.630 m AOD | 1.960m AOD | - | 2.740m AOD |

Flood Zone Contours

4.2.11 The approximate contours of Flood Zones 2 and 3 have been shown in Figure 3. It can be seen that the existing and proposed new buildings are not located in Flood Zone 3. Also it shows that only the proposed care home building is affected by the flood Zone 2 flood envelope in the south east corner.

Finished Floor Level

4.2.12 The minimum finished floor level based on the up-to date Environment Agency modelled flood levels is:

| | |
|---|---|
| Design Water Level (year 2110) | 2.740m AOD |
| Freeboard: | 0.300m |
| Minimum Finished Floor Level: | 3.040m AOD |

4.2.13 The existing ground levels around the flooding area are no lower than 1.60m AOD. It is proposed elevate the ground level around the proposed actual flooding location, raising the building finished floor levels and create a new lower area to be use as balancing pond to compensate the volume of existing floodplain.



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Flood Plain Compensation

4.2.14 If the ground level is modified it will be necessary to relocate this floodplain volume in order to maintain the Design Water Level (year 2110) at 2.740mAOD. This volume has been calculated and has a value of approximate 8,580m³. This calculation has been included in Appendix E. The actual floodplain extension has been shown in a plan (A3992-SK1506) and is also attached in Appendix E.

Safe Access and Exit

4.2.15 With reference to the topographic survey included in Appendix B all areas of the site, apart from the north east corner adjacent to the watercourse, are located well above the modelled 0.5% (2110) flood level, 2.740m AOD. This includes the existing access road. This access road and the future adjacent road needs to be built above the design flood level to ensure a safe access and egress. Safe access and egress would be available to the Flood Zone 1, within the site, to the north east in the event of flooding.

Flood Resilience

4.2.16 If a minimum of 3.040m AOD level is not possible Flood resilient construction will be required to prevent water ingress into buildings in the event of flooding and to make the buildings easier to repair and clean in the event of flooding.

4.2.17 It will be required a minimum flood level of between 2.740 m AOD and 3.040m AOD with the combination of flood resilient construction.

4.2.18 Advice for the provision of flood resilient construction is provided in the publication 'Improving the Flood Performance of New Buildings – Flood Resilient Construction' (2007) published by CIRIA. The construction and choice of materials would depend on the type of structure and external appearance and internal finishes required. General recommendations are summarised below with development specific comments made where applicable.

Table 1: Summary of general flood resilient construction recommendations (See 'Improving the Flood Performance of New Buildings – Flood Resilient Construction' (2007) published by CIRIA.

| Element | Location | Material/Treatment |
|---|---|---|
| Foundations | Reinforced Concrete | • Piled foundations with reinforced concrete ground beams shall be provided. These have low permeability and there will be no exposed steel reinforcement. |



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| Element | Location | Material/Treatment |
|---|---|---|
| Floors | General | • Good compaction of hardcore and binding is required<br>• Damp proof membranes should be included in the design<br>• Suitable floor finishes include ceramic or concrete based floor tiles, stone and sand/ cement screeds. |
| | Suspended to be provided | • Drainage trench to be provided below floor<br>• Cheaper, sacrificial finishes should be used<br>• Steel reinforcement of concrete beams should be assessed following repeated or prolonged flooding |
| | Insulation | • Floor insulation shall be non-absorbent to minimise the impact of flood water |
| | Services | • Underfloor services using ferrous materials should be avoided. |
| External Walls | Outside face | • Dense materials to limit water absorption with good drying ability and good retention of pre-flood dimensions and integrity<br>• Water resistant coatings |
| | Inside face | • Water resistant render<br>• Ceramic Tiles (kitchen, cloakrooms) |
| | Insulation | • Cavity insulation shall incorporate non-absorbent to minimise impact of water |
| Internal Walls | Masonry | • Dense materials to limit water absorption with good drying ability and good retention of pre-flood dimensions and integrity<br>• Water resistant coatings |
| | Plasterboard | • Use standard gypsum plasterboard up to the predicted flood level (+50mm) as a sacrificial material<br>• Fix horizontally to limit extent of potential replacement |
| Doors and Windows | Doors | • The threshold should be raised as high as possible while complying with regulations.<br>• Sealed external framed doors should be used. |
| | Windows/ patio doors | • Adequate sealing of any windows or door sills to the fabric of the house. |



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| Element | Location | Material/Treatment |
|---|---|---|
| Fittings | Storage | • Water resistant units at a high level<br>• Easily cleanable units |
| | Appliances | • Place as high as practical above the floor level<br>• Allow for effective drainage and cleaning behind kitchen units |
| Services | Pipework | • Closed cell insulation should be used for pipes which are below the predicted floor level |
| | Drainage Services | • Non-return valves are recommended to prevent blow back of diluted sewage in situations where there is a risk of the foul sewer surcharging. This is unlikely to be a risk. |
| | Water, electricity and gas meters | • Locate above the predicted flood level |
| | Electrical services | • Locate sockets on the ground floor above the flood level<br>• Electric ring mains should be installed at first floor level with drops to ground floor sockets and switches. A plastic cable conduit should be used. |
| | Heating Systems | • Boiler units and ancillary devices should be installed above predicted flood level and preferably on the first floor.<br>• Underfloor heating should be avoided. |

4.2.19 A flood alert system is operated by the Environment Agency in Rustington. The development would be registered with the system and residents signed up to the flood warning alarm system. Information on the flood warning system should be provided in residents welcome packs.

Historic Flood Events

4.2.20 The Environmental Agency report indicates than the site has not been affected by any recorded flood incidents



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## 4.3 Groundwater

4.3.1 Reference is made to the Arun District Council Strategic Flood Risk Assessment (2016). It states that the majority of the bedrock in the district is classed as Principal, associated with high permeable bedrocks, with the ability to hold high levels of water storage. This is likely to result in susceptibility of the district to groundwater emergence and flooding when the water table rises.

4.3.2 A map has been included in that document showing the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. According to this map the site is located in an area with potential for elevated groundwater to rise sufficiently to interact with the ground surface or with a susceptibility higher than 75%.

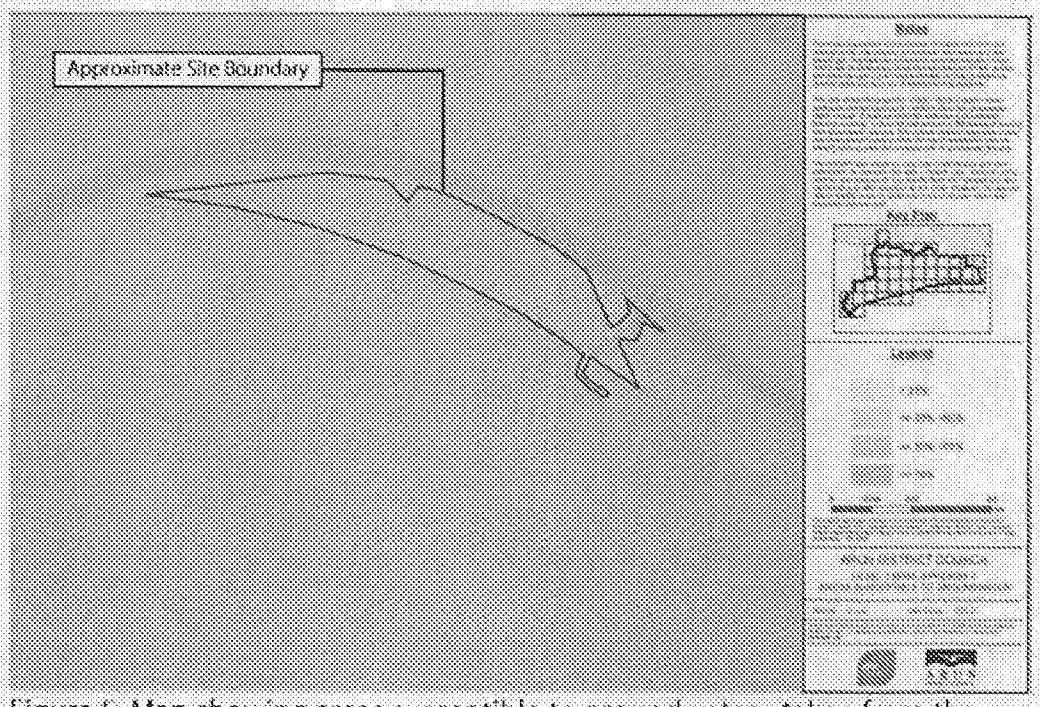



Figure 5: Map showing areas susceptible to groundwater - taken from the Arun Distric Council Strategic Flood Risk Assessment (2016)

4.3.3 It also states that this data should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. It should be noted that although an area may be designated as susceptible to groundwater flooding, this does not mean that groundwater flooding will definitely be a problem within these areas, rather it provides an indication of potential risk.



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4.3.4 Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1 in 100-year plus climate change event.

4.3.5 Appendix H from Arun District Council Strategic Flood Risk Assessment (2016) shows an historic flooding map with the recorded incidents provided by Arun District Council, West Sussex County Council, Southern Water and Environment Agency. These records do not show any historical incidents of groundwater flooding close to the site.

4.3.6 No basement constructions are proposed. It is considered that the finished floor level will be well above groundwater levels. A site investigation needs to be carried out to measure the groundwater depths within the site and confirm that the water table does not represent a flood risk.

4.3.7 The risk of flooding, from this source, to the proposed development is initially assessed as being low. If flooding due to groundwater did occur in the area it is likely to occur in lower, less vulnerable, parts of the site and flow from the site to the watercourse.

## 4.4 Flooding from Sewers and Drainage

4.4.1 No information is currently available regarding existing onsite drainage. It is recommended that a drainage survey is undertaken to assess the condition of any onsite drainage and any defects repaired prior to connecting drainage from the proposed development.

4.4.2 Reference has been made to the Arun District Council Strategic Flood Risk Assessment (2016). No historical flooding from public sewers is recorded.

4.4.3 In the event of flooding from sewers and drainage occurring, flows would follow the topography away from the site towards surrounding watercourse. The risk of flooding from this source is initially assessed as being low.



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## 4.5 Overland Flows

4.5.1 Flooding from the land would be caused by the slope of the site and any 'upstream' land that may cause overland flows during periods of heavy rainfall.

4.5.2 The Environmental Agency has an online interactive map which shows the risk of flooding from surface water – see Figure 6

4.5.3 This map shows that the existing and proposed development is located in an area that is defined as having a low and a very low risk of flooding from surface water. This low risk definition means that each year the site has a chance of flooding from surface water of between 1 in 1000 (0.1%) and 1 in 100 (1%).

