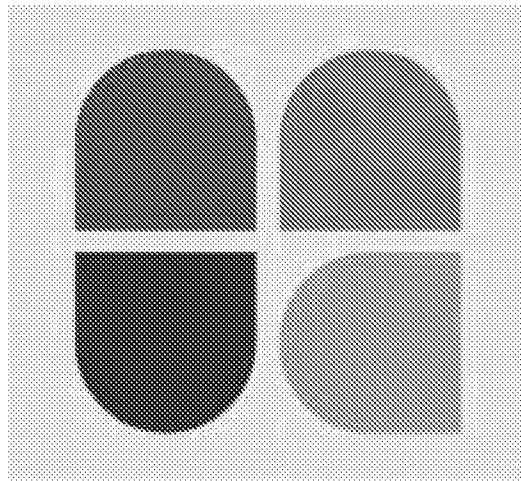




BRIGHT PLAN CIVILS

**SITES A & B, LAND NORTH OF
TODDINGTON LANE, LITTLEHAMPTON**

PROPOSED RESIDENTIAL DEVELOPMENT

Flood Risk Assessment and Drainage
Strategy

Prepared on Behalf of

T&L Crawley (No. 2) LLP

D1970/FRA1.3

01 December 2021

DOCUMENT CONTROL

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 Proposed Residential Development

 Document: Flood Risk Assessment and Drainage Strategy

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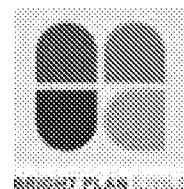
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Appendix A	Site Location Plan and Architectural Development Proposals
Appendix B	Mayer Brown Drainage Strategy (LU/17/19/DOC)
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1 INTRODUCTION

1.1 Background

- 1.1.1 Bright Plan Civils (BPC) is instructed by T&L Crawley (No. 2) LLP to prepare a site-specific Flood Risk Assessment (FRA) and Drainage Strategy to accompany an outline planning application for a residential development in relation to Land North of Toddington Lane, Littlehampton.
- 1.1.2 An existing consent exists under Planning Reference; LU/47/11 which was granted on 23rd January 2013. The application was approved for the construction of up to 1,260 residential dwellings, B1 employment use, Class A facilities, a 100-bed hotel, 60-bed care home, primary school, community centre, youth and leisure facilities in addition to associated infrastructure works. This report relates to two parcels of land, referred to herein as 'Site A & B', under that consent.
- 1.1.3 The proposals for Sites A & B now involve the construction of up to 71 No. residential units across the two parcels of land, consisting of 28 No. dwellings on Site A, with 43 No. dwellings on Site B. The architectural development proposals for this development can be found within **Appendix A**.
- 1.1.4 This FRA and Drainage Strategy has been undertaken in accordance with Planning Practice Guidance: Flood Risk and Coastal Change and National Planning Policy Framework Section 14.
- 1.1.5 In preparing this report, BPC has referred to the following documents and information:
- Environment Agency Flood Maps for Planning
 - Long Term Flood Risk Information; Flood Risk Maps
 - West Sussex County Council Strategic Flood Risk Assessment
 - Arun District Council, West Sussex County Council and Southern Water Drainage Records
 - Mayer Brown Drainage Strategy (A/PHDRAIN.10, dated January 2019)
 - Third Party As Built and Construction Issue Drawings (Mayer Brown and MK Surveys)
- 1.1.6 The Mayer Brown drainage strategy (A/PHDRAIN.10) was prepared to assist in the discharge of Condition 10 of the outline planning consent for Land North of Toddington Lane (LU/47/11). The drainage strategy was submitted under Planning Reference; LU/17/19/DOC.
- 1.1.7 It is confirmed within the Mayer Brown drainage strategy that Sites A & B were encapsulated within the strategy devised, with allowance for these two parcels of land made. Extracts of the Mayer Brown drainage strategy can be found within **Appendix B**.
- 1.1.8 This document has been prepared to assess flood risk specifically in relation to Sites A & B and in view of the wider development within the vicinity of the two parcels of land, to ensure that the risk of flooding is not increased and the development is safe for its design life, whilst also to demonstrate a viable drainage strategy in terms of both foul and surface water to support the proposed residential development. The broad principles of a drainage strategy have already been approved as per LU/17/19/DOC and Mayer Brown's associated drainage strategy report.

1.1.9 This report has been prepared for the benefit of the named Client only.

1.2 Site Location and Description

- 1.2.1 A client prepared site location plan is included within **Appendix A**. Site A & B are located to the west of the overall allocation at Land North of Toddington Lane.
- 1.2.2 The sites have combined total area of 1.66Ha. Site A accounts of 0.88Ha, with the remaining 0.78Ha associated with Site B.
- 1.2.3 An updated topographical survey of the site has been undertaken by Encompass Surveys, dated June 2021. A copy of this survey is included in **Appendix C** of this report.
- 1.2.4 The survey demonstrates falls, broadly, from the south to the north in relation to both Site A and Site B, with levels in the range of 7.50m and 3.75m. Drawings **D1970-PL101 and D1970-PL102 'Existing Topography and Overland Flow Routes'** have been prepared to demonstrate the current topographical trends.
- 1.2.5 Given the nature of the proposed development, which is to tie in wider new development, construction issue drawings for the construction of the road serving the two parcels of land have obtained from Technical & Development Services (Southern) Ltd. to ensure co-ordination between the schemes. These drawings are contained within **Appendix D**.
- 1.2.6 Sites A & B are understood to have previously housed a number of greenhouses and buildings associated with the historic nurseries with run-off understood to drain to Black Ditch and its associated tributaries to the north. As present, following clearance and demolition works, the sites are part of a wider major construction project meaning that levels on site may have changed due to earthworks undertaken in conjunction with the surrounding development. As a result, it is likely that flow routes may have been altered. It is understood that the most recent topographical survey, undertaken in June 2021 as referred to in 1.2.3, reflects the current lie of the land at the two adjacent sites.
- 1.2.7 Black Ditch (Main River) is located approximately 160m north of Site B.
- 1.2.8 There are no areas of hardstanding currently located within the bounds of Site B, although approximately 987m² of impermeable surfacing is present on Site A, as demonstrated on drawing **D1970-PL200 'Impermeable Areas Comparison'**.

1.3 Ground Conditions

- 1.3.1 An independent, detailed assessment of ground conditions has not been undertaken in relation to this drainage strategy given that the sites form part of a wider planning approval for which the principles of both foul and surface water drainage have already been established, with allowances made to accommodate development associated with the use of Sites A & B.
- 1.3.2 The British Geology Survey (BGS) website has been referred to in order to clarify the anticipated underlying geology at the site.
- 1.3.3 The Geology of Britain Viewer indicates a variable chalk Bedrock at the sites. It is apparent that Site B straddles a designation of '**New Pit Chalk Formation**' and '**Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (undifferentiated) – Chalk**', with Site A falling entirely within the latter classification, as indicated in **Figure 1**.



- 2.



1.4 Groundwater

- flooding at the site.

- 1.4.2 Mapping managed by MAGIC (magic.defra.gov.uk) provides geographic information concerning the natural environment from across government. This mapping tool has been referred to in order to confirm whether the site is located within either any groundwater source protection zones or groundwater vulnerability zones as well as to provide further commentary on anticipated ground conditions.
- 1.4.3 The site is located within a 'Principal' Bedrock aquifer. Principal aquifers provide significant quantities of drinking water and water for business needs, and may also support rivers, lakes and wetlands.

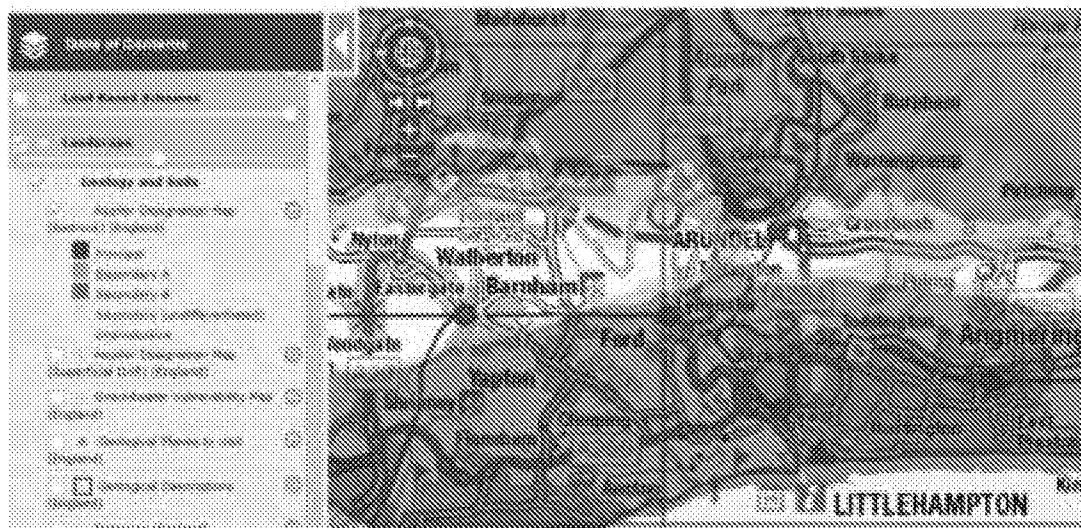


Figure 3. DEFRA Bedrock Aquifer Designation Map

- 1.4.4 The site is located within a 'Secondary A' Superficial Drift aquifer, which comprises permeable layers that can support local water supplies and may form an important source of base flow to rivers.

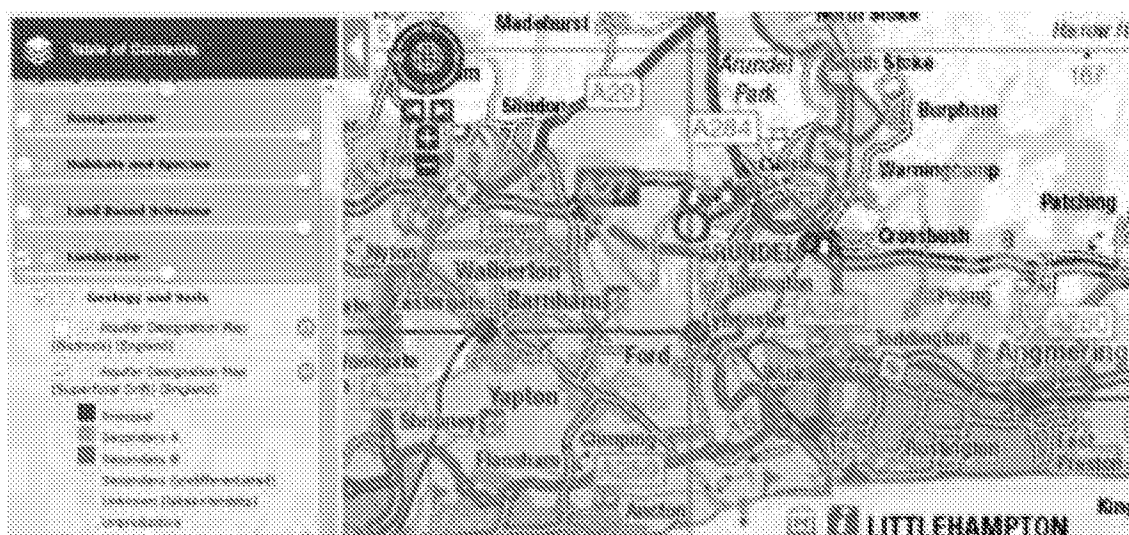


Figure 4. DEFRA Superficial Drift Aquifer Designation Map

- 1.4.5 The Groundwater Vulnerability Map (**Figure 5**) confirms that the site is located within a 'Medium' groundwater vulnerability zone, with a 'Soluble Rock Risk' also indicated. Areas designated as falling within a 'Medium' groundwater vulnerability zone are areas that offer some groundwater protection. A 'Soluble Rock Risk' is an area defined where solution features that enable rapid movement of a pollutant may be present.

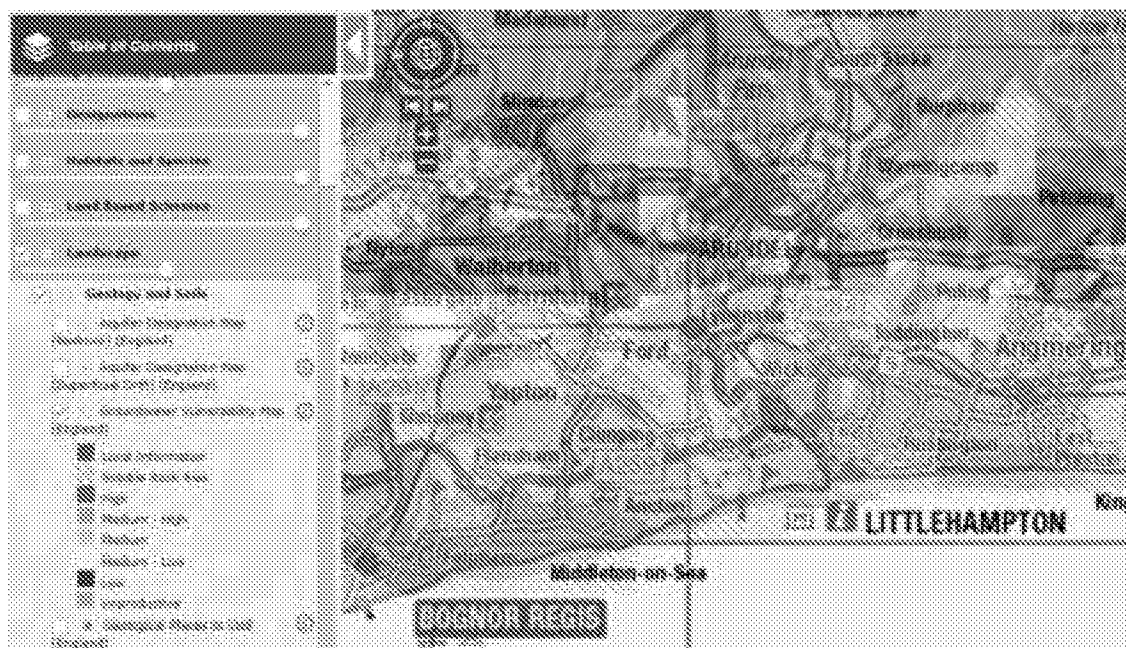


Figure 5. DEFRA Groundwater Vulnerability Map

- 1.4.6 The Groundwater Source Protection Zone Map (**Figure 6**) confirms that the site is located outside of any groundwater source protection zones.

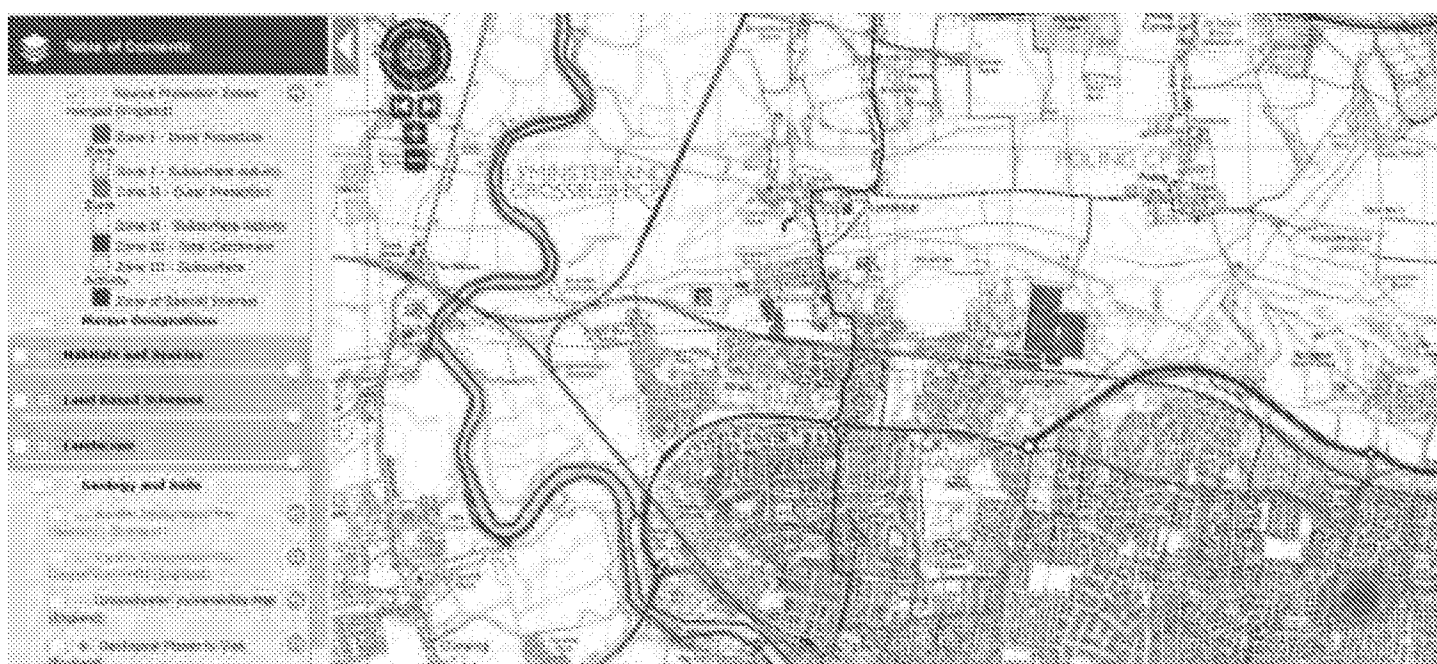


Figure 6. DEFRA Groundwater Source Protection Zones

1.5 Existing Drainage

- 1.5.1 The site falls under the administrative jurisdiction of Arun District Council and West Sussex County Council. Both have been consulted concerning the development of Sites A & B, with correspondence contained within **Appendix E** and **Appendix F**.
- 1.5.2 The local sewerage authority is Southern Water, who provide foul and surface sewerage services within the area. It is noted, however, that sewers associated with the surrounding development are not under the ownership of Southern Water, with ICOSA instead responsible.
- 1.5.3 In view of the wider development either completed, under construction or proposed, engineering drawings have been obtained as provided by the client for infrastructure and/or works within the vicinity of Sites A & B. These drawings can be found within **Appendix D**.
- 1.5.4 Surface Water:
- Existing surface water sewers are located within the road which intersects Site A and Site B. The sewers within the vicinity of the site range in size from 150mm dia. to 450mm dia. The sewers are demonstrated as falling to the east.
 - 2 No. 150mm dia. laterals have been constructed (1 No. serving Site A, 1 No serving Site B) for the future utilisation by the proposed development. Both points of connection are located within the newly constructed, respective bellmouths.
- 1.5.5 Foul Water:
- Foul water sewers have also been constructed between Site A and Site B, located within the carriageway of the newly constructed road. These foul water sewers are also shown to fall in an easterly direction, measuring 150mm dia.
 - 150mm laterals have also been provided for future connectivity to the newly constructed foul water drainage network in relation to Site A and Site B. The lateral for Site A is located towards the north-eastern extent of the site, whilst the lateral for Site B is located to the south-eastern extent of the site.
- 1.5.6 Highway Drainage:
- The newly construction roads are served by traditional road gullies which discharge to the wider surface water drainage system, as demonstrated by the drawings contained within **Appendix D**.

2 PROBABILITY

2.1 Sources of Information

2.1.1 The NPPF requires that all sources of flooding are considered being Tidal, Fluvial, Pluvial, Groundwater, Sewers and Man-made reservoirs/canals.

2.1.2 The likelihood of the site flooding has been established by reviewing the following information:

- Environment Agency Flood Maps for Planning
- Long Term Flood Risk Assessment Surface Water Flood Risk Maps
- Long Term Flood Risk Assessment Reservoir Flood Risk Maps
- West Sussex County Council Strategic Flood Risk Assessment
- Consultation with Arun District Council and Lead Local Flood Authority (West Sussex County Council)

2.2 Flood Maps and Modelling

2.2.1 The Environment Agency's on-line Flood Maps for Planning (rivers and sea) show that Site B is located almost entirely within Flood Zone 1, with minor encroachment into Flood Zones 2 and 3 following the northern boundary. Site A is located fully within Flood Zone 1.

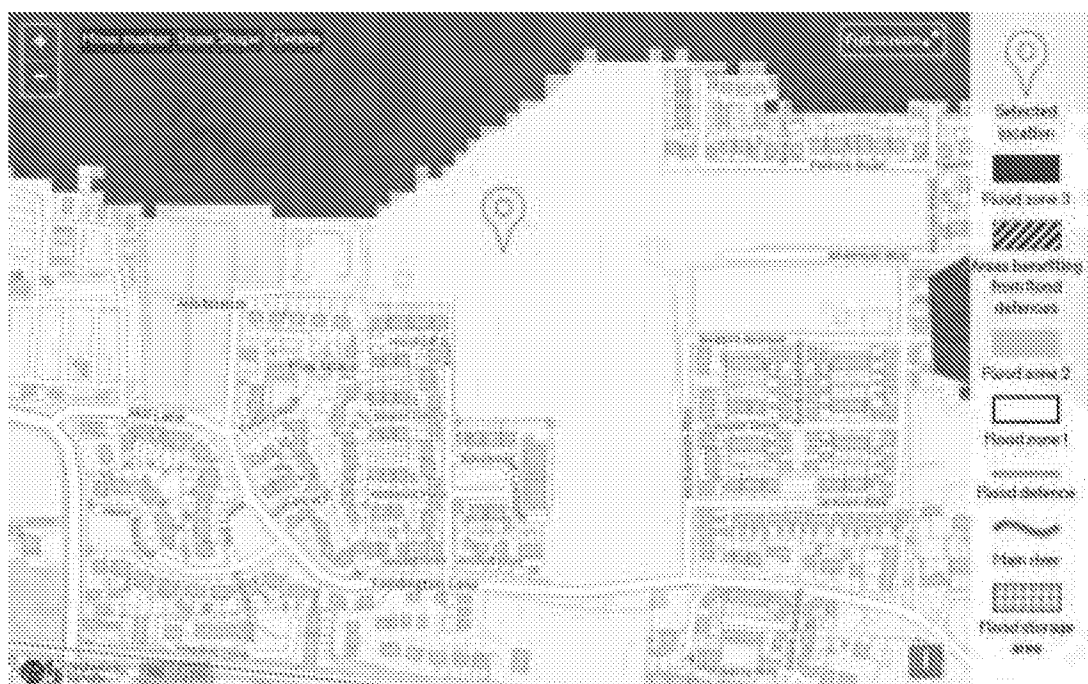


Figure 7. Flood Maps for Planning (Gov.uk)

2.2.2 The definitions of flood zones have been confirmed in Figure 8, as stated by Flood Risk and Coastal Change, Table 1.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Figure 8. Flood Risk and Coastal Change, Table 1 (Gov.uk)

- 2.2.3 Although Sites A and B are located almost entirely within Flood Zone 1, the Environment Agency has been consulted given the proximity to Flood Zones 2 and 3.
- 2.2.4 Following submission of a Product 4 enquiry, the Environment Agency has provided modelled flood level data in relation to the site.
- 2.2.5 The levels data provided confirms a 'peak' tidal undefended modelled flood level of 3.13m (0.5% 2110). Existing levels identified in the vicinity of the proposed develop to the north of Site B currently corresponds with an existing ground level of c. 3.75m AOD. Earthworks are proposed to raise the level(s) on site in order to achieve gravity-based connections to the newly constructed sewer network, therefore the site is not considered to be at risk of flooding from tidal sources.
- 2.2.6 Full correspondence in relation to the Environment Agency's Product 4 response can be found within **Appendix G**.
- 2.2.7 The Environment Agency's Long-Term Flood Risk Map for Rivers or the Sea indicates that the sites are almost entirely identified as being at 'Very Low' risk of flooding from such sources. Land within the bounds of Site B following the northern boundary is indicated as being at 'Low' risk of flooding from such sources but is also within close proximity of land indicated as being at 'High' risk.
- 2.2.8 Land deemed to be at 'Low' risk of flooding from rivers or the sea is defined as having an annual chance of flooding within the range of 0.1% and 1%, taking into account any flood defences. 'High' risk areas are deemed to have in excess of a 3.3% change of flooding annually.

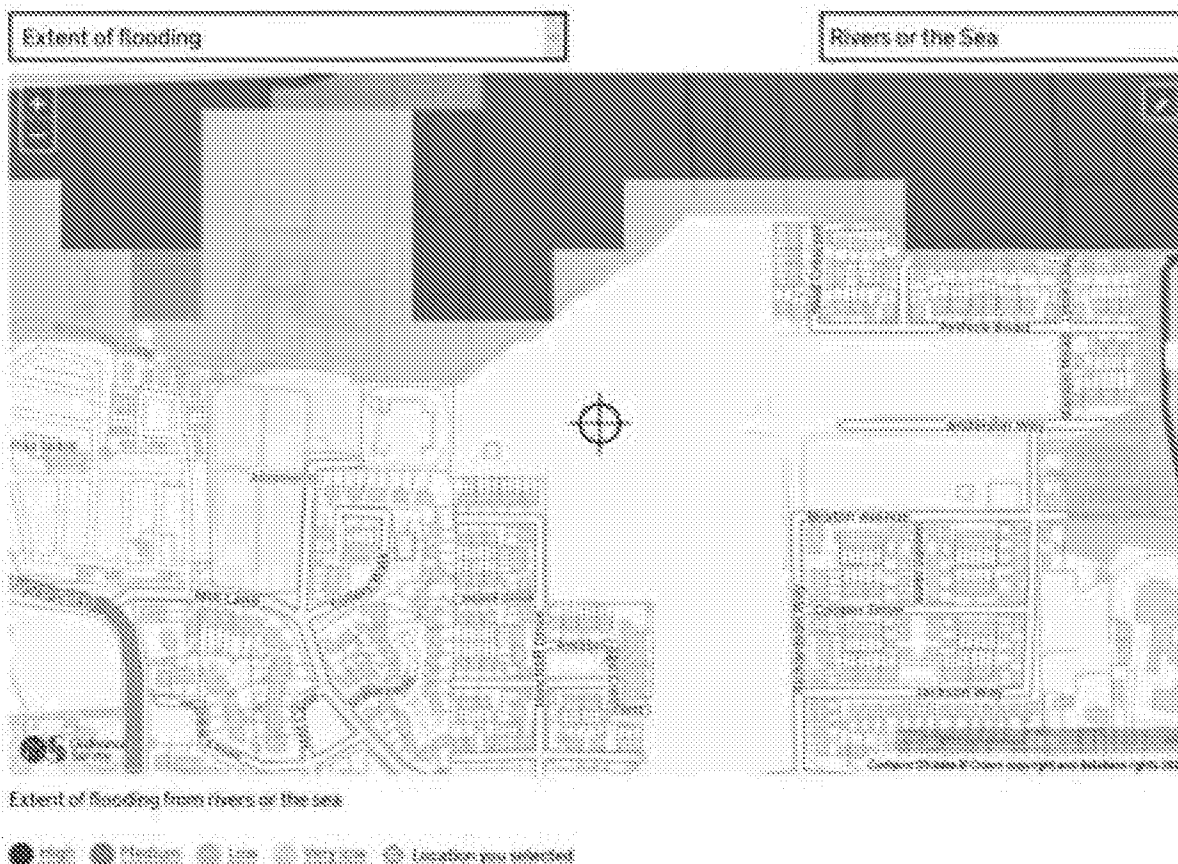


Figure 9. Long-Term Flood Risk Map – Rivers or the Sea (Gov.uk)

- 2.2.9 The Long-Term Flood Risk Map for Surface Water indicates that the sites are deemed to be almost exclusively at 'Very Low' risk of surface water flooding. There is a very small area which is deemed to be at increased risk of flooding, although the risk is indicated as being 'Low'.
- 2.2.10 Land indicated as being at 'Very Low' risk of surface water flooding is defined as having an annual chance of flooding of less than 0.1%. 'Low' risk designations are defined as having an annual chance of flooding in the range of 0.1% and 1%.

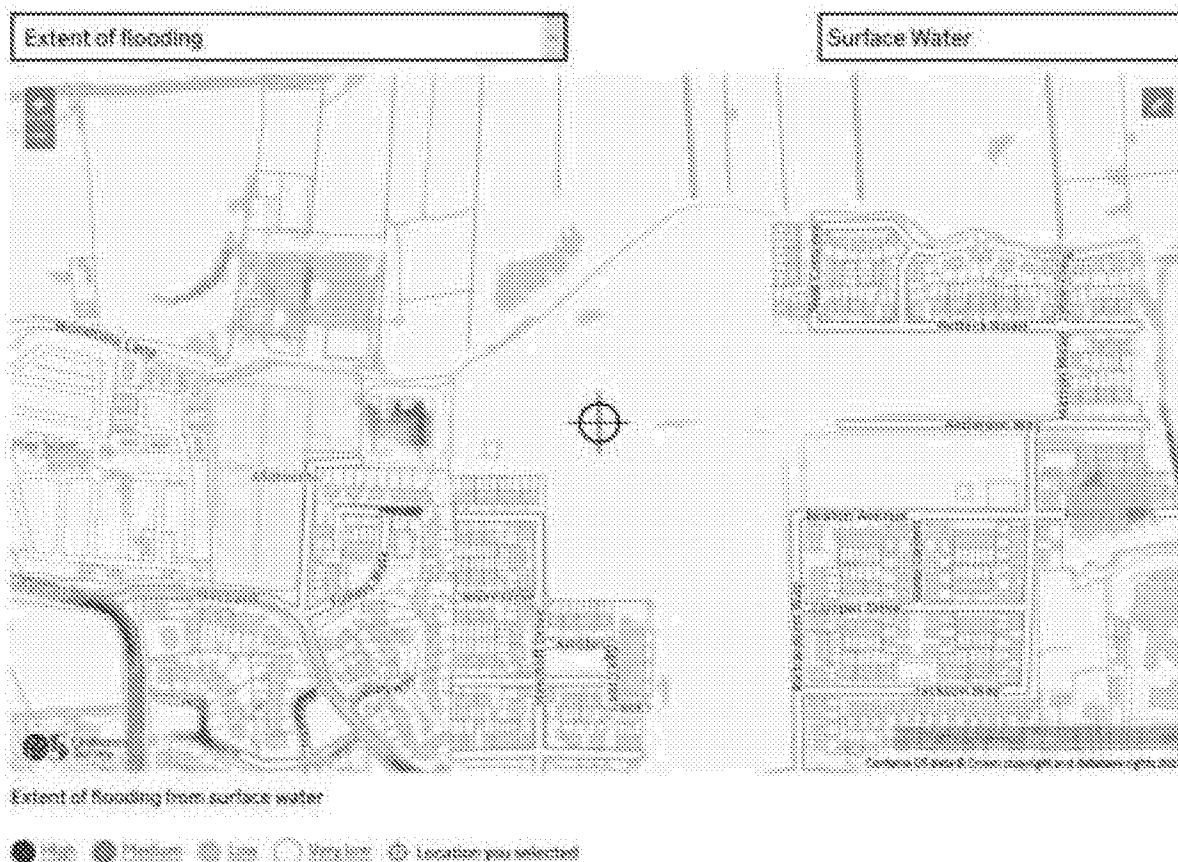


Figure 10. Long-Term Flood Risk Map – Surface Water (Gov.uk)