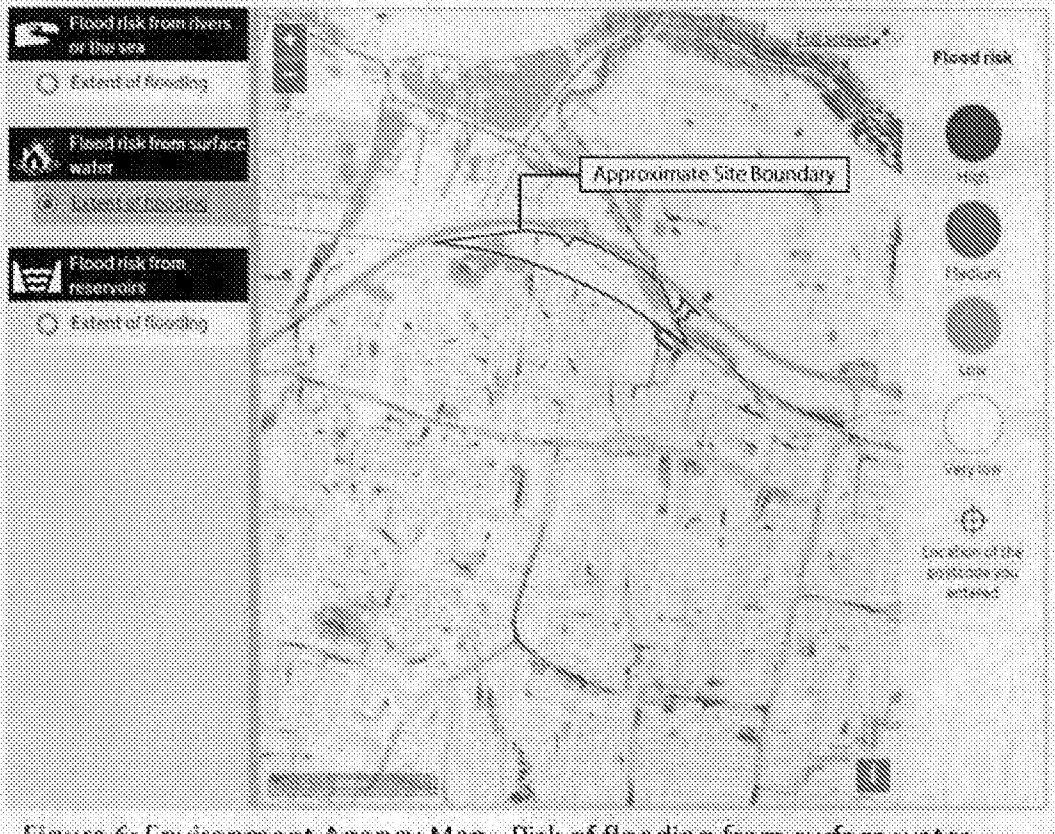



Figure 6: Environment Agency Map - Risk of flooding from surface water



ARUN DISTRICT COUNCIL A/44/17/OUT

4.5.4 Reference is also made to the Arun District Council Strategic Flood Risk Assessment (2016). A map has been included in the document showing the flooding that takes place from the 'surface runoff' generated by rainwater. As shown in Figure 7 the site is located in an area where some flooding incidents are known to occur. Most of the flooding is produced by the 1 in 1000 year storm and is located on proposed landscape areas. The areas currently shown green on figure 7 are small areas of 1 in 30 year storm flooding. These are located in current low points on the existing site but will not occur on the new layout as these areas will be raised in level as part of the development.

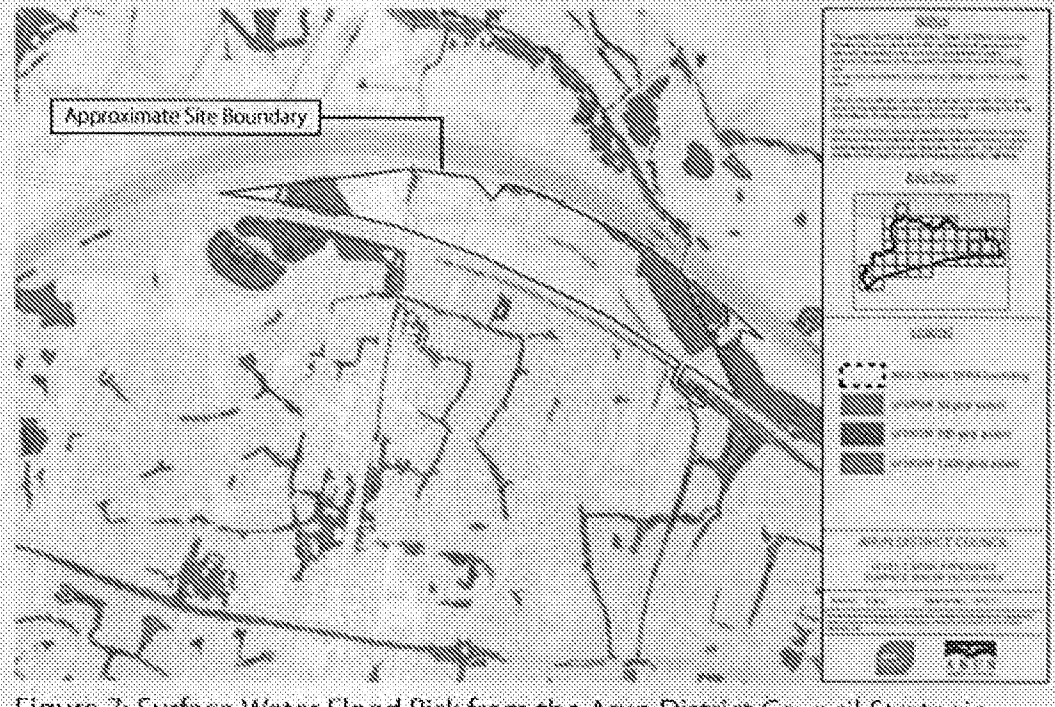



Figure 7: Surface Water Flood Risk from the Arun District Council Strategic Flood Risk Assessment (2016).

4.5.5 As discussed previously if there is flooding in the area, surface water from the site would follow the topography to lower, less vulnerable areas to the south east of the site and into the watercourse. The proposed and existing buildings are located outside of and above these areas. The access road is also located above and outside these areas. The risk of flooding from this source is considered to be low.



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## 4.6 Flooding from Water Infrastructure

4.6.1 An interactive map is available on the Environment Agency website which indicates the maximum extent of flooding in the event of failure of a large reservoir. This map indicates that the site is outside the area that would be flooded in the event of such a failure – See Figure 8.

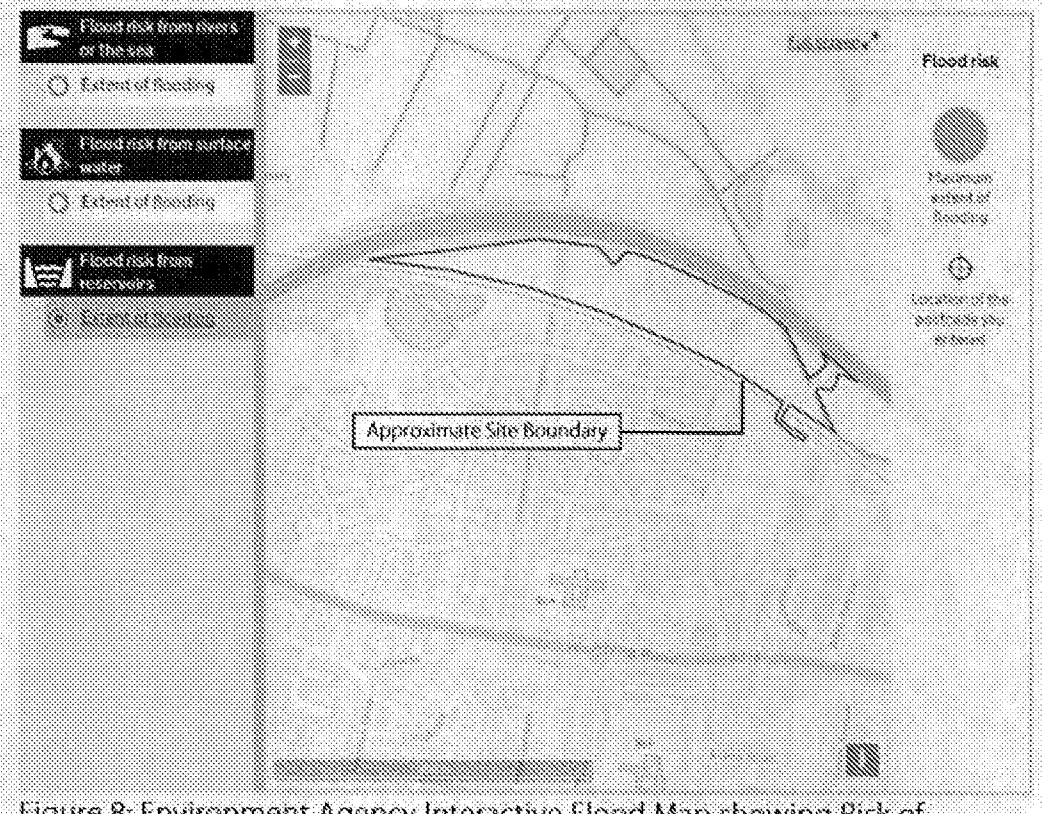



Figure 8: Environment Agency Interactive Flood Map showing Risk of Flooding from Reservoirs

4.6.2 Reference is made to the Arun District Council Strategic Flood Risk Assessment (2016). This states that the possible risk of failure of reservoirs is considered to be minimal. There are no large reservoirs within Arun District and the risk to development for reservoirs is residual. The risk of flooding from this source is considered to be low.



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## 4.7 Flooding from Development Drainage

4.7.1 The proposed development will result in an increase in impermeable areas (See Section 2.2 and 2.8). It will therefore also result in an increase in peak surface water flow. This will be attenuated with SuDS methods and run off restricted to mitigate the increase in impermeable areas.

4.7.2 The risk of flooding from this source is assessed as low.

## 4.8 Summary of Flood Risk

4.8.1 An assessment of key sources of flooding has been carried out and is summarised below:

| | |
|---|---|
| • Flooding from Rivers and the Sea | Flood risk to be mitigated by minimum floor level of 3.040m AOD or minimum 2.740mAOD and the provision of flood resilient construction and residents signing up to Environment Agency's Flood Alert System. |
| • Flooding from Groundwater | Low Risk |
| • Flooding from Sewers and Drainage | Low Risk |
| • Flooding from Overland Flows | Low Risk |
| • Flooding from Artificial Sources | Low Risk |
| • Flooding from Development Surface Water Drainage | Low Risk |



UN DISTRICT COUNCIL A/44/17/OUT

# 5 Drainage Strategy

## 5.1 Drainage Design

5.1.1 The management of the surface water run-off from the proposed development would comprise of the use of Sustainable Drainage Systems (SuDS).

## 5.2 Existing Greenfield Run-Off Rates

5.2.1 The existing greenfield run-off rates from the existing site have been calculated based on the proposed impermeable area of 1.24 ha and based on a 1, 30 and 100 year return period event. It should be noted that areas of public highway have been excluded from these calculation as they are served by a dedicated highway drainage system.

5.2.2 The calculation of the greenfield run-off has been carried out in accordance with the IH Report 124 'Flood estimation for small catchments' (Marshall and Bayliss, 1994) using Microdrainage WinDes software. The existing greenfield run-off rates calculations do not include an allowance for climate change. The greenfield run-off rates are shown below. The results of these calculations are included in Appendix F.

| Return Period | Greenfield Run-Off Rate |
|---|---|
| QBar | 4.4 l/s |
| 1 in 1 year | 3.7 l/s |
| 1 in 30 year | 9.9 l/s |
| 1 in 100 year | 13.9 l/s |

## 5.3 Existing Volume of Run-off

5.3.1 The existing volume of run-off has been calculated based on the proposed impermeable area of 1.24 ha and based on the 1 in 100 year 6 hour event and does not include an allowance for climate change. The results of these calculations, which are included in Appendix F, are included below:

| Event | Volume of Run-off |
|---|---|
| 6 hour 1 in 100 year | 286.990 $m^3$ |



ARUN DISTRICT COUNCIL A/44/17/OUT

## 5.4 Unmitigated Proposed Peak Surface Water Flows

5.4.1 The proposed development results in an increase in roof area and access area and hence an increase in total hardstanding area. The unmitigated proposed peak surface water flow from the site has been calculated based on this increase in impermeable area. The unmitigated proposed peak flow has been calculated for a 1, 30 and 100 year return period event of 15 minute duration and includes a 40% allowance for climate change. Calculations have been undertaken using the Modified Rational Method. The unmitigated peak flows for each of these storm events are shown below:

| Storm Event | Unmitigated Peak Flow |
|---|---|
| $Qp_{1+CC}$ | 131.7 l/s |
| $Qp_{30+CC}$ | 322.6 l/s |
| $Qp_{100+CC}$ | 417.2 l/s |

5.4.2 Due to the increase in impermeable area, and an allowance for climate change, the run-off from the site would be increased post development without any mitigation measures. Mitigation measures to reduce the run-off to greenfield rates are described in section 5.5. Again detailed calculations are provided in Appendix G.

## 5.5 Proposed Surface Water Drainage Strategy

5.5.1 The majority of the proposed development will be constructed over existing undeveloped area. The impermeable area thus will increase which will result in an increase of peak surface water run-off from the development site without any further mitigation measures.

5.5.2 It is therefore proposed that the run-off from the proposed development will be limited to the greenfield run-off rates for all storm return periods up to a 1 in 100 year storm event plus an allowance of 40 % for climate change. The following SuDS measures have been considered for the development.



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Attenuation of rain water in ponds and open water features

5.5.3 With reference to the Arun District Council Local Plan (2014) it states in its Policy GEN9, The Local Planning Authority will promote the use of balancing ponds for the attenuation of surface water run-off where this is required.

5.5.4 There are suitable areas for new open water features within the site located in Flood Zone 1 and outside the floodplain area. Attenuation of rain water in ponds and open water features will then be considered further. Groundwater monitoring, infiltration tests to BRE digest 365 standards and contamination testing is required to confirm the areas for which this would be possible within the site.

Infiltration

5.5.5 Infiltration techniques are used to discharge surface water from hardstanding areas into the ground.

5.5.6 Disposal of the surface water run-off to soakaways has been considered. Soakaways were not considered suitable for the development site due to space constraints within the development site and possible temporarily high water tables. The arrangement of the proposed buildings means that minimum clearance distances of 5m between foundation structures/boundaries and soakaways would not be achievable. In addition it is likely that minimum clearance distances of 1 m between the ground water table and the bottom of the below ground infiltration structure is unlikely to be achievable.

5.5.7 Shallow infiltration measures such as permeable paving can allow the maintenance of the minimum clearance of 1 metre, with additional storage proposed for the impermeable areas. It is proposed that the houses fronting hard landscaped and parking areas will be constructed from permeable paving blocks overlaying a permeable sub-base with infiltration into the ground. Surface water falling on these areas will infiltrate into the ground reducing the run-off from the site. Groundwater monitoring, infiltration tests to BRE digest 365 standards and contamination testing is required to confirm the areas for which this would be possible within the site and an alternative drainage strategy may be required if adequate infiltration is not available at suitable depths.



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5.5.8 Permeable paving is designed to intercept surface water runoff and to provide a pollutant treatment prior to discharge into the ground. Permeable paving will limit the potential for deterioration in groundwater quality. The use of permeable paving areas is subject to suitable infiltration rates being confirmed onsite and contamination testing.

Attenuation of rain water through tanks or sealed water features

5.5.9 It is proposed that some areas could not be allowed to discharge to open features due to the ground level difference. It is therefore proposed that surface water run-off would be attenuated with controlled discharge to the existing watercourse along the site. Surface water run-off from roofs and hardstanding area would be stored where possible in wet ponds which are proposed in the landscape layout and/or in underground storage. The controlled discharge to the ditch would be limited to greenfield run-off rates for all storm return periods up to and including the 1 in 100 year storm event including an allowance of 30 % for climate change.

5.5.10 The overall storage volume required for the development site will be calculated during detailed design following soakage tests and groundwater monitoring.

5.5.11 Ponds and wetlands also provide pollutant treatment, e.g. through retaining suspended solids in sediments or uptaking nutrients by plants.

5.5.12 Consent from the relevant land drainage authority would be required to discharge surface water to the existing watercourse.



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# 6 Conclusions

This Flood Risk Assessment has been undertaken for the proposed demolition of existing buildings on site and the erection of a mixed use development comprising residential units and care home (Use Class C2 and C3) and ancillary facilities including the railway crossing together with associated access, car parking and landscaping at the land west of Brook Lane and south of A259, Rustington, West Sussex, BN16 3JL. This assessment has been prepared in compliance with guidance given in the National Planning Policy Framework (NPPF) and Technical Guidance (March 2012).

The Environment Agency Flood Risk maps indicate that the proposed development site is partly situated in Flood Zone 1 and partly in Flood Zone 2 and 3. It is required that the Local Planning Authority apply the sequential test. In accordance with Table 2 and Table 3 of the NPPF the new construction are considered as "More Vulnerable". This type of construction is appropriate in Flood Zone 1 and 2 and the Exception Test is not required.

Environment Agency flood modelling for the tributary of the River Arun in the vicinity of the site has been obtained. The 0.5% (2110) design flood level for the site is 2.740mAoD. Based on this a minimum floor level of 3.040mAoD is recommended in the Environment Agency's standing advice. If this level is not possible, even though the site is not recorded as being previously affected by flooding it is recommended that flood resilient construction up to 300mm above the design flood level is provided. Residents of the new development shall be signed up to the Environment Agency's flood warning system for the tributary of the River Arun.

The risk of flooding from the different possible key sources has been assessed. This assessment has deemed that the risk of flooding from other sources at the site is low.

An initial assessment of the risk of flooding from the different possible key sources from the NPPF lists which could potentially affect the development site has been undertaken based on presently available information. According to the available information, this assessment has deemed that the risk of flooding from other sources at the site is low.

The proposals result in an increase of the impermeable areas and to mitigate the increase in surface water discharge rate, attenuation methods have been proposed. These measures would result in the peak surface water flows being limited to the greenfield run-off rates for all storm return periods up to a 1 in 100 year storm event plus an allowance of 40 % for climate change.



ARUN DISTRICT COUNCIL A/44/17/OUT

Shallow infiltration measures, such as permeable paving, are required to achieve these run-off rates. It is proposed that the houses fronting hard landscaped and parking areas will be constructed from permeable paving blocks overlaying a permeable sub-base with infiltration into the ground. Also Arun District Council seeks the implementation of ponds within developments where there are suitable areas. There are suitable areas for new open water features within the site located in Flood Zone one and outside the floodplain area. Attenuation of rain water in ponds and open water features will then be considered further.

Due to the ground water table permeable paving and the discharge of floors into the proposed pond will not be possible. In this instance, attention tanks need to be provided. The proposed attenuation volumes have been sized to adequately convey storm events up to and including the 100 year storm events including an allowance of 40% for climate change using Microdrainage Windes software. These calculations are included in Appendix F. The surface water drainage proposals have been provided in the schematic drainage layout drawing included in Appendix G.



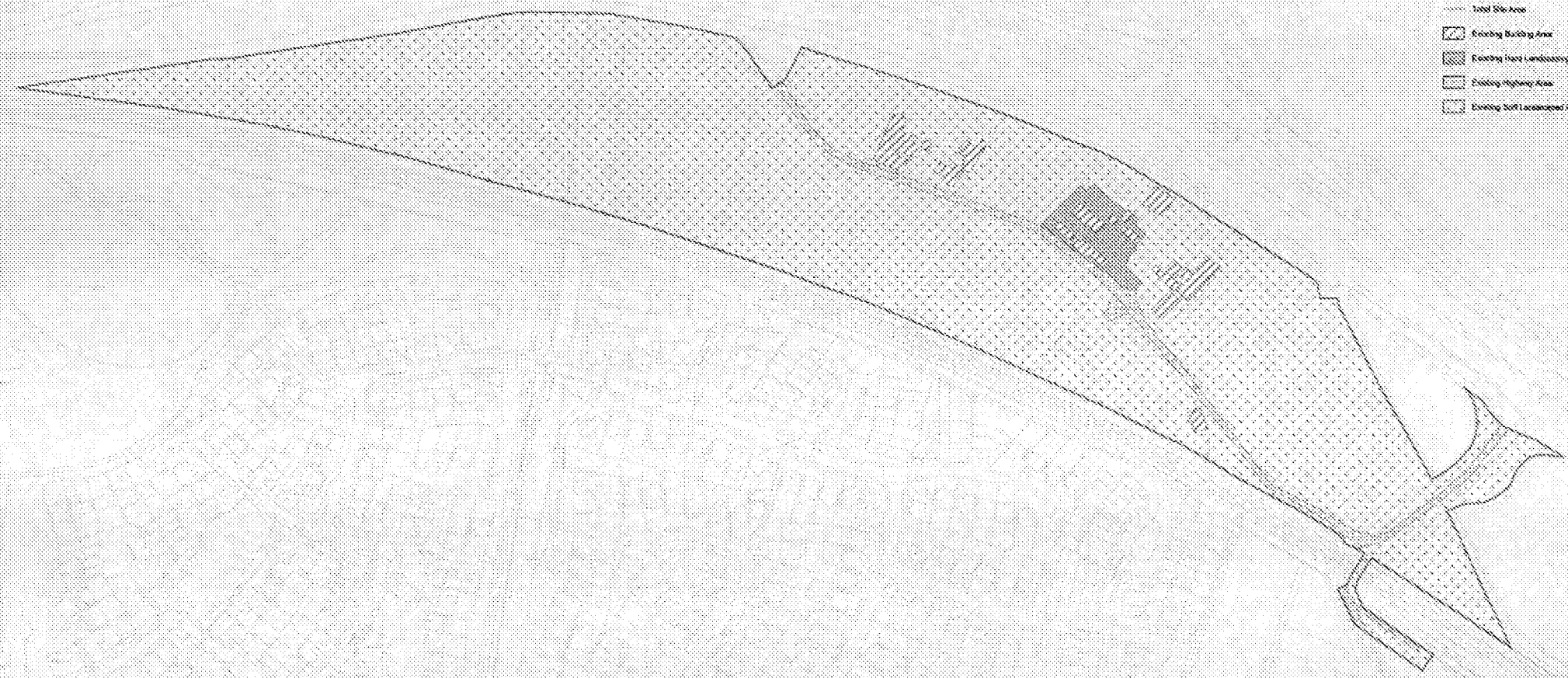
ARUN DISTRICT COUNCIL A/44/17/OUT

NOTES

1. DO NOT SCALE THIS DRAWING.
2. This drawing is to be read in conjunction with all relevant Architects, Engineers and Consultants drawings and their respective Specifications.
3. All work to comply with the relevant British Standards, Codes of Practice and the Building Regulations.
4. Any discrepancies between all existing dimensions, conditions and construction of all buildings to be demolished must be BOTH the responsibility of and to be confirmed on site by the Contractor before the commencement of any demolition.