2.2.11 The Long-Term Flood Risk Map for Reservoirs indicates that the site is not at risk of flooding from such sources.

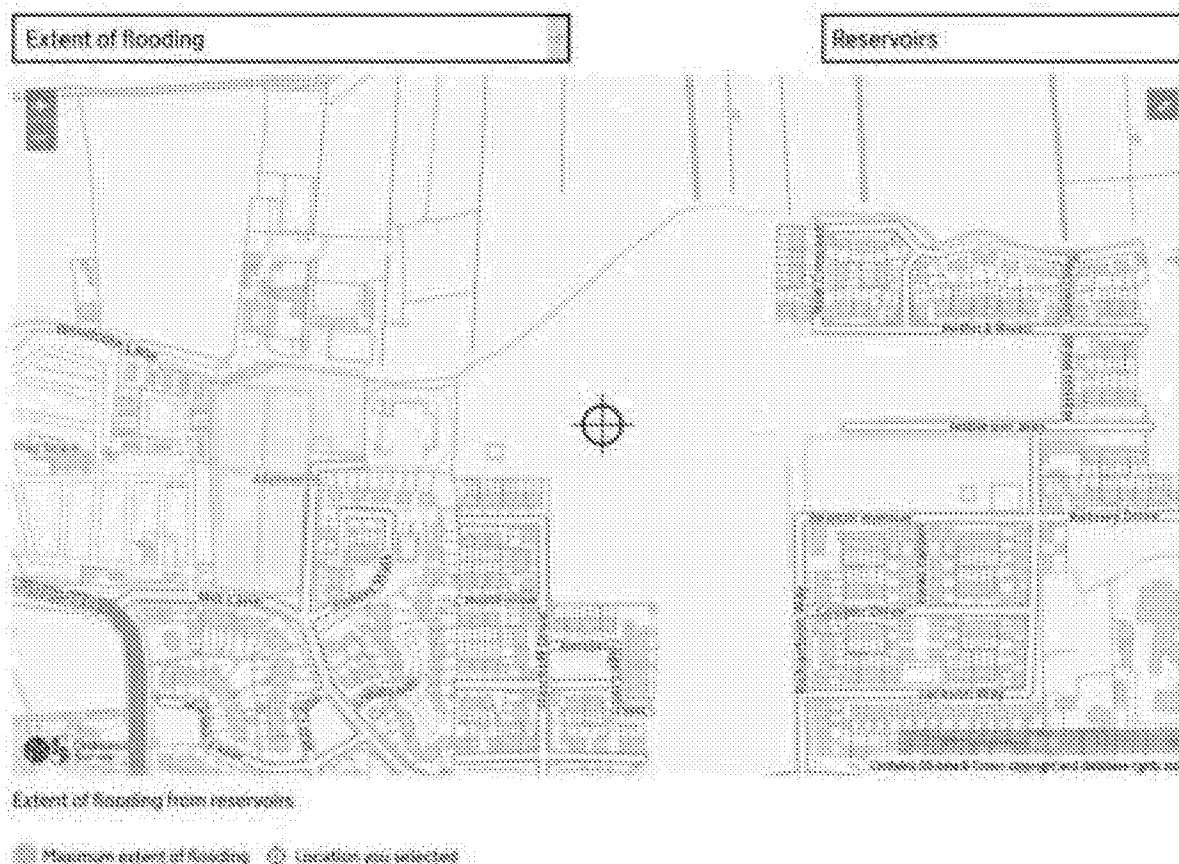


Figure 11. Long-Term Flood Risk Map – Reservoirs (Gov.uk)

2.3 Strategic Flood Risk Assessment

- 2.3.1 Arun District Council has a published Level 1 and 2 Strategic Flood Risk Assessment, dated November 2016.
- 2.3.2 Mapping has been referred to in the Strategic Flood Risk Assessment which identifies future extents of flood zones in view of climate change. The Strategic Flood Risk Assessment Appendix D Climate Change Mapping indicates that the sites will not fall within any future extents of Flood Zone 3a, and with specific reference to Sites A & B, there are no predicted changes in the flood zone classifications or extents compared with the current day extents.

2.4 Historic Flooding

- 2.4.1 Arun District Council and West Sussex County Council have both stated that they hold no records of historic flooding in relation to the sites.
- 2.4.2 The Environment Agency has confirmed that they hold no records relating to historic flooding at the site.

2.5 Summary of Flood Risk

- 2.5.1 The potential sources of flooding are:

Source of Flooding	Level of Risk
Rivers and Coastal	Low The sites are located almost entirely within Flood Zone 1, with the exception of a minor encroachment along the northern boundary of Site B (Flood Zones 2 and 3). Black Ditch (Main River) is located approximately 160m north of Site B. The Environment Agency has confirmed in correspondence that the 'peak' tidal undefended flood level in relation to the northern boundary of Site B is 3.13m AOD (0.5% 2110). Known site levels in relation to the proposed development towards the northern boundary of Site B are indicated as being in the range of 3.75m AOD, whilst earthworks are proposed to raise levels on site in order to achieve gravity-based connections to the constructed laterals implemented to support the two parcels of land.
Surface Water	Very Low The Long-Term Flood Risk Map for Surface Water indicates that the sites are almost exclusively at 'Very Low' risk of surface water flooding. New surface water drainage infrastructure has been installed in support of surrounding development whilst any development proposals specific to the sites will be fully supported by dedicated surface water drainage infrastructure, details of which are confirmed later in this report.
Groundwater	High *TBC West Sussex County Council has confirmed in correspondence that the sites are deemed to be at 'moderate' to 'high' risk of groundwater flooding.
Sewers	Very Low New drainage infrastructure has been installed in support of surrounding development, in view of current design standards and approval procedures, it is deemed that the risk of flooding from such source will be 'Very Low'.
Artificial Sources	None

	There are no artificial sources within the vicinity of the site, and therefore there is no risk of flooding from such sources.
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- 2.5.2 As demonstrated by the above table, the greatest risk of flooding to the sites is deemed to be from groundwater. Additional monitoring will be required in relation to a Reserved Matters/Full planning application in due course.
- 2.5.3 At present, the sites form part of what is currently a much wider major construction site, with the new Lyminster bypass running adjacent to the two parcels of land (Sites A & B). As a result, flood zone boundaries and surface water flow routes both within the bounds of the sites and also adjacent to them are likely to have changed as a result of the development both currently under construction as well as already completed. This point has also been recognised by West Sussex County Council.
- 2.5.4 In view of the above, the accuracy of current Environment Agency flood maps is uncertain, and the reliability of such information is unclear.

3 PROPOSED DEVELOPMENT

3.1 Description of Development

- 3.1.1 The proposed development will involve the construction of up to 71 No. residential units across the two parcels of land, consisting of 28 No. dwellings on Site A, with 43 No. dwellings on Site B. The architectural development proposals for this development can be found within **Appendix A**.
- 3.1.2 The type of development falls within the 'More Vulnerable' classification (Flood Risk and Coastal Change Table 2). Residential development is confirmed as being compatible with Flood Zone 1, as per Flood Risk and Coastal Change, Table 3 (below).

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	Exception Test Required	✓	✓	✓
Flood Zone 3a†	Exception Test Required †	✗	Exception Test Required	✓	✓
Flood Zone 3b*	Exceptions Test Required *	✗	✗	✗	✓†

✓ = Development is appropriate
 ✗ = Development should not be permitted

- 3.1.3 The development has been set out to avoid the negligible extents of Flood Zone 2 and 3 which marginally encroach within the bounds of Site B, along the northern boundary. As confirmed in 2.5.3 and 2.5.4, the accuracy and reliability of the flood maps can be questioned given the change(s) in the wider land profile in view of the surrounding development which is either under construction or recently completed.
- 3.1.4 The proposed development at Sites A & B will result in an impermeable area totalling 9,358m² (0.94Ha). This total is attributed to Site A which accounts for 5,448m² (0.54Ha), with Site B responsible for the remaining 3,910m² (0.39Ha).
- 3.1.5 In refinement of the proposed impermeable area, the areas which will be positively drained have also been assessed. Site A totals 4,722m² whilst Site B totals 3,485m².
- 3.1.6 The Mayer Brown Drainage Strategy prepared as submitted under Planning Reference; LU/17/19/DOC confirms that allowance has been made for Sites A & B in the wider drainage strategy. Construction issue/As Built drawings for the wider infrastructure are contained within **Appendix D**.
- 3.1.7 It has been confirmed by the client's agent that Sites A & B are the subject(s) of a Deed of Covenant and Release which was made between the client and Persimmon Homes, dated May 2019.
- 3.1.8 Persimmon Homes are obligated under the deed to undertake specified works to the client's land by 31st December 2021 to 'serve a development of the property for both its permitted use or for residential development of a similar character and density to the retained development'. The works required relate to, but are not limited to, the provision of drainage infrastructure to provide a means of draining the site and the proposed development.

- 3.1.9 With specific reference to Sites A & B, the use of Sustainable Drainage System (SuDS) methods and techniques (where site conditions and constraints allow) within the bounds of the site (whilst adhering to the SuDS hierarchy as stated within Building Regulations (Part H) and The CIRIA SuDS Manual C753) will be introduced to provide a robust drainage strategy which is able to support the develop for its intended design life, following the principles agreed in relation to the drainage strategy approved under Planning Reference; LU/17/19/DOC for the discharge of Condition 10 (Planning Reference; LU/47/11).
- 3.1.10 The specific foul and surface water drainage proposals are detailed in **Section 4** of this report.

4 PROPOSED DRAINAGE STRATEGY

4.1 Surface Water

4.1.1 The SUDS manual and Building Regulations set out a hierarchy of drainage methods to ensure that developments maximise the use of sustainable drainage techniques. The hierarchy favours infiltration methods of disposal over other methods such as watercourse and sewers, as detailed below;

- i. Utilise infiltration techniques
- ii. Attenuate rainwater in ponds or open water features for gradual release
- iii. Attenuate rainwater by storing in tanks or sealed water features for gradual release
- iv. Discharge rainwater direct to a watercourse
- v. Discharge rainwater to a surface water sewer/drain
- vi. Discharge rainwater to a combined sewer

SUDS Technique	Suitable	Comments
Living Roof	Yes	No initial constraints, although implementation will be subject to developer's proposals
Basins and Ponds		
- Constructed Wetlands	Yes	No initial constraints identified, although design and associated land take, to allow for the pond footprint including maintenance buffers and/or easements will need to be considered.
- Balancing Ponds	Yes	
- Detention Basins	Yes	
- Retention Ponds	Yes	
Filter strips and swales	Yes	Subject to groundwater investigation and monitoring. If groundwater is present at shallow depths, such measures may not be appropriate
Infiltration Devices	Yes ^{*TBC}	West Sussex County Council has advised that the risk of groundwater flooding is likely to be 'moderate' to 'high', which may impact upon the ability to infiltrate if correct and groundwater is
- Soakaways		
- Infiltration trenches and basins		

		found to be present at shallow depths. The Mayer Brown drainage strategy prepared under Planning Reference; LU/17/19/DOC states that infiltration is likely to be impractical given ground conditions encountered as part of wider investigative works. Given the wider drainage strategy which has been approved – broadly attenuated discharge to Black Ditch, it is unlikely that infiltration will be wholly viable, although opportunities to maximise the use of such methods and techniques where conditions allow should be considered.
Permeable surfaces and filter drains - Gravelled areas - Solid paving blocks - Porous pavers	Yes Yes Yes	Such measures will be considered in view of site specific constraints and opportunities allow.
Tanked systems - Oversized pipes - Cellular tanks	Yes Yes	Attenuation with controlled discharge is the accepted wider strategy, therefore tanked systems including the use of oversized pipes and cellular tanks shall be considered, in accordance with the relevant drainage hierarchies if higher ranking alternatives cannot be accommodated.

- 4.1.2 Following discussions with Arun District Council, the wider drainage strategy prepared by Mayer Brown in relation to Planning Reference; LU/17/19/DOC for the discharge of Condition 10 (drainage) concerning Planning Reference; LU/47/11 has been referred to in order to ensure that allowance has been made for the proposed development of Sites A & B.
- 4.1.3 As has been stated already in this report, the Mayer Brown drainage strategy confirms that allowances have been made for Sites A & B as part of the wider development, in conjunction with the associated planning approval.
- 4.1.4 An allowance for an impermeable area totalling 70% of the overall site areas has been provided.
- 4.1.5 Further to 4.1.4, the drainage catchments have been considered as follows;

	Site Area	70% Impermeable Area (Considered Catchment)
Site A	0.91Ha*	0.637Ha*
Site B	0.81Ha*	0.567Ha*

*The figures stated in the above table relate to the original assessment undertaken as part of the wider drainage strategy. Actual figures relating to the proposed development as detailed within this document are confirmed below.

- 4.1.6 Given that a wider strategy has already been developed and approved as per the drainage strategy submitted by Mayer Brown for the discharge of Condition 10 of the original outline application (under Planning Reference; LU/17/19/DOC), it is proposed that attenuation with a controlled discharge will be provided to support the develop of Sites A & B.
- 4.1.7 The Mayer Brown drainage strategy confirms that an accepted discharge from Site A of 5l/s, in addition to a rate of discharge of 5l/s for Site B has been allowed for in the wider design and strategy. Flows from Sites A & B therefore shall not exceed these rates of discharge which have been allowed for, in view of the catered catchment areas as per a 70% impermeable area of the over site areas.
- 4.1.8 The impermeable area associated with the development of Site A totals 5,448m² (0.54Ha). The positively drained area amounts to 4,722m² (0.47Ha).
- 4.1.9 For Site A, it is proposed that permeable paving will be introduced, covering a total area of 1,581m². With a 450mm sub-base and 32% voids, this would provide a volume of storage totalling 228m³.
- 4.1.10 The permeable paving would be supplemented in terms of attenuation by a cellular tank measuring 30.00m x 11.00m x 1.20m. With 95% void potential, this would provide an additional volume of storage totalling 376m³.
- 4.1.11 Flows will discharge to the newly constructed surface water sewer network at a pre-agreed rate of 5l/s.
- 4.1.12 The proposed surface water drainage strategy for Site A is shown on drawing **D1970-PL300 'Conceptual Drainage Strategy – Site A'**.
- 4.1.13 The impermeable area associated with the development of Site B totals 3,910m² (0.39Ha). The positively drained area amounts to 3,485m² (0.35Ha).
- 4.1.14 For Site B, it is proposed that permeable paving will again be introduced to support the development. The extents of permeable paving in relation to Site B total 782m², providing 113m³ of storage (450mm sub-base, 32% voids).
- 4.1.15 Further attenuation will be provided in the form of a basin, located towards the western boundary, adjacent to the proposed access road. At it's base, a footprint totalling 100m² is proposed, with 1:3 side slopes and a depth of 1.50m.
- 4.1.16 Flows will again discharge to the newly constructed surface water sewer network at a pre-agreed rate of 5l/s.
- 4.1.17 Owing to the constraint of the existing lateral which has been constructed to support this development parcel, levels on Site B will need to be raised in order to establish a gravity-based connection where both foul and surface water drainage is concerned. The extent at which levels will need to be raised, as well as the relationship with surrounding land, will need to be considered at Reserved Matters/Detailed Design, once wider proposals (in relation to the continuation of the northern bypass) have been confirmed.
- 4.1.18 The proposed surface water drainage strategy for Site B is shown on drawing **D1970-PL301 'Conceptual Drainage Strategy – Site B'**.