AREA

| | |
|---|---|
| Total Site Area | 56,211 m² |
| Existing Building Area | 1,411 m² |
| Existing Hard Landscaping Area | 1,328 m² |
| Existing Highway Area | 1,995 m² |
| Existing Soft Landscaped Area | 51,477 m² |



PRELIMINARY

| | | | |
|---|---|---|---|
| P1 | First Issue | | |
| rev | date | drwn | chkd |

ARUN DISTRICT COUNCIL A/4/17/OUT

consulting engineers

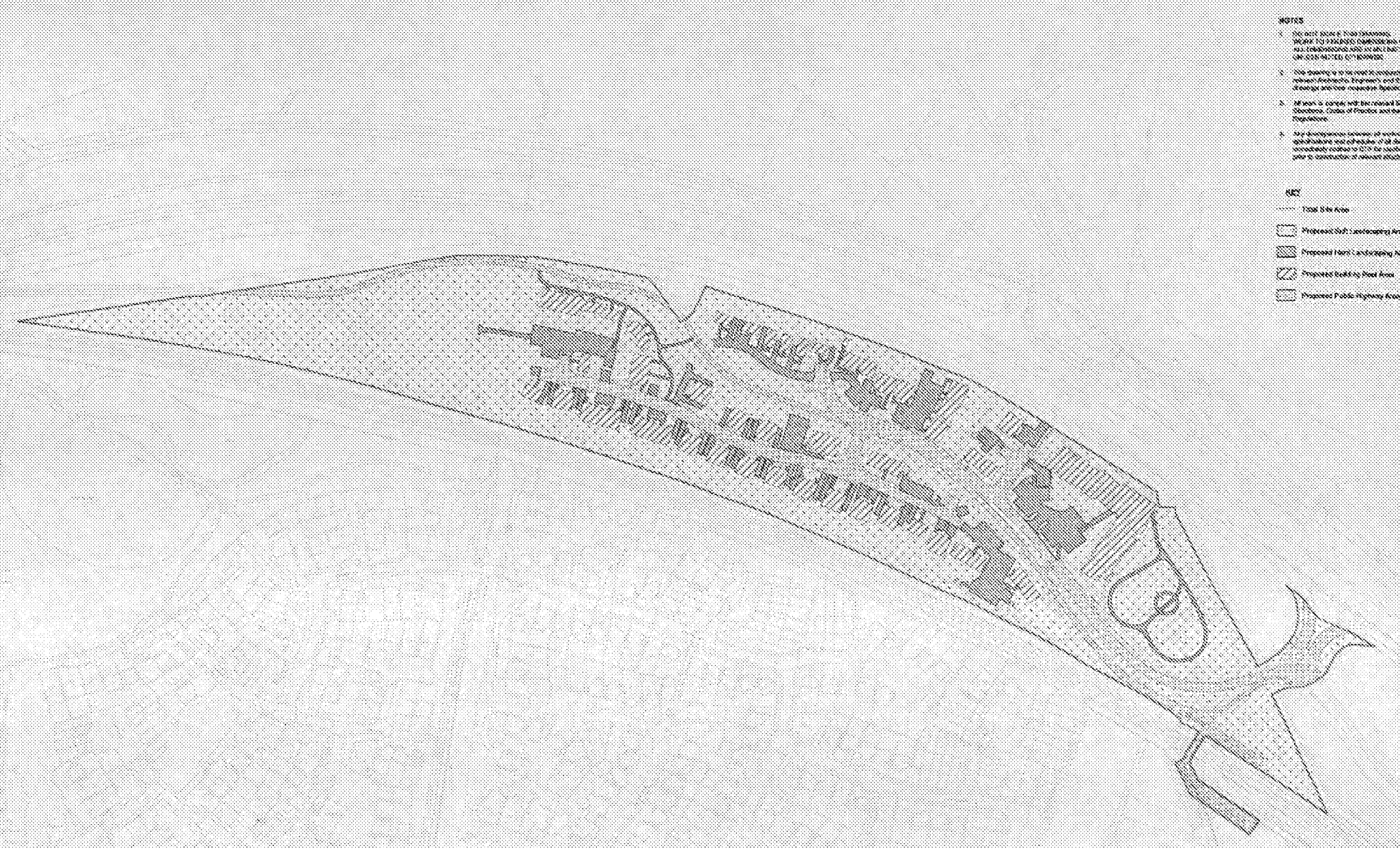
Brook Lane, Rustington
BN16 3JL

Existing Area Plan

A3991-1500

1:1000@A1
1:2000@A3

P1



PRELIMINARY

consulting engineers

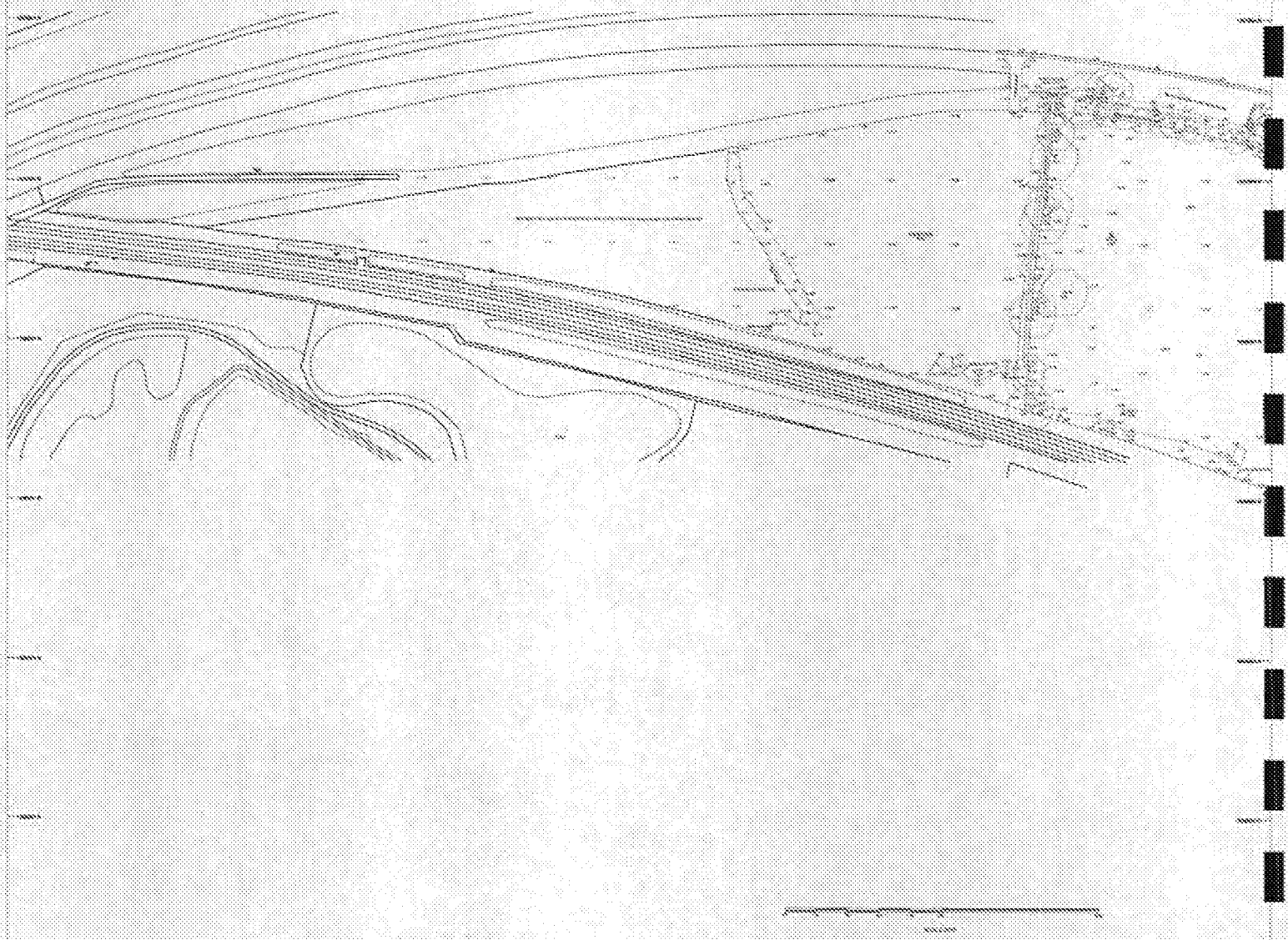
Brook Lane, Rustington

BN16 3JL

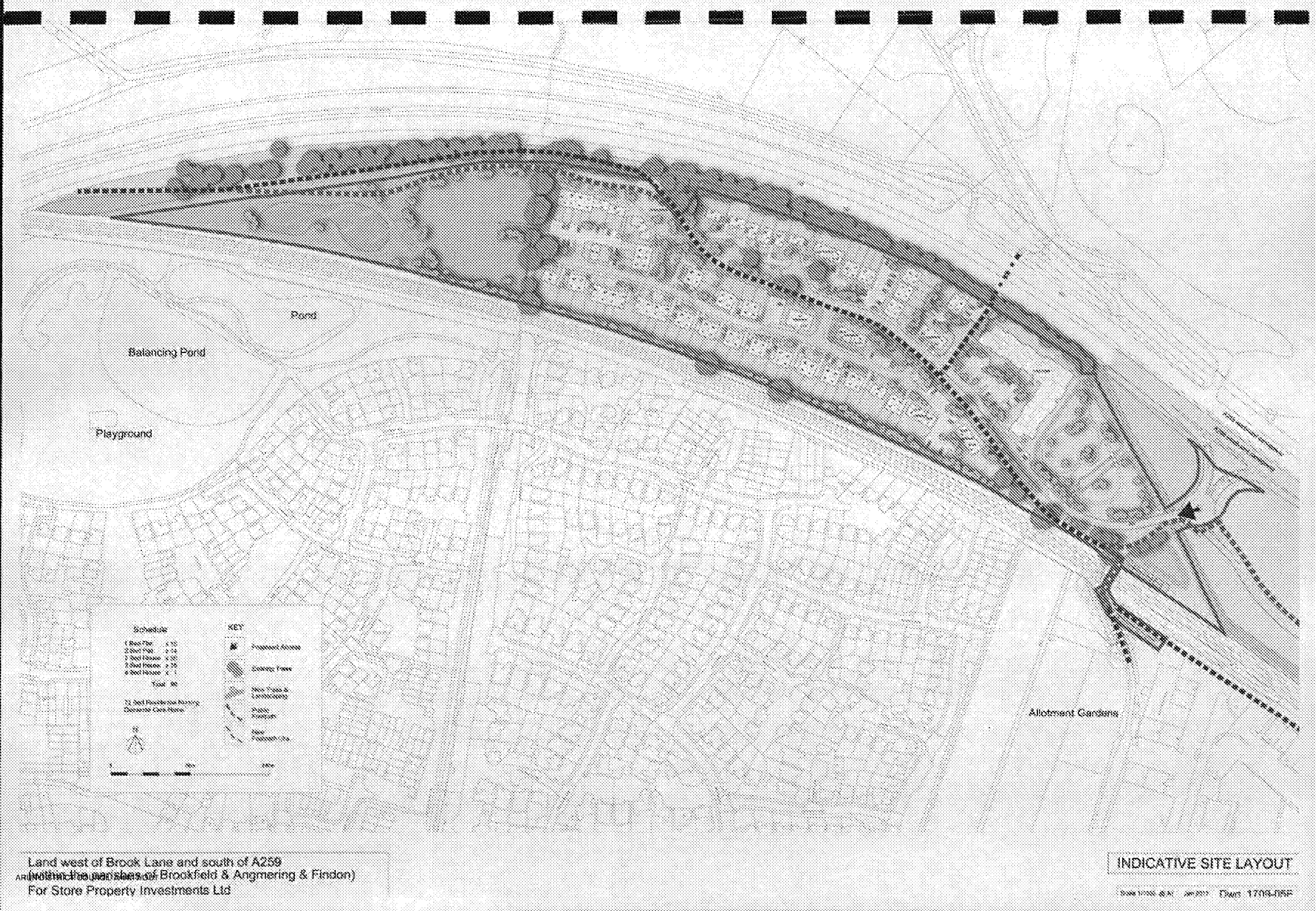
Proposed Area Plan

A3992-1501

ARUN DISTRICT COUNCIL A/44/13/OUT

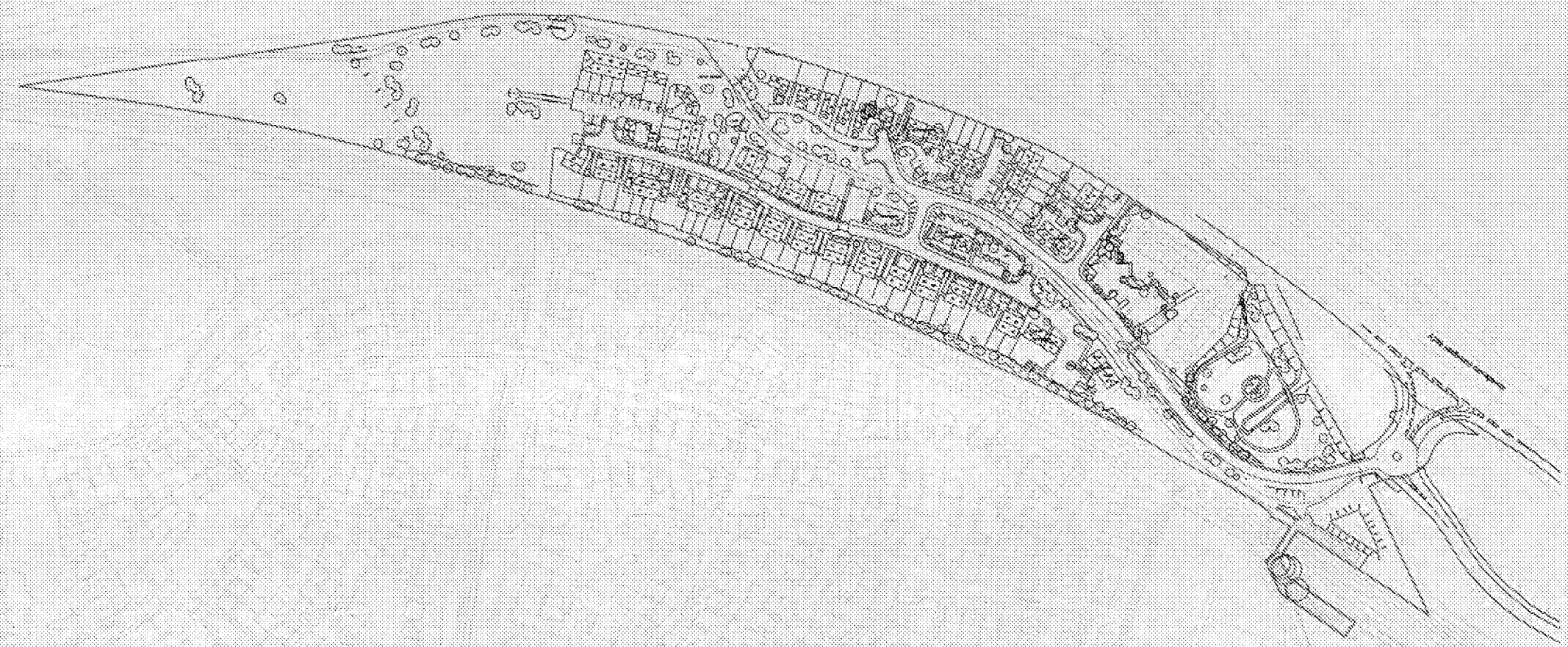


ARUN DISTRICT COUNCIL A/44/17/OUT




Land west of Brook Lane and south of A259
Indicative Masterplan (Sheet 1 of 2)
For Store Property Investments Ltd

INDICATIVE SITE LAYOUT



LAND AT BROOK LANE, RUSTINGTON - ILLUSTRATIVE PROPOSALS

ARUN DISTRICT COUNCIL

## Use of Environment Agency Information for Flood Risk Assessments

**Important**
If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

You should refer to the Environment Agency's Flood Risk Standing Advice, Planning Practice Guidance, and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

https://www.gov.uk/flood-risk-assessment-standing-advice
http://planningguidance.planningportal.gov.uk/
http://www.planningportal.gov.uk/planning/planningpolicyandlegislation/previousenglishpolicy/ppgpps/pps25

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk Assessment (FRA) where one is required, but does not constitute such an assessment on its own.

2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.

3. Where a planning application requires a FRA and this is not submitted or deficient, the Environment Agency may well raise an objection.

4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

Maria Orellana
CTP Consulting Engineers
Suffolk House
154 High Street
Sevenoaks
Kent
TN13 1XE

**Our ref:** SSD/37767

**Date:** 20/02/2017

Dear Maria

Provision of Product 4 for address: Brook Lane, Rustington, Littlehampton BN16 3JL

Thank you for your request of 9th February 2017 to use Environment Agency data, Product 4. The information is attached.

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

**The property is in an area located within Flood Zone 3 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.*

Please find attached a copy of the Flood Map for Planning (Rivers and Sea) for the area relating to your address.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments

https://www.gov.uk/planning-applications-assessing-flood-risk
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD
Customer services line: 03708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk


RUN DISTRICT COUNCIL A/44/17/OUT

## Supporting Information

### Flood Defences

As a result of the Littlehampton Arun East Bank Tidal Walls Flood Defence Scheme the flood defences on the East Bank of the River Arun in the town of Littlehampton have been raised to 4.8mAOD. These have been designed to reduce the risk of flooding to an estimated 0.33% (1in300yr) up to the year 2110. Further details available at http://www.environment-agency.gov.uk/homeandleisure/floods/114650.aspx

### Model Information

The flood outlines, depths and levels are taken from the Lower Tidal River Arun Strategy Study, completed in 2010 by Atkins.

Please note the defended scenarios include the beach profile and show flooding from wave overtopping of defences. The undefended scenarios do not include any wave overtopping. The calculations used to generate estimated wave overtopping volumes require defence crest, toe and profile information which are obviously not available for an undefended scenario. As such, you may see greater flood extents for the defenced scenarios rather than the undefended.

### Flood History

We do not have any records of previous flood events affecting this site. I would suggest contacting West Sussex County Council for a more comprehensive flood history check.

Please note our records are not comprehensive and may not include all events, you can contact your Local Authority to check if they hold any relevant information regarding your application.

You are encouraged to use and re-use this information freely and flexibly, with only a few conditions. Details of which can be found here: http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

We respond to requests for recorded information that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information you can contact us within 2 calendar months to ask for our decision to be reviewed.

If you have any queries or would like to discuss the content of this letter further please call us on 03708 506506.

Yours faithfully
**Freddie Fielding**
**PSO West Sussex**

Enc. Flood Map for Planning (Rivers and Sea) / Node point locations / Flood levels/depths / Modelled flood outlines / Flood Defence Locations

# Flood Defence Locations. Centred BN16 3JL. Created 20/02/2017.

Environment Agency

Legend

Defences

- Embankment
- Wall
- Flood Gate
- Demountable Defence
- Bridge Abutment
- High Ground
- Beach
- Barrier Beach
- Promenade
- Quay
- Cliff
- Dunes
- Culvert



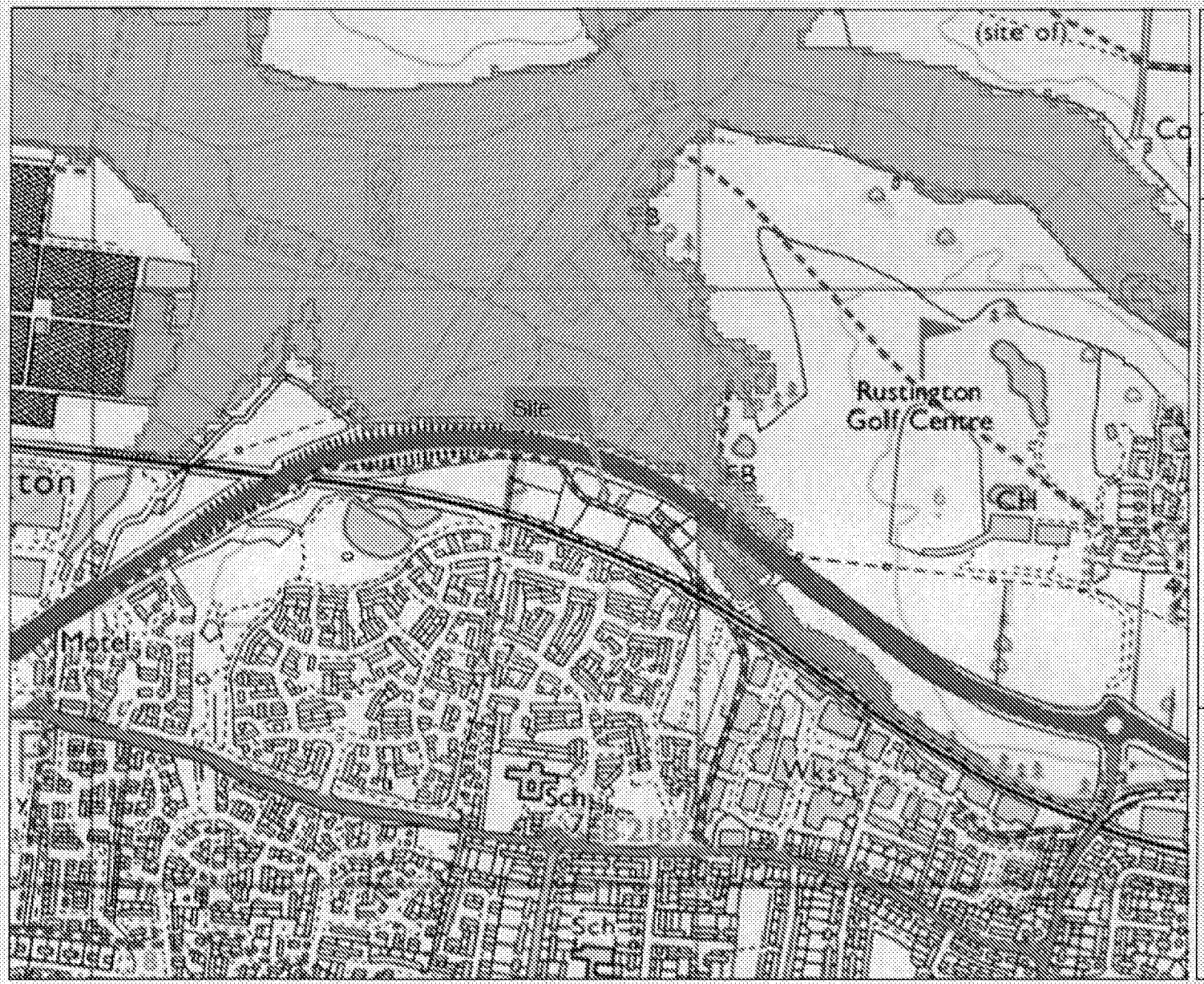

0 100 200 300

Metres

N W E S

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# Flood Map for Planning (Rivers and Sea). Centred BN16 3JL. Created 20/02/2017.