- 4.1.19 Condition 10 of the approval under LU/47/11 stated that 'SuDS shall be designed to attenuate the 1 in 100 year storm event (plus climate change allowance of 30% in accordance with DEFRA's national Standards for Sustainable Drainage Systems'. It has been discussed with Arun District Council that an allowance of 30% in view of the impacts and effects of climate change is no longer the acceptable standard, with an allowance of 20% required and an assessment of the impacts for an allowance of 40% now the requirement. As a result, it has been agreed that the impacts of 40% will be considered, and allowance provided to accommodate such within the drainage strategy proposals developed herein for Sites A & B.
- 4.1.20 In accordance with West Sussex County Council's Policy for the Management of Surface Water, as a result of the proposed residential development at Sites A & B, an allowance is required for the potential occurrence of 'urban creep' across the design life of the development.
- 4.1.21 Further to 4.1.13, an allowance of 10% has been considered in the hydraulic calculations which support the strategy outlined in the section above.
- 4.1.22 The strategy above will ensure that run-off is managed fully within the confines of the sites and will not present an increase in the risk of flooding either to the specific sites, or off-site. Therefore, there will be no increase in the risk of flooding as a result of the proposed development.

4.2 Treatment

- 4.2.1 The use of permeable paving will ensure that run-off from the site receives a level of treatment required by the SuDS manual, with hydrocarbons being filtered by the aggregate and geotextile layers.
- 4.2.2 In accordance with the CIRIA SuDS Manual C753 regarding methods for managing pollution risks, the risk posed by surface water runoff to the receiving environment depends on the pollution hazard at the site (the source), SuDS treatment techniques (the pathway), and the sensitivity of the environment (the receptor).
- 4.2.3 The simple index approach considers whether SuDS techniques are appropriate for the site. The states that for SuDS components to deliver adequate treatment, the total pollution mitigation index for each contaminant type should equal or exceed the pollution hazard index.
- 4.2.4 The SuDS Manual outlines three categories of pollution hazard identification, which vary depending on proposed land use, which are as follows:
- Total Suspended Solids (TSS).
 - Metals (M).
 - Hydrocarbons (H).
- 4.2.5 In accordance with C753 Table 26.2, the proposed land uses at the site are categorised as follows:
- Residential Roofs – Very Low/TSS=0.2/M=0.2/H=0.05
 - Individual property driveways and low traffic roads - Low/TSS=0.5/M=0.4/H=0.4

- All roads except low traffic roads and trunk roads/motorways - Medium/TSS=0.7/M=0.6/H=0.7

4.2.6 In accordance with C753 Table 26.2, the proposed land uses at the site are categorised as follows:

- Permeable Pavement – TSS=0.7/M=0.6/H=0.7
- Pond/Basin – TSS=0.7/M=0.7/H=0.5

4.2.7 As the pollution hazard index does not exceed any pollution mitigation index for any contaminant type, the proposed SuDS methods will provide sufficient treatment for the proposed development.

4.3 Foul Water Drainage

4.3.1 The aforementioned Mayer Brown drainage strategy again confirms that allowance has been made as part of wider development works to provide a means of draining Sites A & B where foul water drainage is concerned.

4.3.2 Two points of connection have been constructed within the bounds of Sites A & B to provide a means of connectivity to the wider drainage network, which discharges to an adoptable pumping station to the east of the sites.

4.3.3 Recent changes to infrastructure and connection charges (OFWAT Charging Rules) place the onus on the sewerage undertaker to reinforce their network should there no longer be sufficient capacity to serve the new development. Funding for this is provided by revised charging arrangements for infrastructure and connection charges for each dwelling constructed comprising a Network Reinforcement Charge and Site-Specific Charges. The revised charging arrangement (funded by the developer) covers alterations to the Existing Sewer Network and the sewerage undertaker remains responsible for the cost of reinforcing their Strategic Assets. The developer is responsible for connecting the development to the public sewer network.

4.3.4 Based on the design guidance provided in Design and Construction Guidance, the proposed foul flow to the existing foul sewer network will total 3.29l/s for up to 71 No. units (based upon Design and Construction Guidance, Water UK, 2020).

4.4 Climate Change

4.4.1 NPPF sets out percentage increases to be applied to the peak rainfall intensity values used in the design of a surface water drainage system to allow for the effects of climate change.

4.4.2 In accordance with NPPF 'climate change allowances' updated in July 2021, an increase of 20% should be applied for this development and a review should be undertaken to determine the impact of an increase of 40%.

4.4.3 A 40% level of climate change has been accounted for within the overall surface water drainage strategy for the site.

4.5 Flood Compensation

- 4.5.1 Any loss of flood storage must be compensated for by the reduction in level of surrounding land, such that the same volume of flood storage is provided following development within the flood plain.
- 4.5.2 The proposed development of Sites A & B falls entirely within Flood Zone 1 and as a result, flood compensation is not required.

4.6 Urban Creep

- 4.6.1 The proposed drainage strategy has been designed with an assumption of a 10% increase in impermeable area in the lifetime of the development due to urban creep, and the calculations show sufficient capacity during the design rainfall event with the urban creep allowance included.

5 RESIDUAL RISK AND MITIGATION

5.1 Residual Risk

5.1.1 The following residual risks have been identified in relation to the proposed development at Sites A & B:

- Increased flow through Black Ditch and/or minor tributaries as a result of climate change causing flooding to the sites
- Blockage of Black Ditch and/or minor tributaries, as well as downstream drainage infrastructure as a result of debris or otherwise, causing flooding to the sites,
- Extreme rainfall events that exceed the design criteria used for the drainage system causing surface water flooding
- Blockage/failure of the proposed drainage system causing flooding to the site
- Groundwater flooding to the site caused by groundwater levels exceeding the ground surface level
- Surface water flooding of proposed buildings

5.2 Mitigation

5.2.1 Consideration has been taken to the residual risks stated in Section 5.1, and the following mitigation measures are proposed:

- The Environment Agency has confirmed that the 'peak' tidal undefended (0.5% 2110) modelled flood level is 3.13m AOD. In relation to the proposed development of Site B, existing ground levels to the northern extent of the development proposed at Site B are in the region of 3.75m AOD. As confirmed in 4.1.17, levels are likely to raise significantly in order to establish gravity-based connections to the existing foul and surface water laterals constructed to support Site B. It is therefore evident that the site will be significantly higher than the identified modelled flood level.
- Black Ditch is a designated 'Main River' and as such is the responsibility of the Environment Agency to maintain and ensure the free conveyance of flows. Surface water from the development will discharge to the drainage network constructed to support the wider development which will discharge to Black Ditch, to the east of the sites. The sites (A & B) themselves will be subject to specific maintenance regimes in order to ensure that on-site drainage infrastructure is able to operate as designed and intended. The downstream sections of the network will be subject to their own drainage maintenance regimes, the responsibility for which will lie with the relevant asset owner(s).

- The drainage strategy has been developed to capture run-off up to and including a 1-in-100-year critical rainfall event, with a 40% allowance for climate change as well as a 10% allowance for urban creep. Should a more extreme rainfall event occur, however, there is the potential for the drainage system to be exceeded. The existing topography of the site has been reviewed and the existing overland flow routes assessed. Flows currently follow the existing topography – falling broadly to the north. In light of the wider development within the vicinity of the sites, it is noted that off-site drainage infrastructure has been installed to support the adjacent highway, for example. In exceedance events, it is likely that exceedance flows would be captured by the highway drainage infrastructure, although additional drainage infrastructure should be considered which can intercept run-off in exceedance events.
- The proposed drainage system will attenuate and store run-off up to the design event. Blockage of the drainage system has the potential to cause flooding on the site. Surcharged flows will likely travel overland to the existing surrounding drainage infrastructure, however maintenance measures proposed in Chapter 8 will mitigate the risk of the system becoming blocked.
- Due to the underlying ground conditions at the sites and the possible presence of groundwater in the upper layers, there is a risk of groundwater exceeding the surface level and emerging on the site. There are no records of previous groundwater flooding, however. If groundwater flooding were to occur, it would flow away from the proposed buildings and be intercepted by the drainage infrastructure proposed to support the development of Sites A & B.
- The surface water drainage strategy has been designed to accommodate a 1-in-100-year storm event, inclusive of allowances for both climate change (40%) and urban creep (10%). The site is not identified as being in a location susceptible to surface water flooding, although the current land use no longer resembles that which the flood maps depict. Given all newly constructed surface water drainage infrastructure for the surrounding development has been designed to 'current day' standards, it is unlikely that surface water flooding will occur except for in exceedance events. Levels shall be designed to ensure run-off falls away from building access points, whilst drainage infrastructure which has the ability to intercept run-off in exceedance shall also be considered at detailed design stage.

6 SEQUENTIAL AND EXCEPTION TESTS

6.1 Sequential Test

6.1.1 In relation to the Sequential Test, Flood Risk and Coastal Change, Paragraph 019 states that;

'The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required. The proposed development is located fully within Flood Zone 1, and therefore application of the Sequential Test is not required.'

6.1.2 The proposed development associated with Sites A & B falls entirely within Flood Zone 1, therefore application of the Sequential Test is not required.

6.2 Exception Test

6.2.1 The proposed development is located fully within Flood Zone 1. Table 3 within Paragraph 067 of Flood Risk and Coastal Change confirms that "More Vulnerable" development is compatible within Flood Zone 1, and therefore application of the Exception Test is not required.

FLOOD RISK MANAGEMENT

6.3 Safe Access and Egress

- 6.3.1 Access to Site A and Site B will be via the newly constructed bellmouths to each parcel of land.
- 6.3.2 Both bellmouths are located fully within Flood Zone 1 whilst current flood maps do not indicate any risk of surface water flooding. It is noted that the current flood maps do not, however, acknowledge the surrounding development which is under construction, or recently completed. With the provision of newly designed and constructed surface water drainage infrastructure, it is not anticipated that access to either site will be impacted as a result of surface water flooding, except in an extreme exceedance event.

6.4 Flood Warning

- 6.4.1 The proposed development is located fully within Flood Zone 1, therefore there is no requirements for a Flood Evacuation Plan (FEP). Additionally, the site is deemed to be at 'Very Low' or 'Low' risk of flooding from all sources.

7 MAINTENANCE

7.1 Proposed Maintenance Regime

7.1.1 Maintenance is required to ensure the long-term operational performance of the proposed surface water drainage system.

7.1.2 The drainage system has been designed to minimise maintenance requirements; however, a number of key tasks will need to be undertaken so that the system remains in optimal condition. These operations are summarised in the table below, along with the required frequency of works.

Drainage System feature	Proposed maintenance / remedial works	Required frequency of works
Permeable Paving	Surface sweeping to reduce silt and debris accumulation.	Every 8 to 12 weeks
	Removal / management of weed growth	At least once a year
	Silt removal from permeable surfaces, possibly involving raking out of joints, redressing, removal and remedial works.	As required / to be specified by manufacturer
Pond/Basin	Inspection, vegetation clearance and additional clearing/cleansing of potential blockages. Particular attention to incoming/outcoming connections.	At least once a year
	Inspection and clearance of blockages	After major storm events
Diffuser units & catch pits, gully sumps and drains	Inspection and additional cleansing as required.	Annual
	Desilting	Year 1, Year 3, then every 5 years
Inlets and Outfalls	Clearance of safety grilles and pipework	After every storm event/regularly/to be specified by manufacturer
Pipework	Jetting to clear blockages	As required
Induced Vortex Flow Control Device	As specified by manufacturer	As specified by manufacturer

7.1.3 The responsibility of maintenance regime will be determined by the Developer, by agreed appointment.

7.1.4 A detailed maintenance document shall be established prior to appointment in order to detail the roles and responsibilities where maintenance is concerned.

Permeable Paving / Diffuser Units

7.1.5 The areas of permeable paving are designed to allow infiltration of surface water run-off through the joints in the block paving surface course and into the sub-base below. The water is then collected and discharged into the positive drainage system.

7.1.6 As part of the permeable paving system, diffuser units are used to discharge surface water run-off from roof areas into the sub-base, as well as forming links between areas of permeable paving. These diffuser units are small heavy-duty cellular units which allow more efficient discharge of surface water into the

sub-base base of the permeable paved areas.

7.1.7 The areas of permeable paving will require additional maintenance measures to ensure they operate as designed. Failure in carrying out this maintenance, could increase the risk of flooding. The additional measures are as follow:

- Periodic surface sweeping to reduce silt and debris accumulation. The permeable surfaces should be swept at least every 8 to 12 weeks with additional sweeps in the autumn to clear fallen leaves
- Removal / management of weed growth, as required. Typically, once or twice a year for regularly used areas
- Periodic silt removal from permeable surfaces as described by the manufacturer. If any areas are showing signs of ponding, they shall be dealt with by raking out the joints and redressing. The entire surface shall be monitored and when there are signs of excessive siltation resulting in poor drainage over the whole area, the blocks shall be taken up and a replacement of bedding layer and geotextile shall be undertaken
- Redressing of joints on the block paving as required
- Catchpits upstream of diffuser units, should be emptied and inspected on the same regime as all catchpits specified previously set out in this document

Induced Vortex Flow Control Device

7.1.8 An induced vortex flow control device is self-activating, relying on upstream hydraulic head to generate an air-filled vortex within the centre of the casing. Once the vortex is initiated water drains down through a small opening in the back of the device at the designed restricted flow rate.

7.1.9 The flow control device has two measures in case of emergency (i.e. blockage). The first is a door situated in the front of the unit itself, this can be operated from the surface by a release cable situated just under the manhole cover which closes under its own weight and does not require any mechanism to operate. The second is a high-level overflow pipe situated with the flow control manhole. Both measures allow the system to drain down freely, until the blockage can be cleared.

7.1.10 The induced vortex flow control device will require additional maintenance measures to ensure it operates as designed. The additional measures are as follows:

- The sump within the flow control chamber should be monitored for build-up of silts and should be emptied, as a minimum, on the same regime as specified for catchpits previously within this document
- The drain down door located on the centre of the unit will require inspection and opening annually, to ensure it is operating as intended

Remedial/Repair Actions

7.1.11 Significant storm events may cause considerable damage to SuDS and their associated components.

As such, it may be necessary to inspect and carry out essential recovery works to return the feature to full working order.

- 7.1.12 Resetting of uneven blocks by lifting block area, removing bedding material and relaying to match original design are all actions which may need to be undertaken.

Accidental Spillages

- 7.1.13 It is not envisaged that any materials are to be stored onsite once the development has been completed, which could cause major spills and potential pollution issues within the drainage system. If this situation alters in the future consultation with a specialist will be required in order to confirm if any upgrades to the existing system are necessary.
- 7.1.14 Minor spillages of fuels and oils will be dealt with by the permeable paving and deep trapped gullies, by bio-degrading and collecting the hydrocarbons respectively.

Future Alterations to the Development

- 7.1.15 Any future alterations to the permeable paving should be confirmed by a specialist. Where possible any future services are to avoid being located through areas of permeable paving. If new services are required to run through areas of permeable paving, services should be installed below the depth of permeable paving with the permeable system reinstalled above.