Environment Agency

Scale 1: 10,000

N
W
E
S

## Flood Map for Planning (Rivers & Sea)

- 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 occuring each year.

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

ARUN DISTRICT COUNCIL A/44/17/OUT

**Product 4 Flood Risk Data Requested by:** Maria Orellana

**Site:** Brook Lane, Rustington, Littlehampton BN16 3JL

**Table 1:** Water Levels: Fluvial Undefended

| | NGR | | Modelled Flood Levels in Metres<br>Undefended Annual Exceedance Probability | | | |
|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 5% | 1% | 1% Plus Climate Change | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - |
| 2 | 504962 | 103593 | - | - | - | - |
| 3 | 505020 | 103564 | - | - | 1.63 | - |
| 4 | 505052 | 103508 | - | - | - | - |

**Table 2:** Water Levels: Fluvial Defended

| | NGR | | Modelled Flood Levels in Metres<br>Defended Annual Exceedance Probability | | | | | |
|---|---|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 20% | 5% | 1.3% | 1% | 1% + CC | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - | - | - |
| 2 | 504962 | 103593 | - | - | - | - | - | - |
| 3 | 505020 | 103564 | - | - | - | - | - | - |
| 4 | 505052 | 103508 | - | - | - | - | - | - |

**Table 3:** Water Levels: Tidal Undefended

| | NGR | | Modelled Flood Levels in Metres<br>Undefended Annual Exceedance Probability | | | |
|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 5% | 0.5% | 0.5% (2110) | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - |
| 2 | 504962 | 103593 | - | - | - | - |
| 3 | 505020 | 103564 | - | - | 1.96 | - |
| 4 | 505052 | 103508 | - | - | 1.96 | - |

**Table 4:** Water Levels: Tidal Defended

| | NGR | | Modelled Flood Levels in Metres<br>Defended Annual Exceedance Probability | | | |
|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 5% | 0.5% | 0.5% (2110) | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - |
| 2 | 504962 | 103593 | - | - | 2.74 | - |
| 3 | 505020 | 103564 | - | - | 2.74 | - |
| 4 | 505052 | 103508 | - | - | 2.74 | - |

Office Address: Guildbourne House, Chatsworth Road, Worthing BN11 1LD.
Customer services line: 03708 506 506. Email: enquiries@environment-agency.gov.uk
www.gov.uk/government/organisations/environment-agency

**Table 5:** Water Depth: Fluvial Undefended

| | NGR | | Modelled Flood Depth in Metres<br>Undefended Annual Exceedance Probability | | | |
|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 5% | 1% | 1% Plus Climate Change | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - |
| 2 | 504962 | 103593 | - | - | - | - |
| 3 | 505020 | 103564 | - | - | 0.03 | - |
| 4 | 505052 | 103508 | - | - | - | - |

**Table 6:** Water Depth: Fluvial Defended

| | NGR | | Modelled Flood Depth in Metres<br>Defended Annual Exceedance Probability | | | | | |
|---|---|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 20% | 5% | 1.3% | 1% | 1% + CC | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - | - | - |
| 2 | 504962 | 103593 | - | - | - | - | - | - |
| 3 | 505020 | 103564 | - | - | - | - | - | - |
| 4 | 505052 | 103508 | - | - | - | - | - | - |

**Table 7:** Water Depth: Tidal Undefended

| | NGR | | Modelled Flood Depth in Metres<br>Undefended Annual Exceedance Probability | | | |
|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 5% | 0.5% | 0.5% (2110) | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - |
| 2 | 504962 | 103593 | - | - | - | - |
| 3 | 505020 | 103564 | - | - | 0.33 | - |
| 4 | 505052 | 103508 | - | - | 0.28 | - |

**Table 8:** Water Depth: Tidal Defended

| | NGR | | Modelled Flood Depth in Metres<br>Defended Annual Exceedance Probability | | | |
|---|---|---|---|---|---|---|
| Node Reference | Eastings | Northings | 5% | 0.5% | 0.5% (2110) | 0.1% |
| 1 | 504877 | 103622 | - | - | - | - |
| 2 | 504962 | 103593 | - | - | 0.17 | - |
| 3 | 505020 | 103564 | - | - | 1.14 | - |
| 4 | 505052 | 103508 | - | - | 1.09 | - |

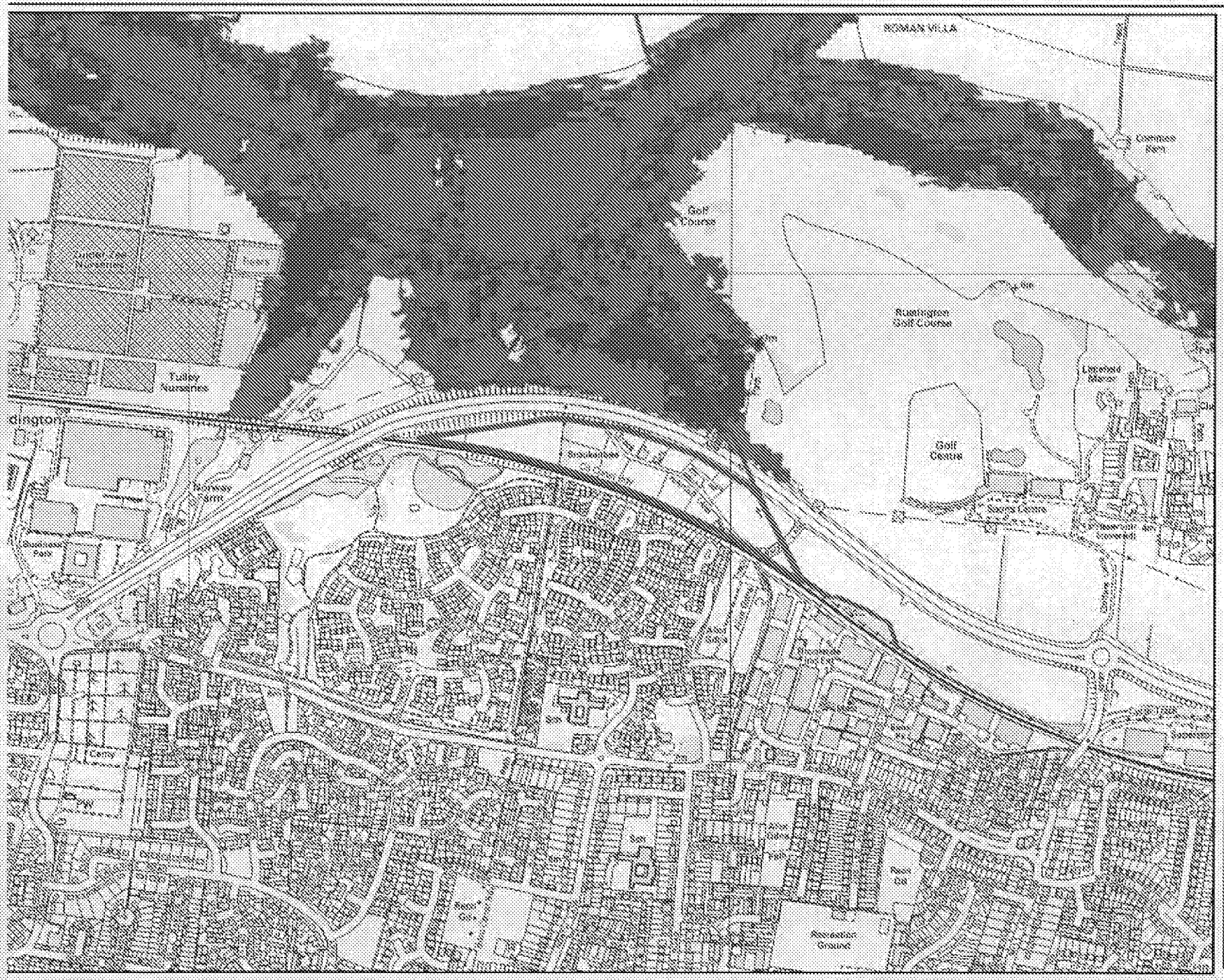
All levels taken from: Lower Tidal River Arun Strategy Study, completed in 2010 by Atkins.

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

Produced on 20/02/2017

Office Address: Guildbourne House, Chatsworth Road, Worthing BN11 1LD.
Customer services line: 03708 506 506. Email: enquiries@environment-agency.gov.uk
www.gov.uk/government/organisations/environment-agency

Modelled Flood Outlines (Fluvial Defended). Centred BN16 3JE. Created 20/02/2017 (Ref: 33b/37767)




Environment Agency

N

**Legend**

- Site Boundary
- Main River
- 20% AEP (Defended Fluvial)
- 5% AEP (Defended Fluvial)
- 1.3% AEP (Defended Fluvial)
- 1% AEP (Defended Fluvial)
- 0.1% AEP (Defended Fluvial)
- 1% AEP Plus Climate Change (Defended Fluvial)