8 OFFSITE IMPACTS

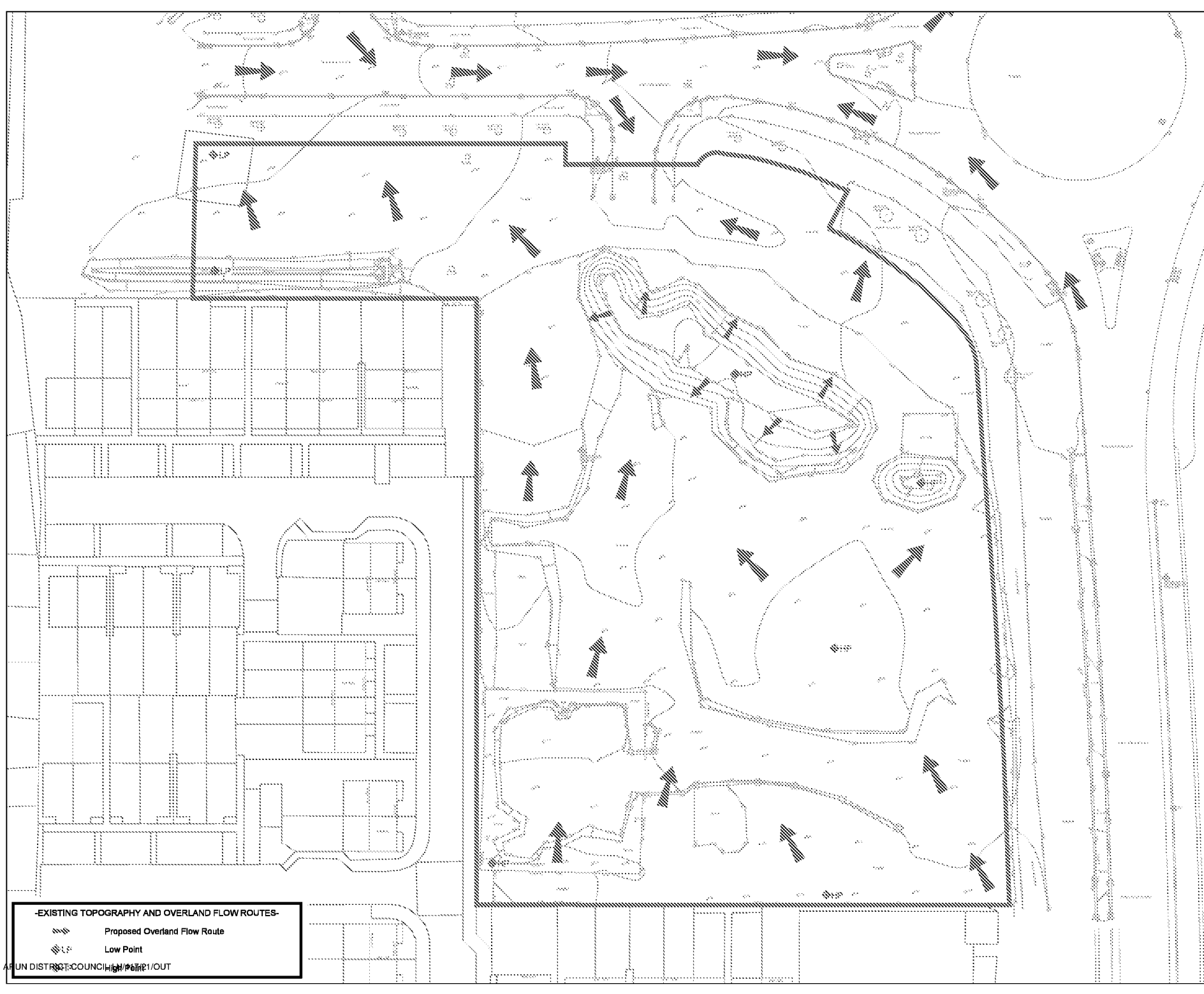
- 8.1.1 Run-off generated by the proposed development of Sites A & B will be captured and attenuated within the bounds of the sites, up to and including a 1-in-100-year storm event, inclusive of allowances for both climate change as well as urban creep. The captured run-off will then gradually discharge to the wider drainage network at a restricted rate, before reaching the ultimate outfall.
- 8.1.2 Discharge from the sites will not exceed the rates which have been allowed for as per the wider drainage strategy, meaning there will be no increased risk of flooding as a result of the development being completed.
- 8.1.3 Foul flows generated by the development of Sites A & B will contribute flows to the order of 3.29l/s. It is noted that the wider drainage network drains to an adoptable pumping station to the east of the site.
- 8.1.4 The effects of climate change have been considered in the design of the proposed surface water drainage system, to ensure there is no off-site impact, whilst consideration towards the impacts and effects of potential urban creep has also been afforded to the design to ensure there is no detrimental impact upon the network which could result in an increased risk of flooding.

9 SUMMARY

- 9.1.1 This site-specific flood risk assessment is based on Environment Agency Flood Maps for Planning, Long-Term Flood Risk Information; Flood Risk Maps, West Sussex County Council Strategic Flood Risk Assessment, Arun District Council, West Sussex County Council and Southern Water Drainage Records, Mayer Brown Drainage Strategy (A/PHDRAIN.10, dated January 2019) and Third Party As Built/Construction Issue Drawings
- 9.1.2 The proposed development will involve the construction of up to 71 No. residential units across the two parcels of land, consisting of 28 No. dwellings on Site A, with 43 No. dwellings on Site B.
- 9.1.3 The proposed development will be constructed fully within Flood Zone 1.
- 9.1.4 Post-development surface water run-off will discharge to the newly constructed surface water sewers associated with the wider development as per the consented scheme under Planning Reference; LU/47/11. The wider drainage strategy which has been consented under LU/17/19/DOC, which the sites forms a part of, approved the use of attenuated discharge to Black Ditch. The drainage strategy for up to 71 No. residential units proposed on Sites A & B will follow the principles agreed under this consent.
- 9.1.5 Permeable paving will be introduced across Site A (1,581m²) and Site B (782m²). This will provide a combined volume of storage totalling 340m³ (450mm sub-base and 32% voids).
- 9.1.6 Site A will be further supported by a cellular tank (30.00m x 11.00m x 1.20m) whilst flows to the wider sewer network will be restricted to a rate of 5l/s.
- 9.1.7 An attenuation basin is proposed for Site B to provide additional storage. The pond (100m² at base, 1:3 side slopes and 1.50m depth) will provide attenuation with flows discharging to the sewer network also at 5l/s.
- 9.1.8 Allowance has been made for climate change (40%) as well as urban creep (10%) in the development of on-site surface water drainage proposals, whilst the drainage strategy will also accommodate a up to and including a 1-in-100-year storm event.
- 9.1.9 The wastewater from the proposed development will discharge to the existing foul water sewers constructed as part of the wider development. Allowance has been made for the development associated with Sites A & B. Connections will be subject to S106 approval, which will be required from ICOSA.
- 9.1.10 The completion of the development will not increase flood risk on or off the site.
- 9.1.11 In conclusion, this development is suitable with regards to flood risk and surface water drainage.

DRAWINGS

D1970-PL101	Existing Topography and Overland Flow Routes – Site A
D1970-PL102	Existing Topography and Overland Flow Routes – Site B
D1970-PL200	Impermeable Areas Comparison
D1970-PL300	Conceptual Drainage Strategy – Site A
D1970-PL301	Conceptual Drainage Strategy – Site B
D1970-PL400	Hydraulic Model Reference Plan – Site A
D1970-PL401	Hydraulic Model Reference Plan – Site B



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4. Any information given regarding existing underground services is given in good faith after consultation with the relevant authority, however accuracy is not certain.



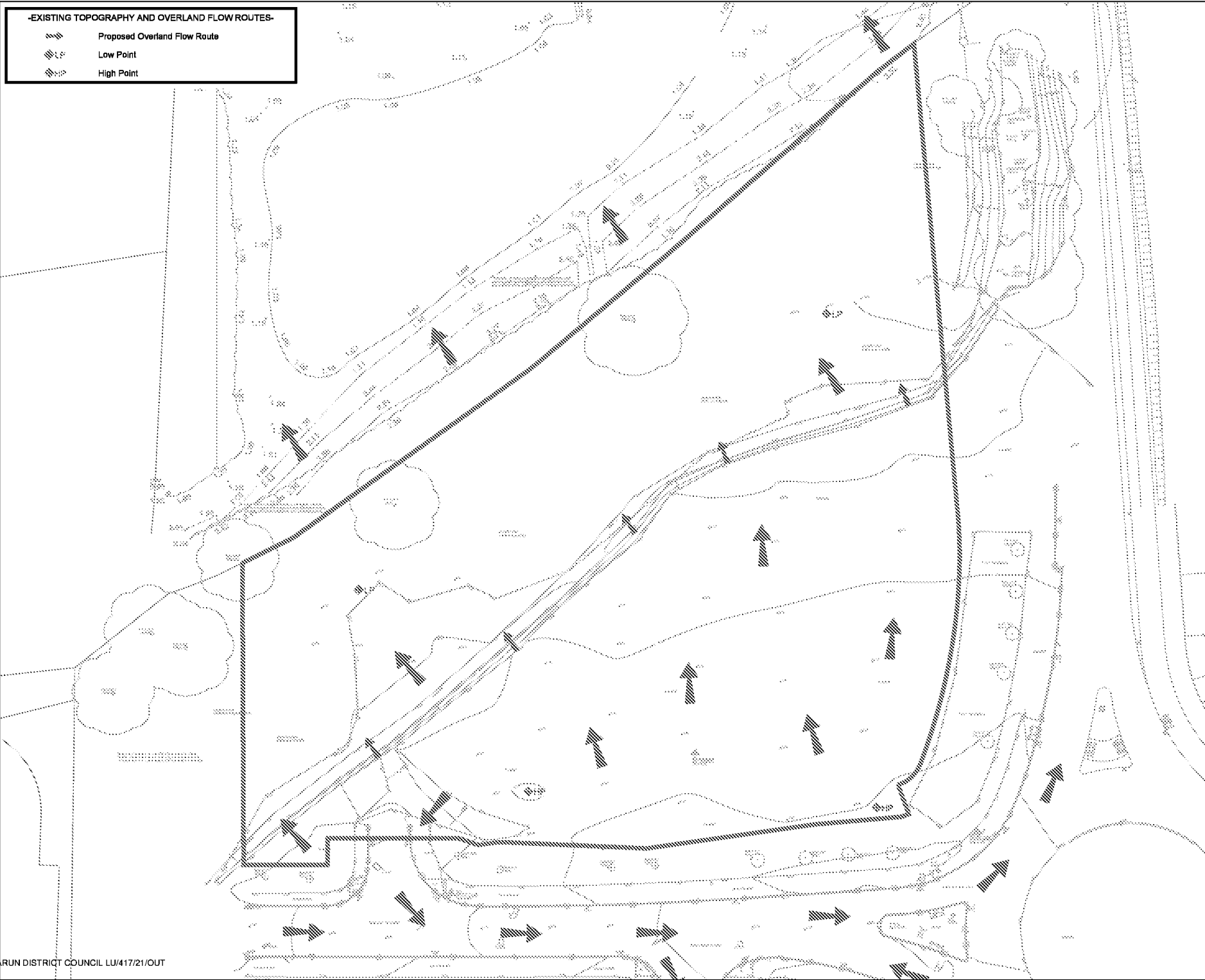
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	Original Issue	04/11/2021
Rev.	Amendments	Date

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Drawing Status	PLANNING		
Client	T&L Crawley (No. 2) LLP		
Project	Land North of Toddington Lane, Littlehampton		
Drawing Title	Existing Topography and Overland Flow Routes - Site A		
Scale	Date	Drawn By	Checked By
1:500	Nov. '21	SPB	LDF
Drawing No.	Rev.		
D1970-PL101	-		



ARUN DISTRICT COUNCIL LU/417/21/OUT

A3

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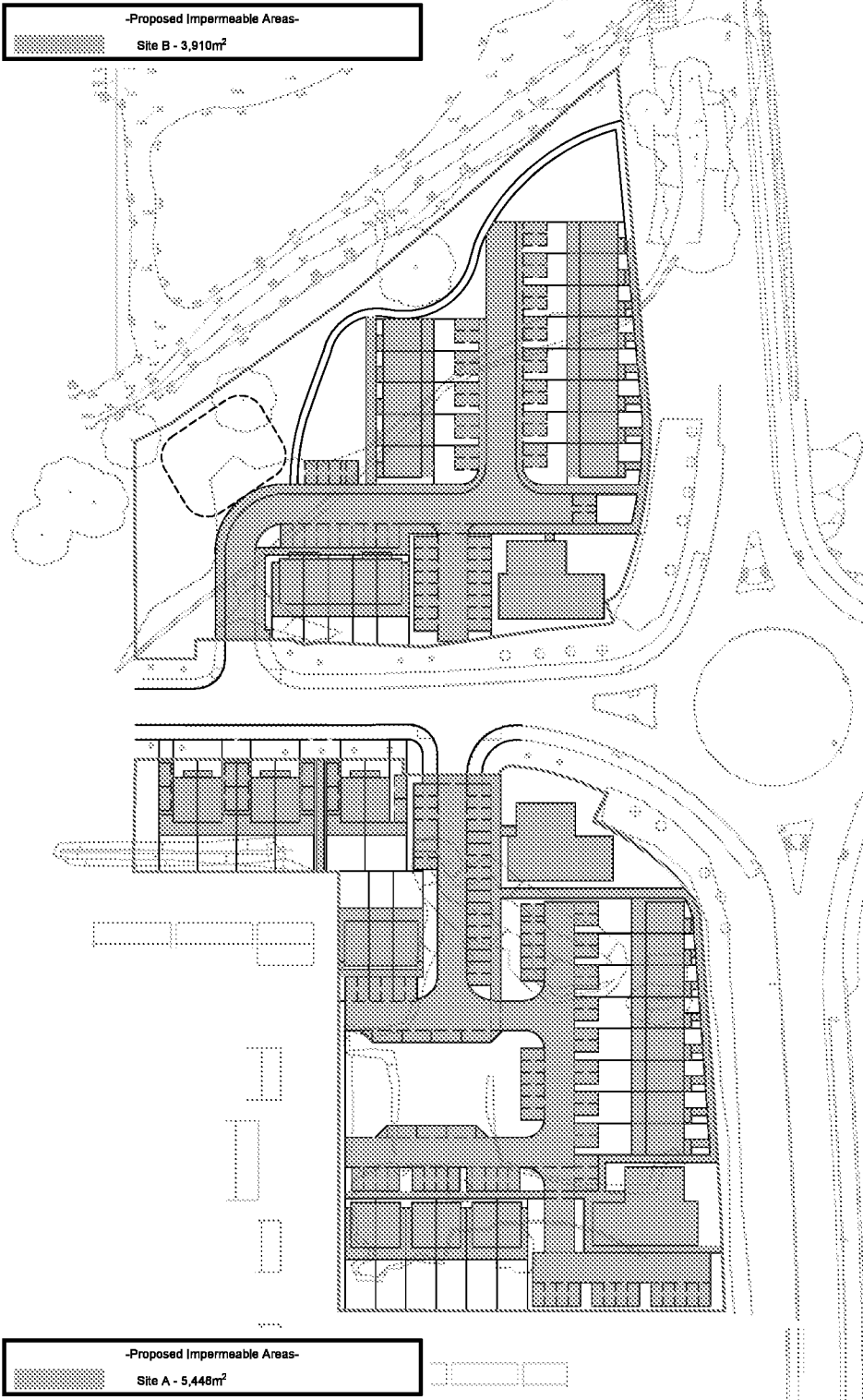
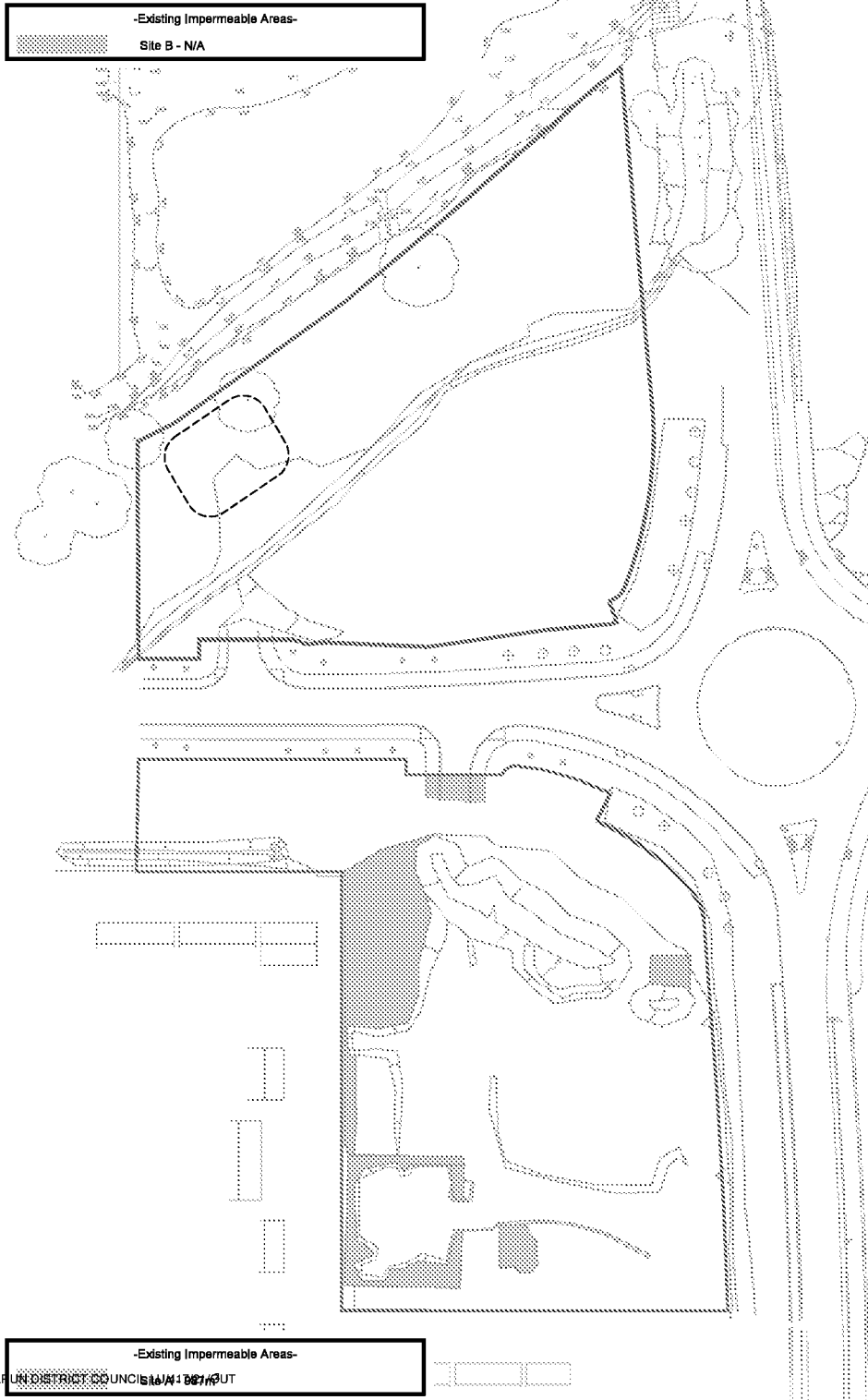
Drawing Status PLANNING

Client T&L Crawley (No. 2) LLP

Project Land North of Toddington Lane,
Littlehampton

Drawing Title Existing Topography and Overland
Flow Routes - Site B

Scale 1:500	Date Nov. '21	Drawn By SPB	Checked By LDF
Drawing No. D1970-PL102			Rev. -



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A	Minor updates	01/12/2021
-	Original issue	04/11/2021
Rev.	Amendments	Date

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Drawing Status	PLANNING
Client	T&L Crawley (No. 2) LLP
Project	Land North of Toddington Lane, Littlehampton
Drawing title	Impermeable Areas Comparison
Scale	1:1000
Date	Nov. '21
Drawn By	SPB
Checked By	LDF
Drawing No.	D1970-PL200
Rev.	A

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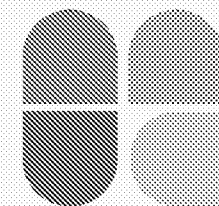


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A	Minor layout adjustments	01/12/2021
-	Original issue	04/11/2021
Rev.	Amendments	Date



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Drawing Status **PLANNING**

Client

T&L Crawley (No. 2) LLP

Project

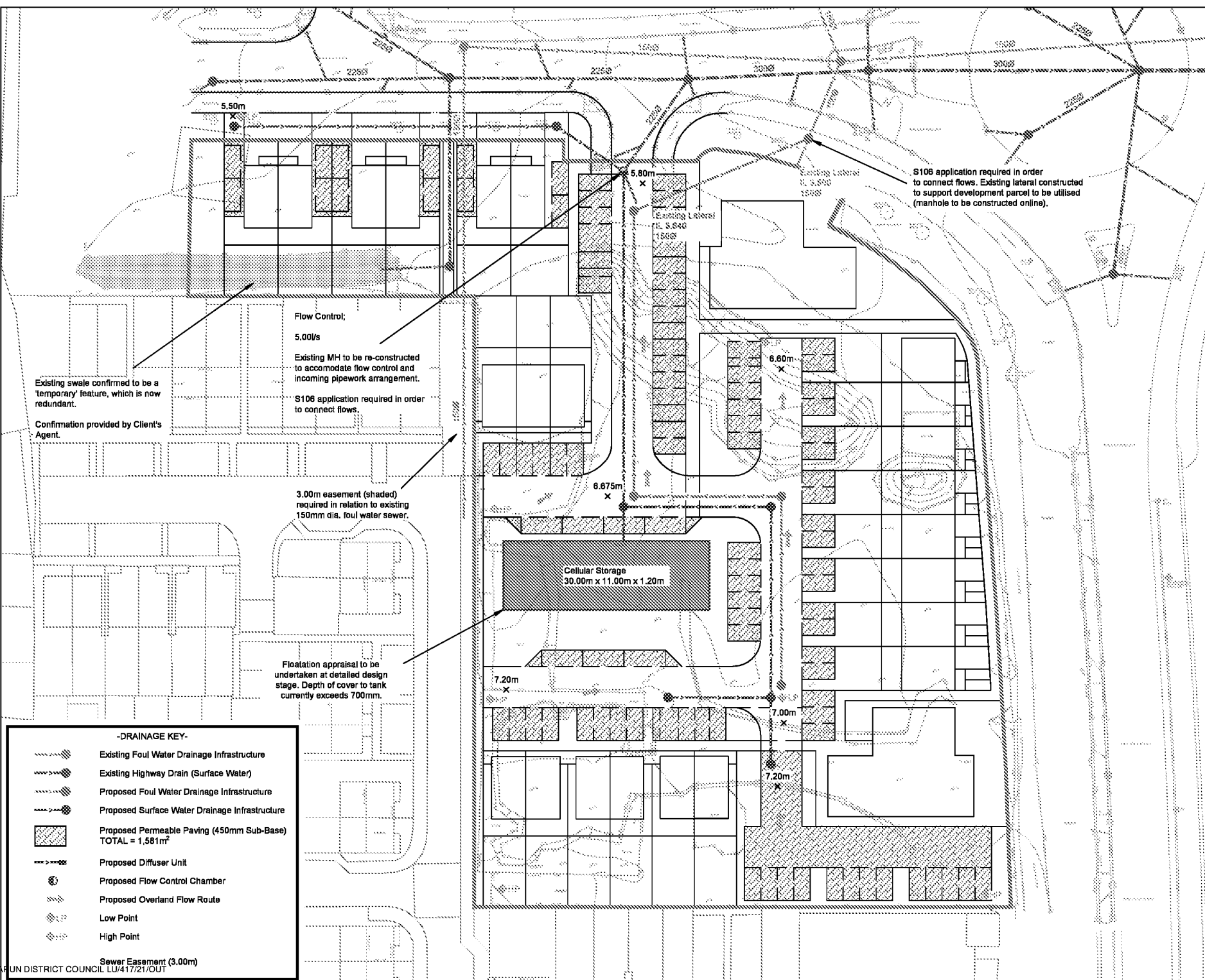
**Land North of Toddington Lane,
Littlehampton**

Drawing title

**Conceptual Drainage Strategy -
Site A**

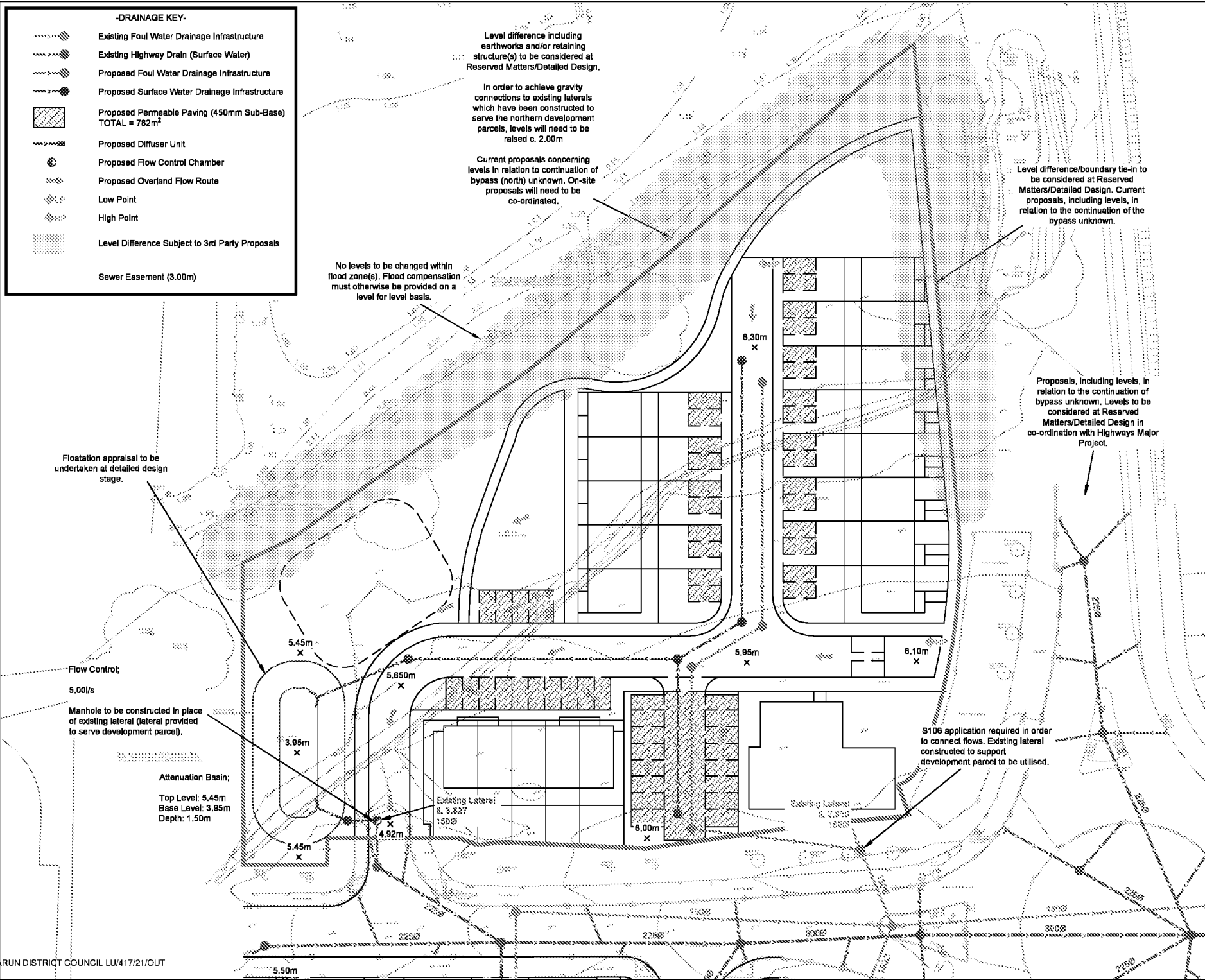
Scale **1:500** Date **Nov. '21** Drawn By **SPB** Checked By **LDF**

Drawing No. **D1970-PL300** Rev. **A**



-DRAINAGE KEY-

- Existing Foul Water Drainage Infrastructure
- Existing Highway Drain (Surface Water)
- Proposed Foul Water Drainage Infrastructure
- Proposed Surface Water Drainage Infrastructure
- Proposed Permeable Paving (450mm Sub-Base)
TOTAL = 782m²
- Proposed Diffuser Unit
- Proposed Flow Control Chamber
- Proposed Overland Flow Route
- Low Point
- High Point
- Level Difference Subject to 3rd Party Proposals
- Sewer Easement (3.00m)



NOTES

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Rev.	Amendments	Date
A	Pond revised	01/12/2021
	Original issue	04/11/2021

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Client **T&L Crawley (No. 2) LLP**

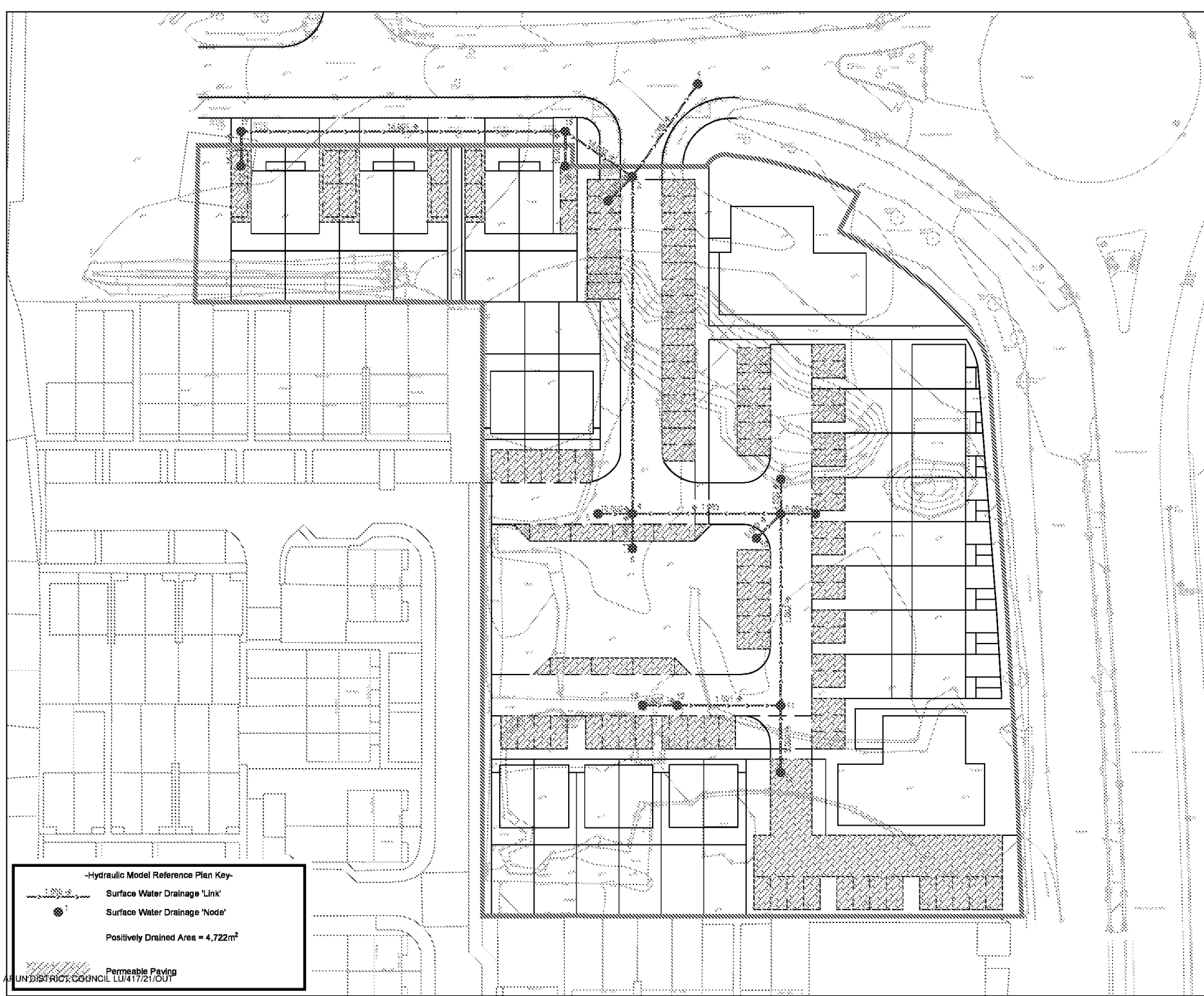
Project **Land North of Toddington Lane, Littlehampton**