Scale: 1:10,000

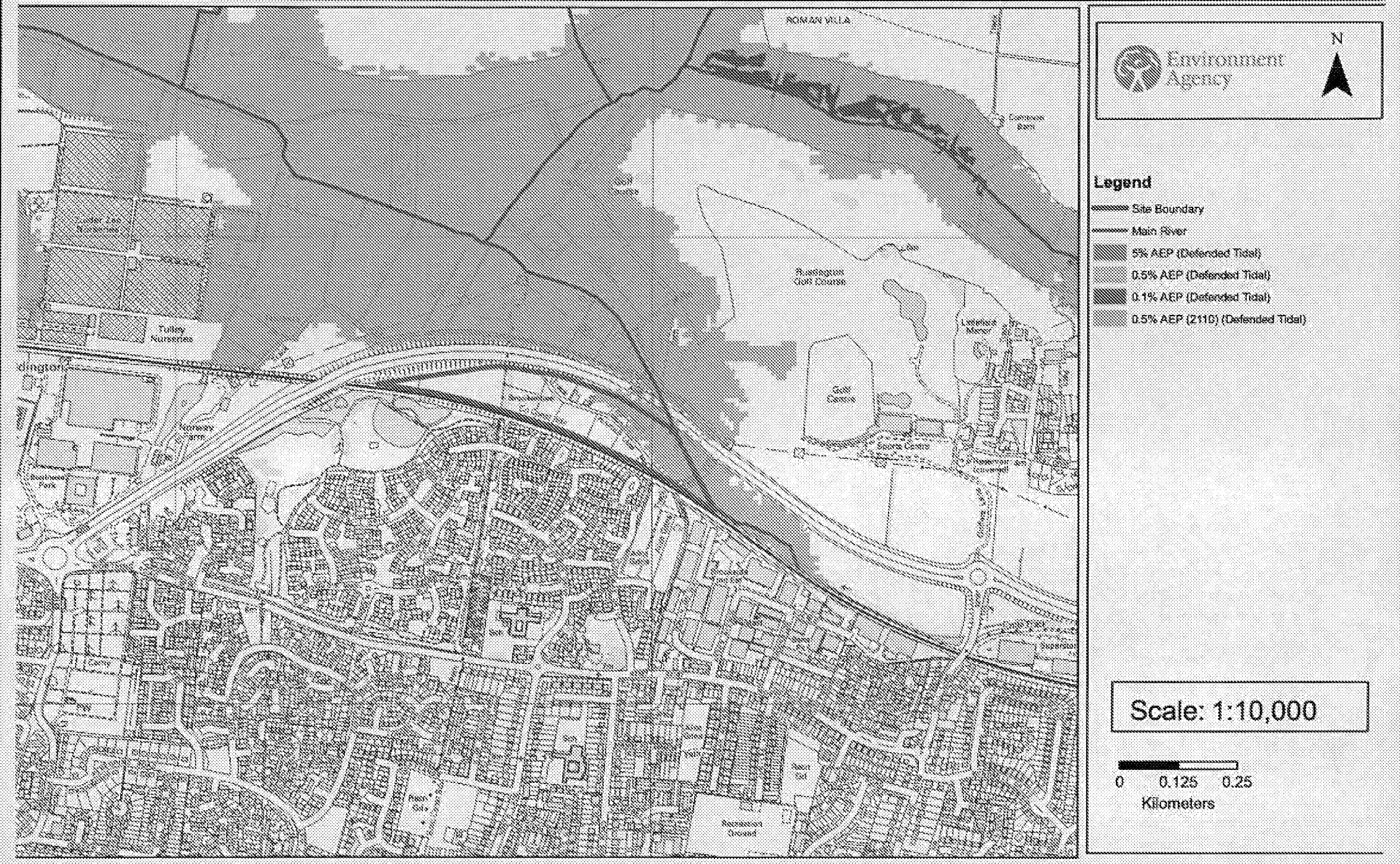
0 0.125 0.25

Kilometers

ARUN DISTRICT COUNCIL A/44/17/OUT

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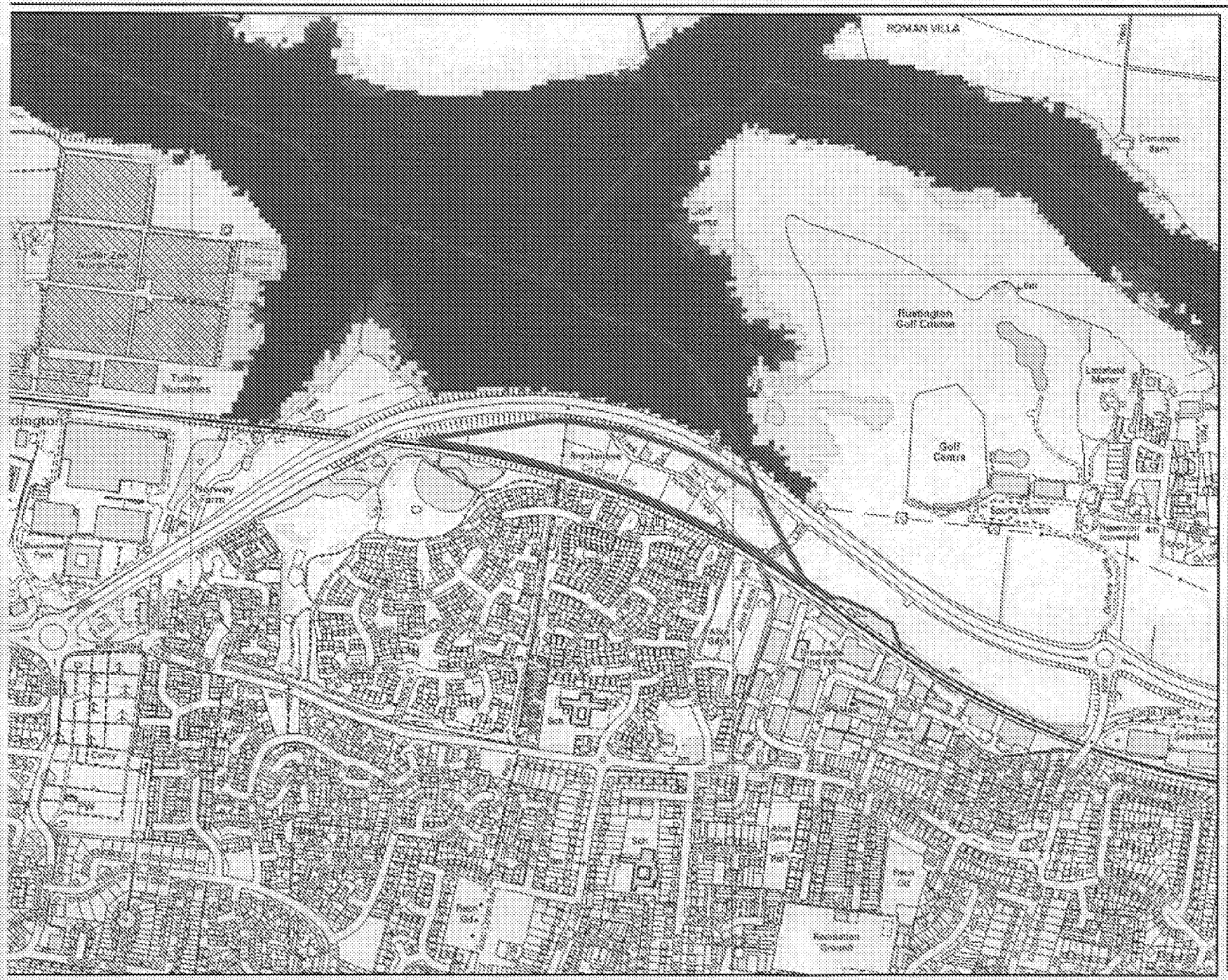
Modelled Flood Outlines (Tidal Undefended). Centred BN16 3JL. Created 20/02/2017 (Ref: SSD/37767)




ARUN DISTRICT COUNCIL A/44/17/OUT

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Modelled Flood Outlines (Fluvial Undefended). Centred BN16 3JL. Created 20/02/2017 (Ref: SSD/37767)




Environment Agency

N

**Legend**

- Site Boundary
- Main River
- 5% AEP (Undefended Fluvial)
- 1% AEP (Undefended Fluvial)
- 0.1% AEP (Undefended Fluvial)
- 1% AEP Plus Climate Change (Undefended Fluvial)