Drawing Title **Conceptual Drainage Strategy - Site B**

Scale	Date	Drawn By	Checked By
1:500	Nov. '21	SPB	LDF

Drawing No. **D1970-PL301**

Rev. **A**



AFUN DISTRICT COUNCIL LU/417/21/OUT

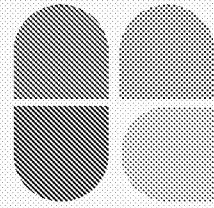
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A	Minor updates	01/12/2021
-	Original issue	04/11/2021
Rev.	Amendments	Date



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Drawing Status			
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Project			
Land North of Toddington Lane, Littlehampton			
Drawing title			
Hydraulic Model Reference Plan Site A			
Scale	Date	Drawn By	Checked By
1:500	Nov. '21	SPB	LDF
Drawing No.			Rev.
D1970-PL400			A

-Hydraulic Model Reference Plan Key-

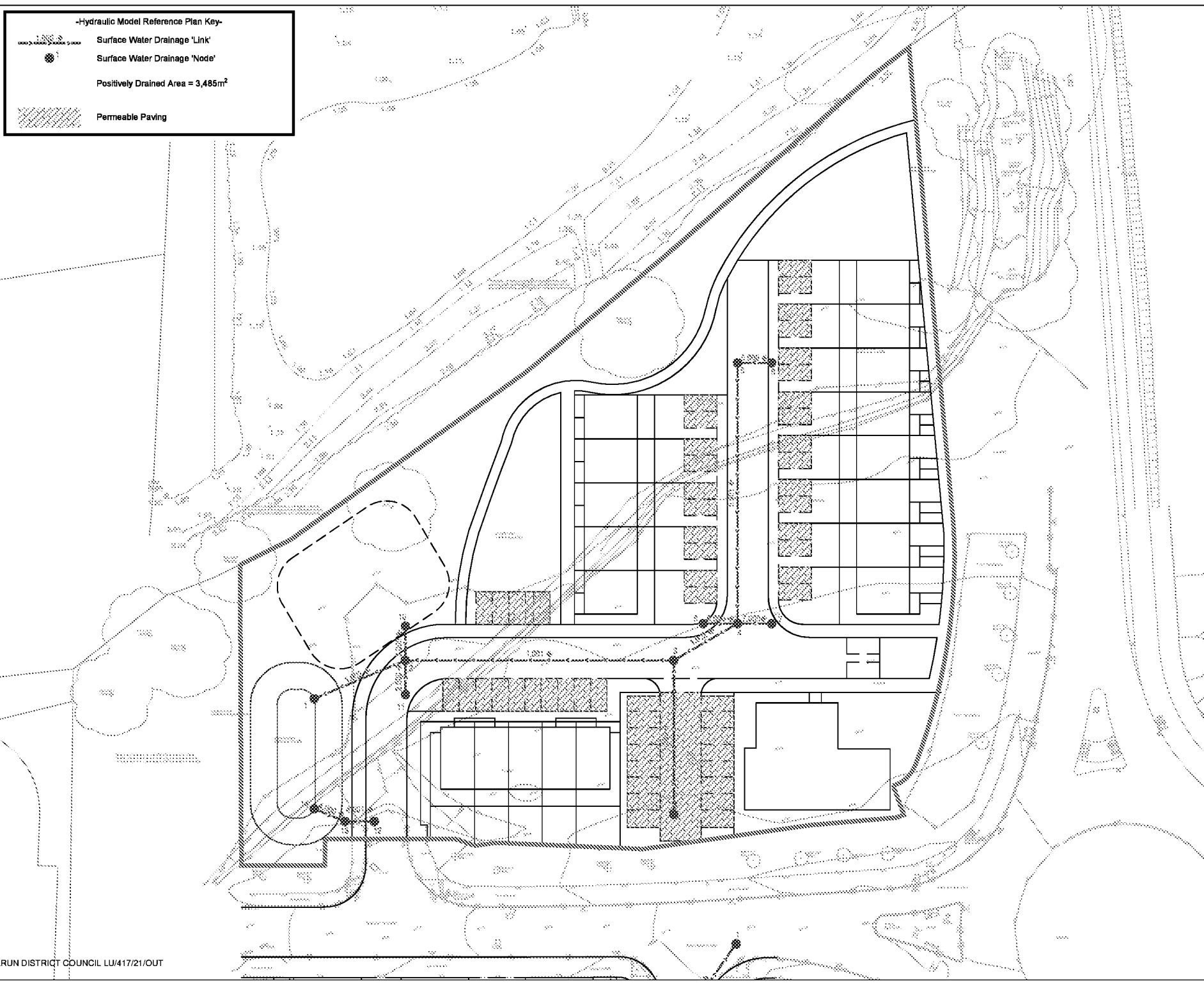
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Surface Water Drainage 'Link'

Surface Water Drainage 'Node'

Positively Drained Area = 3,485m²

Permeable Paving



NOTES

A3

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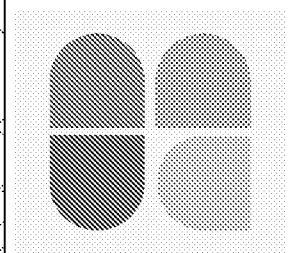


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Drawing Status **PLANNING**

Client
T&L Crawley (No. 2) LLP

Project
**Land North of Toddington Lane,
Littlehampton**

Drawing title
**Hydraulic Model Reference Plan
Site B**

Scale **1:500** Date **Nov. '21** Drawn By **SPB** Checked By **LDF**

Drawing No. **D1970-PL401** Rev. **A**

APPENDICIES

Appendix A Site Location Plan and Architectural Development Proposals



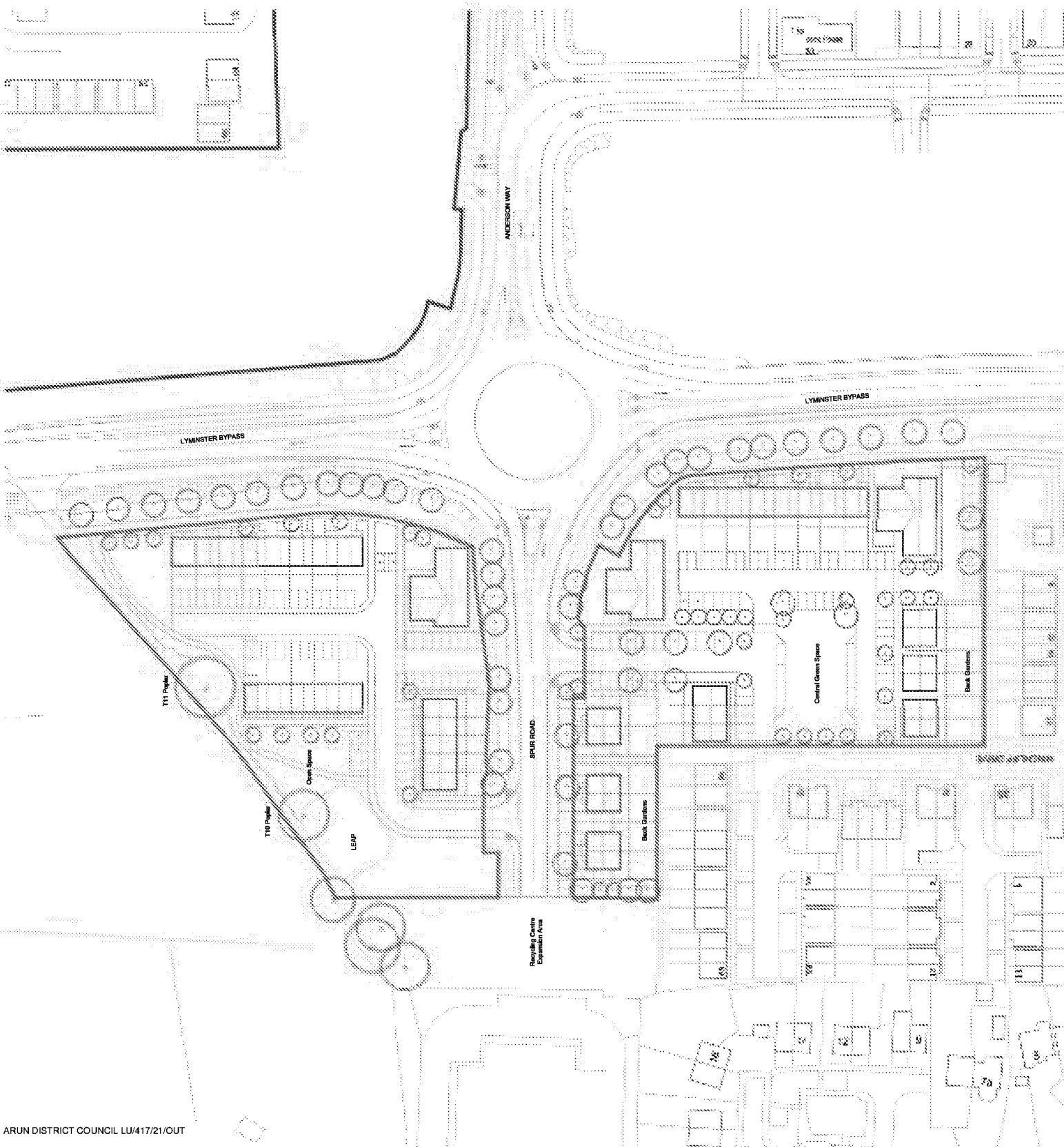
This official copy was issued on 28 June 2018 pursuant to the provisions of the Land Registration Act 2002 or 1925.

The information is evidence to the same effect as the original title plan as registered with HM Land Registry on 28 June 2018.

This title plan shows the general position of the boundaries. It may be subject to easements or other encumbrances. Measurements scaled from this plan may not reflect measurements taken on the ground.

This title is issued with the HM Land Registry, Ordnance Survey.

Rev	Description	By	Chk'd	Date



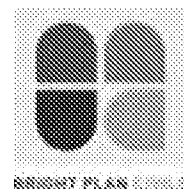
Drawing is based on the following information:
 - OS Plan, revised 13/08/18.
 - Survey undertaken by Encompass Surveys dated 18 June 2018.
 - S1/B1 Rev. E - Landscape Proposals (Sheet 1 of 2) dated 06/03/18 from application LU78/17/RES

Date: 09/04/21
 Scale: 1:500
 Project: Land North of Toddington Lane, Littlehampton

Drawn by: GP DS
 Checked by: DS
 Date Checked: 09/04/21

Title: Indicative Site Layout

Drawing Status: Preliminary
 Drawing Number: 21023-HWN-22-00-DR-A-2001
 Drawing Date: 09/04/21



Appendix B Mayer Brown Drainage Strategy (LU/17/19/DOC)



PERSIMMON HOMES THAMES VALLEY
LAND NORTH OF TODDINGTON LANE,
LITTLEHAMPTON

DRAINAGE STRATEGY, WEST OF
WETLANDS
(DISCHARGE OF CONDITION 10)

JANUARY 2019

the journey is the reward

**PERSIMMON HOMES THAMES VALLEY
LAND NORTH OF TODDINGTON LANE,
LITTLEHAMPTON**

**DRAINAGE STRATEGY, WEST OF
WETLANDS
(DISCHARGE OF CONDITION 10)**

JANUARY 2019

Project Code:	A/PHDRA24.10
Prepared by:	SF
Approved by:	AB
Issue Date:	24th January 2019
Status:	1 st Issue

**Persimmon Homes Thames Valley
Land North of Toddington Lane, Littlehampton
Drainage Strategy, West of Wetlands
(Discharge of Condition 10)**

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APPENDIX L: List of Drawings in West of Wetlands Catchment	

1 Introduction

- 1.1 Mayer Brown Ltd has been commissioned by Persimmon Homes Thames Valley (PHTV) to compile this report to assist with the discharge of planning condition 10 for their outlined approved development (**Arun DC reference LU/47/11/**) for up to 1,260 residential dwellings, B1 employment use, Class A facilities, a 100 bed hotel, 60 bed care home, primary school, plus many other facilities and improvements to the local infrastructure.

Outline Planning Consent

- 1.2 Outline Planning Consent was granted in 2011, under Arun District Council planning reference LU/47/11, which includes Condition 10 that relates to surface water drainage.

Purpose of this Drainage Report

- 1.3 This drainage report does not cover the entire area that received outline planning approval. It includes the development area of approximately 19.0 hectares to the west of the wetlands as identified Appendix B, titled "Land Uses and Drainage Areas Covered".
- 1.4 There are a total of 18 land parcels and associated road infrastructure identified within this catchment at varying states of progress. The report describes the design philosophy behind the main surface sewers within the road network that will eventually drain the development parcels within this area. It also specifies the proposed connection points and peak allowable surface water discharge from each of the land parcels.
- 1.5 A parcel specific surface and foul water drainage strategy will still be required to accompany the reserved matters (RM) applications from the individual land parcels.
- 1.6 This report is to be used to accompany the RM planning applications for each of the individual parcels in order to demonstrate that the receiving drainage network has been adequately designed and considered.

Previous Consultancy Work

- 1.7 Greencore obtained outlined planning consent for the scheme in 2011, using White Young Green as their drainage consultants, and subsequently sold the site to PHTV.

- 1.8 Glanville Consulting Engineers were employed by PHTV to develop the surface and foul water strategy further. Glanville are no longer working on the project but produced useful information to depict the pre-development scenario, which is contained in a number of Appendices within this report.
- 1.9 Mayer Brown were employed by PHTV as their drainage consultants for the project in September 2017 and where possible will utilise the information produced by previous Consultants.
- 1.10 There are numerous projects, sub-parcels and associated civils and drainage drawings that inform the works within the west of wellands catchment. It is not practical to include all the drawings for these projects within this report and, as such, they are listed in Appendix L. These drawings can be supplied on request to Mayer Brown Ltd.

2 Condition 10 - Surface Water Drainage

Condition 10: No development shall begin until a fully detailed surface water drainage scheme for that phase of the development, based on sustainable drainage principles and designed in accordance with the SUDS strategy for the whole development, has been submitted to and approved in writing by the Local Planning Authority. It should be demonstrated how each detailed scheme will contribute to delivering, and link into, the surface water drainage strategy for the site as a whole.

- The SUDS shall be designed to attenuate the 1 in 100 year storm event (plus climate change allowance of 30% in accordance with DEFRA's National Standards for Sustainable Drainage Systems).
- No infiltration of surface water drainage shall occur within ground affected by contamination unless suitable remediation is undertaken.
- Each detailed scheme should include a timetable for its implementation; and provide a management and maintenance plan in the form of a site specific Maintenance Manual for the SUDS system for the lifetime of the development. This shall include the arrangements for adoption by any public authority or statutory undertaker or details of the financial management of the scheme throughout its lifetime.

Elements of the scheme serving any particular phase shall subsequently be implemented in accordance with the approved details (unless otherwise agreed with the Local Planning Authority) prior to the occupation of any dwellings in that phase and no building in that phase of the development shall be occupied until the surface water drainage scheme has been fully implemented in accordance with the approved details.

Reason: To ensure that the proposed development is satisfactorily drained to prevent the increased risk of flooding, and improve and protect water quality, habitat and amenity, and ensure future maintenance of these in accordance with national guidance and policies GEN7, GEN9 of the Arun District Local Plan.