Scale: 1:10,000

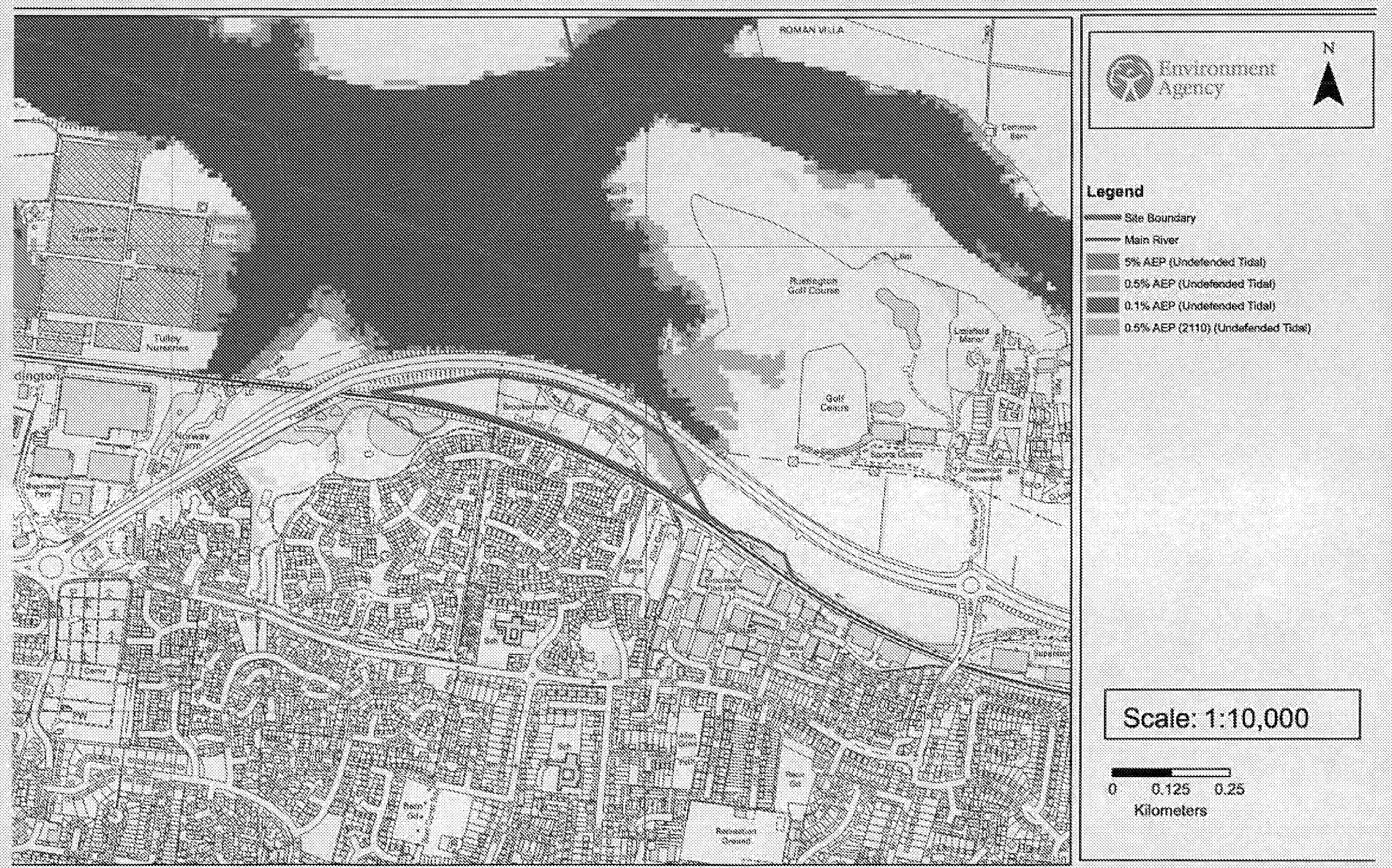
0 0.125 0.25

Kilometers

ARUN DISTRICT COUNCIL A/44/17/OUT

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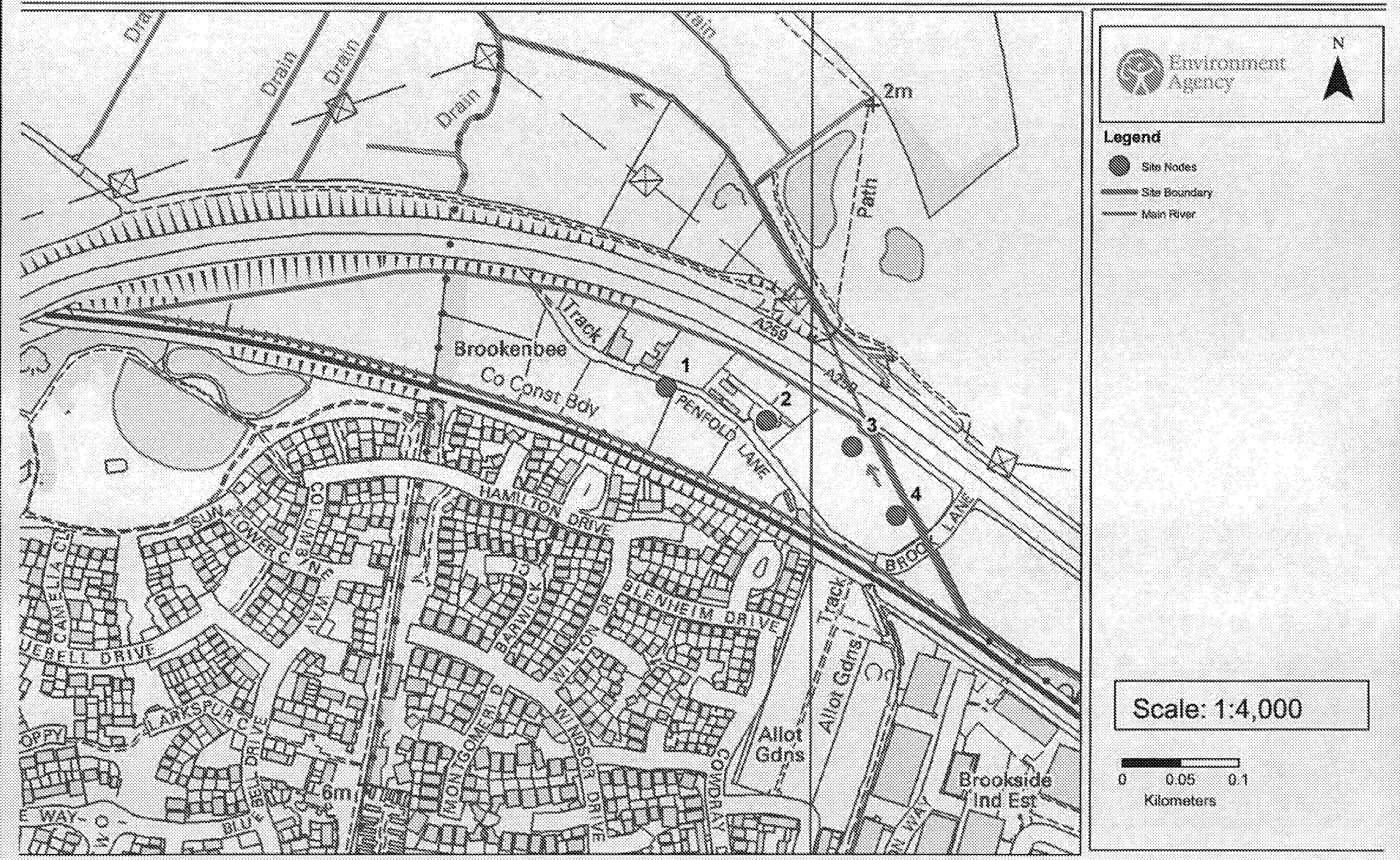
Modelled Flood Outlines (Tidal Undefended). Centred BN16 3JL. Created 20/02/2017 (Ref: SSD/377/67)




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Modelled Site Node Points. Centred BN16 3JL. Created 20/02/2017 (Ref. SSD/3767)




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## Volumes of PGM2 model relative to PGM1 model

PGM1 (Existing) model:
N:\JOBS\A3750_A3999\A3992\CALCULATIONS\PDS\FINAL\PGM\EXISTING.DGM
PGM2 (Proposed) model:  Datum plane at level: 2.740

Zones of PGM1 included in volume calcs:
  All zones

Zones of PGM2 included in volume calcs:
  All zones

Volumes were calculated within a digitised boundary

---

### Areas and Perimeters of PGM1:

| Zone No. | | Surface Area (sq.m.) | Plan Area (sq.m.) | Perimeters Internal (m.) | Perimeters External (m.) |
|---|---|---|---|---|---|
| 1 | Zone 1 | 68090.0 | 67903.3 | 0.0 | 1713.3 |
| Totals: | | 68090.0 | 67903.3 | | 1713.3 |

### Areas and Perimeters of PGM2:

| Zone No. | | Surface Area (sq.m.) | Plan Area (sq.m.) | Perimeters Internal (m.) | Perimeters External (m.) |
|---|---|---|---|---|---|
| 1 | Zone 1 | 252972.8 | 252972.8 | 0.0 | 2164.1 |
| Totals: | | 252972.8 | 252972.8 | | 2164.1 |

### Total Plan and Surface Areas of Overlap between both PGM models:

| | In Cut | In Fill | Balanced |
|---|---|---|---|
| Total Plan Area: | 244.6 | 15065.8 | 0.0 |
| Total Surface Area: | 245.2 | 15113.5 | 0.0 |

---

### Total of Cut and Fill Volumes listed by zones of PGM1:

| Zone No. | | Volumes Cut (cu.m.) | Volumes Fill (cu.m.) | Nett Volumes Cut (cu.m.) | Nett Volumes Fill (cu.m.) |
|---|---|---|---|---|---|
| 1 | Zone 1 | 19.6 | 8580.8 | | 8561.2 |
| Total Volumes: | Gross: | 19.6 | 8580.8 | | |
| | Nett: | | 8561.2 | | |



RUN DISTRICT COUNCIL A/44/17/OUT

Note:
Volumes are of PGM2 surface relative to PGM1 formation

---

Summary of Total Volumes of Cut/Fill:

| | | PGM2 surface relative to PGM1 surface Cut | Fill |
|---|---|---|---|
| Total | Gross: | 19.6 | 8580.8 |
| | Nett: | | 8561.2 |

---



ARUN DISTRICT COUNCIL A/44/17/OUT

NOTES

1. DO NOT SCALE THIS DRAWING
   WORK TO FIGURED DIMENSIONS ONLY
   ALL DIMENSIONS ARE IN MILLIMETRES UNLESS
   OTHERWISE STATED
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL
   RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS
   DRAWINGS AND THEIR SUBMISSION SPECIFICATIONS
3. ALL WORK IS TO COMPLY WITH THE RELEVANT BRITISH
   STANDARDS, CODES OF PRACTICE AND THE BUILDING
   REGULATIONS
4. ANY DISCREPANCIES BETWEEN ALL WORKING DRAWINGS,
   SPECIFICATIONS AND SCHEDULES OF ALL DISCIPLINES TO BE
   IMMEDIATELY NOTIFIED TO CTP FOR CLARIFICATION/CORRECTION
   PRIOR TO COMMENCEMENT OF RELEVANT ELEMENTS

KEY

Site Boundary

Modelled Flood Outline
1 in 100 yr ARD, 30% ARF (CC+30)
Undefended Peak, Based on Environment Agency Modelled Flood Levels

A259

A259

PRELIMINARY

ARUN DISTRICT COUNCIL A/41/13/OUT

consulting engineers

Brook Lane, Rustington
BN16 3JL

Modelled Flood Outline

A3991-1506

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 1 | Soil | 0.400 |
| Area (ha) | 1.860 | Urban | 0.000 |
| SAAR (mm) | 721 | Region Number | Region 7 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 6.3 |
| QBAR Urban | 6.3 |
| Q1 year | 5.4 |
| Q1 year | 5.4 |
| Q30 years | 14.4 |
| Q100 years | 20.2 |

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## Greenfield Runoff Volume

FSR Data

| | |
|---|---|
| Return Period (years) | 100 |
| Storm Duration (mins) | 360 |
| Region | England and Wales |
| M5-60 (mm) | 18.900 |
| Ratio R | 0.350 |
| Areal Reduction Factor | 1.00 |
| Area (ha) | 1.800 |
| SAAR (mm) | 721 |
| CWI | 107.710 |
| Urban | 0.000 |
| SPR | 37.000 |

Results

| | |
|---|---|
| Percentage Runoff (%) | 36.72 |
| Greenfield Runoff Volume (m³) | 416.598 |

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UN DISTRICT COUNCIL A/44/17/OUT

| Title: | Job No. | A3992 |
|---|---|---|
| Brook Lane, Rustington | By | MOM |
| Description: Estimate of unmitigated peak rate and volume of run-off from proposed development (including allowance for climate change) | Date: | 03.03.2017 |
| | Sheet No. | 1 of 2 |

Suffolk House, 154 High St,
Sevenoaks, Kent, TN13 1XE
Telephone: 01732 740 195
Facsimile: 01732 740 662
www.ctp-llp.com

| Ref: | Calculations | Output |
|---|---|---|

**Proposed Development**

Proposed Development: Estimate of Surface Water Run-Off using the Modified Rational Method

Catchment Area = 59210 $m^2$

Proposed Impermeable Area = 12360 $m^2$

Average Rate of Rainfall:
Average rainfall values from Micro-Drainage using:

FSR method where:
M5-60(mm)= 19.000 R, ratio= 0.350

1 Year 15 Minute Event (M1-15D) = 28.1 mm/hr

30 Year 15 Minute Event (M30-15D)= 68.8 mm/hr

100 Year Event 15 Minute Event (M100-15D)= 89.0 mm/hr

**Peak Rate of Run-Off (+ climate change allowance)**

$Q_p = C \cdot A_p \cdot I$ (+30% allowance for climate change), where C = Cv . Cr

Cv = 0.75 (Volumetric run-off co-efficient)
Cr = 1.30 (Routing co-efficient)

Allowance for climate change 40%

$Q_{1+CC}$ = 131.7 l/s

$Q_{30+CC}$ = 322.6 l/s

$Q_{100+CC}$ = 417.2 l/s

| Title: | Job No. | A3992 |
|---|---|---|
| Brook Lane, Rustington | By | MOM |
| Description: Estimate of unmitigated peak rate and volume of run-off from proposed development (Including allowance for climate change) | Date: | 03.03.2017 |
| | Sheet No. | 2 of 2 |

ctp
Suffolk House, 154 High St,
Sevenoaks, Kent, TN13 1XE
Telephone: 01732 740 185
Facsimile: 01732 740 662
www.ctp-ltd.com

| Ref: | Calculations | Output |
|---|---|---|

**Volume of Run-Off (M100-360D) (+ climate change allowance)**

This is calculated using the 100 Year return period, 360 minute storm event

Average Rate of Rainfall:

100 Year 360 Minute Event (M100-360D) = 10.505 mm/hr

(Rain intensity taken from Microdrainage WinDes using FSR method)

Proposed Volume of Run-Off for 6 hour storm duration +Climate Change

Allowance for climate change = 40%

Average rainfall (M100-360D) +CC% = 14.707 mm/hr (i)

Average depth of rainfall +30% (6h) = 88.242 mm

Volume = C . $A_g$ . i . t Where C = Cv . Cr

Cv = 0.75 (Volumetric Co-efficient)
Cr = 1.30 (Routing Co-efficient)

V = 1063.4 $m^3$

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