Pre-Demolition Site

- 2.1 The pre-demolition site was heavily developed comprising large glasshouses with associated outbuildings and areas of hardstanding. Refer to the site location plan in Appendix A that shows the extent of the glasshouses covering the site to the east and west of the wetlands.
- 2.2 A plan illustrating the existing surface water regime, produced by Glanville in 2014, is contained in Appendix H.
- * The former Toddington Nurseries: The western part of the site comprising is understood to have discharged to a combination of soakaways and outfall to the existing ditch system north of the site.
 - * Central West Former Holland Nursery: Discharged to an irrigation pond before discharging to Toddington ditch. It is understood that there was no restriction of flows from the system.

Infiltration

- 2.3 Intrusive ground investigations and soakage testing undertaken by Merebrook have confirmed that infiltration methods for the disposal of surface water runoff are unlikely to be practical across the majority of the site as the underlying material is generally found to comprise of Clay.
- 2.4 Review of these investigative reports appears to indicate only two areas where infiltration drainage were feasible (subject to further testing):
- * Towards the western part of the site at depths of around 1.0m into the localised sand deposits; Parcels B3, B5, B1, Care Home, Enterprise Zone
 - * Towards the western part of the site at depths of around 2.0m into localised Sand deposits; notably Parcels A1, A2, Youth Facility, B6, Waste Recycling Centre, and Commercial Areas.
- 2.5 Other than the locations noted above infiltration methods for the disposal of surface water runoff are unlikely to be feasible due to either the presence of Clay material or high groundwater levels.
- 2.6 Modelled Flood Levels in the Black Ditch are within a metre of ground level in many locations which could restrict depths available to effectively locate SuDS features.

Sustainable Drainage (SuDS) and Drainage Hierarchy

- 2.7 Sustainable Urban Drainage Systems (SuDS) are a range of techniques that aim to mimic the way rainfall drains in natural systems and so reduces the hydraulic and hydrological impact on the local area and downstream catchments. There are a number of options available to impose surface water restrictions on proposed development plots such as oversized sewers, below ground storage tanks, attenuation ponds and basins, swales, permeable paving, or infiltration systems.
- 2.8 To determine the most sustainable method of surface water disposal the hierarchy from approved document part H was used, see below.
- **An adequate soakaway or some other adequate infiltration system** apart from a few locations across the site infiltration methods for the disposal of surface water runoff are not feasible due to either the presence of Clay material or high groundwater.
 - **A Watercourse** – The Black Ditch is located to the north of the site within the boundary of the consented scheme. There are ordinary watercourse tributaries that run across the wetlands and connect to the Black Ditch
 - **A Sewer** – There are no public surface water sewers in the immediate vicinity. The only drains available were those that drained the pre-demolition glasshouses and discharged into the black ditch.

Proposed Surface Water Strategy

- 2.9 Based upon the above hierarchy a high level description of the surface water strategy is that the entire 19 hectare catchment as identified in Appendix B will drain at a restricted rate of run-off into the Black Ditch via a single outfall located at the northern boundary of development parcel C2.
- 2.10 As explained in the introduction this report describes the drainage strategy for the development parcels and associated road network for the consented scheme to the west of the wetlands. (The remaining area to the east of the wetlands is currently under development).

Proposed and Pre-Demolition Discharge Rates

Pre-Demolition Discharge

- 2.11 As described in paragraph 1.9 Glanville Consulting Engineers (GCE) produced useful information to depict the pre-demolition scenario. In order to understand and quantify the existing drainage and associated discharge rates

PHTV commissioned MK Surveys to carry out a drainage survey of the pre-demolition drainage network. The resulting survey is contained in Appendix H of this report (a total of 12 AO drawings covering the whole site).

- 2.12 GCE subsequently reviewed the drainage survey and ascertained there was a total of 10 outfalls, ranging in diameter from 150mm up to 375mm, with run-off eventually ending up in the Black Ditch via the series of smaller upstream ditches.
- 2.13 GCE produced basic micro drainage models in order to quantify the discharge rate from each outfall. They also produced a plan summarising the discharge rates from the individual parcels. Refer to Appendix H of this report.
- 2.14 The resulting total pre-demolition discharge rate from the West of Wetlands is as follows:
- * Outfalls 01, 02, 03 (**Not** including outfalls 04 to 09 or the overland flow)
 - * Combined impermeable area = 8.33 hectares
 - * Peak Pre-demolition 1 in 1 year discharge = **390 Litres / second**
- (The above figure does not account for the run-off from the demolished buildings and unrecorded drainage, as shown on the GCE plan. These areas are hatched on the GCE plan and are referred to as overland flow)
- 2.15 The overall development area of the west of wetlands catchment is 19.0 hectares, which equates to a pre-demolition peak **1 in 1 year** discharge rate of **20 litres / second / hectare**.
- 2.16 It is worth noting that the calculated pre-demolition discharge rate of 20 litres / second / hectare is for the 1 in 1 year return period and, although not calculated, would be significantly larger for the higher 1 in 30 year and 1 in 100 year return periods.

Proposed Discharge Rate

- 2.17 The Arun DC SFRA identifies the site as brownfield and states that development is unlikely to significantly increase run-off but should seek to reduce rates where possible. Therefore, the proposal is to specify a reduced rate of run-off when compared to the pre-demolition run-off described above.
- 2.18 A proposed peak discharge rate has been calculated using Greenfield runoff methods provided in Ioh124 using a Soil Type of 5 to make allowance for the possible effect of the previous extensive impermeable area. The resulting 1 in 1 year brownfield rate has been calculated at approximately 15 litres

/second / hectare. A copy of the relevant calculation is contained in Appendix H.

- 2.19 The peak rate of surface water discharge for up to the **1 in 100 year return period + 30% climate change** will be restricted to **15 litres / second / hectare**. This proposed peak rate of surface water discharge will provide significant betterment when compared to the pre-demolition undeveloped scenario.

Calculations and Results

- 2.20 A Micro Drainage model has been created of the drainage network covering the overall catchment area of 19.0 hectares. The pipes have been sized to convey the surface water run-off from each area, and the proposed peak allowable discharge has been specified from each future development plot. The overall network schematic and details are contained in Appendix E.
- 2.21 Outfall B, the final outfall from the overall catchment, will discharge through a headwall into the existing ditch that is also located in a flood plain. There will be a flap valve on the final headwall to ensure floodwater within the floodplain will not back up into the drainage network. However, in this scenario the drainage network can't push open the flap valve until the water level within the site goes above the flood level in the wetlands.
- 2.22 There is a risk that a fully surcharged outfall could coincide with the on-site critical 1in100yr+CC storm so the Micro Drainage model has been simulated with a fully surcharged outfall.
- 2.23 The EA supplied 1in100yr+20%CC modelled flood level within the floodplain ranges from 1.72m AOD to 1.83m AOD. A flood level in the wetlands of 1.8m AOD by the outfall will result in the outfall (@ 1.0m AOD) being surcharged by approximately 0.8m.
- 2.24 There is also permeable sub-base designed beneath some of the Phase 2 roads, which has been incorporated into the Micro Drainage model.
- 2.25 The final peak allowable discharge of **285 litres / second** (19 hectares x 15 litres / second / hectares) has been modelled for the worst case 1 in 100 year storm event + 30% climate change. The simulation results are contained in Appendix F & G.

2.26 The discharge rates will be considerably lower for lower intensity storm events as shown below (discharge rates below are for a surcharged outfall. When the outfall is unsurcharged the full 285 litres / sec discharge is achieved):

- * Critical 1 in 100 year storm (+30% CC): 265 litres / second
- * Critical 1 in 30 year Storm: 207 litres / second
- * Critical 1 in 1 year Storm: 167 litres / second

2.27 The proposed discharge rates represent a significant reduction when compared to the pre-demolition 1 in 1 year discharge rate of 390 litres / second, as follows:

- * Critical 1 in 100 year storm (+30% CC): 32% Reduction
- * Critical 1 in 30 year Storm: 47% Reduction
- * Critical 1 in 1 year Storm: 58% Reduction

2.28 Most of the surface water attenuation will be located within the future car park area in a 1500 cubic metre proprietary storage tank and permeable paving sub-base. There will also be attenuation in the 900mm diameter pipe running from the car park to the outfall.

2.29 A maximum allowable discharge will be imposed on the majority of development parcels and, as such, each parcel will need to contain surface water storage within its respective reserved matters (RM) application boundary. These have been modelled indicatively within the micro drainage network but their design will need to be undertaken to accompany each RM Application.

Existing & Future Development Parcels

2.30 The discharge from each parcel into the main drainage network will be restricted to the following peak rate of run-off:

- * Non-Resi Land (0.91Ha) 5 litres / second
- * Non-Resi Land (0.81Ha) 5 litres / second
- * Non-Resi Land (0.32Ha) 5 litres / second
- * Non-Resi Land (Hotel) 5 litres / second
- * Care Home: 5 litres / second
- * Parking Square: 5 litres / second
- * A1 Parcel (Existing): 34.5 litres / Second
- * A2 Parcel: 5 litres / second
- * B1 Parcel: 5 litres / second

- * B2 Parcel: Free Discharge – See Appendix I & K
- * B3 & B5 Parcel (Existing): 120 litres / second
- * B6 Parcel: 5 litres / second
- * Block B Parcel: 5 litres / second
- * Block A Parcel: 5 litres / second

Free discharge areas below – See paragraph 2.27 to 2.29

- * B4 Parcel (Phase2): Free Discharge – See Appendix I & K
- * C1 Parcel: Free Discharge – See Appendix I & K
- * C2 Parcel: Free Discharge – See Appendix I & K
- * C4 Parcel: Free Discharge – See Appendix I & K
- * Roads Serving Above Free Discharge into Network

Total Peak Discharge: **285 litres / Second**

(1in100yr return period, including climate change)

Free Discharge from Parcels

- 2.31 The surface water network serving the above parcels (C1, C2, C4, B4 Partial, Roads) are interconnected and overlap with each other, and the roads passing through these parcels also drain the upstream and surrounding parcels
- 2.32 There are also no flow controls (ie hydro-brakes) on the surface water sewers within Phase 2 parcels or roads. A total of 23 individual locations / sub-catchments have been identified within Phase 2. The free discharge varies for different return periods and their associated storm durations varying for short durations high intensity storms to longer durations low intensity rainfall events. The critical discharge rates have been identified in
- 2.33 Although there is a free discharge from these sub-catchments the downstream network has been designed to cater for this and the final outfall / discharge rate will not exceed 285 litres / second for the peak 1in100yr return period, including climate change. (The peak discharge rate will be considerably less for lower returns periods as set out above in paragraph 2.27.)
- 2.34 The type of attenuation tanks in the future development plots are to be determined at the time of the RM application. The volumes of tanks identified in Appendix I is approximate only and will need to be designed accurately by the Consultants undertaking the detailed design. Catch pit chambers are to

be specified immediately upstream to the tanks in order to limit the volume of debris / silt entering the tanks.

Modelled Overflow into Future Parcel B4

- 2.35 There is a requirement to add an overflow in the drainage network at the south west corner of the catchment (by SW01). The drainage is exceptionally shallow in this location so there is no scope to add surface water attenuation under the road or adjacent parking areas.
- 2.36 Approximately 226m³ of surface water run-off will overflow into the proposed surface water drainage network that will eventually serve the future development parcel B4. This will only occur for the critical duration storm (120mins) for the 1in100yr return period + climate change.
- 2.37 Therefore, the plan is to increase the size of the future attenuation tank in the adjacent B4 parcel so it will store the 226m³ and release it into the wetlands via a future outfall at the agreed rate of 15 liters / second / hectare.

Surface Water Treatment

- 2.38 Table 26.2 of the SuDS Manual identifies the pollution hazard level associated with the land uses within the Proposed Development as being 'Low'. On a scale from 0-1 a 'Low' pollution hazard level relates to the following pollution hazard indices (See table 26.2 of the SuDS Manual) This is applicable to runoff from residential roofs, driveways, paths, residential parking areas and low traffic roads:
- * Total Suspended Solids = 0.5
 - * Metals = 0.4
 - * Hydrocarbons = 0.4

- 2.39 Table 26.3 of the SuDS Manual sets out the indicative mitigation indices provided by different SuDS features for discharges to surface water.

Permeable Paving

- 2.40 Communal parking and private driveways will be constructed using permeable paving allowing the rainwater falling onto permeable paved areas to be treated by the microorganisms as it passes through drainage medium, see Figure 4.1 below.

mitigation indices of 0.7, 0.6 and 0.7, which are in excess of the requirement set out in paragraph 2.25

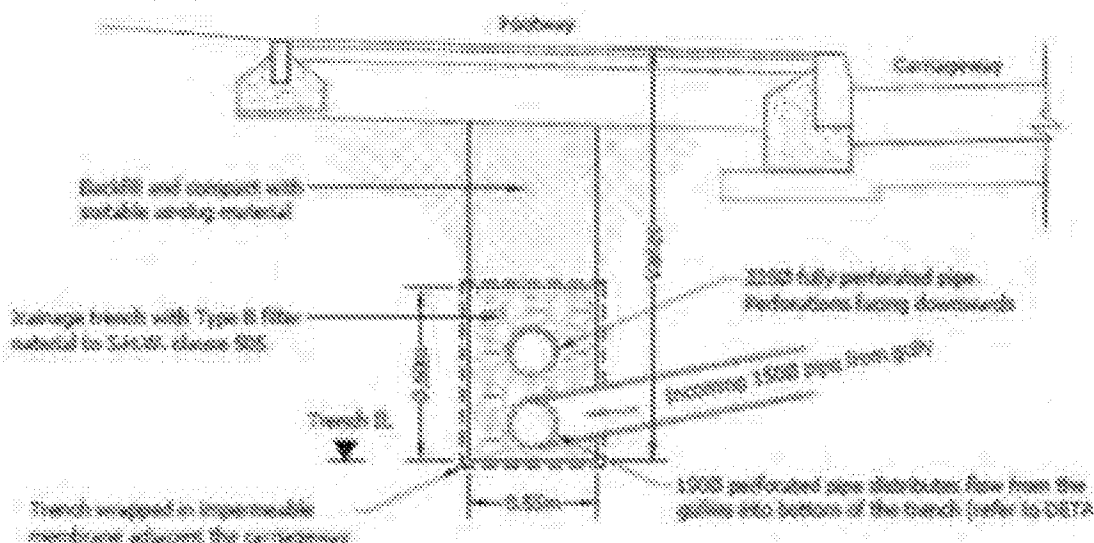


Figure 2.3: Permeable Sub-base Road (refer to Appendix J)

Traditional Gullies

- 2.46 Full size precast concrete gully pots draining the asphalt roads that will act as the first line of defence to trap silt and sediments in the drainage network.

Exceedance Flows & Surcharged Outfall

- 2.47 The drainage network is designed to cope with flooding up to the **1in100yr+30%CC** flood event and this water will be contained on site within the developed areas (not the wetlands)
- 2.48 Appendix D contains drawings that show the route of overland flow in the event of system failure, blockage or overload. This demonstrates that dwellings will be suitably protected in the event of a drainage system failure and resulting overland flow can find its way safely through the road network and into the wetlands.
- 2.49 Discussions have been had with Arun DC to ascertain what would happen if the wetland are flooded and the outfall becomes surcharged. The EA supplied 1in100yr+20%CC modelled flood level within the floodplain ranges from 1.72m AOD to 1.83m AOD. A flood level in the wetlands of 1.8m AOD by the outfall will result in the outfall (@ 1.0m AOD) being surcharged by approximately 0.8m.

- 2.50 The chances of the critical 1in100yr-CC flood level in the wetlands (which is tidal) coinciding with the peak 1in100yr-CC storm event on the site are very small. However, a fully surcharged outfall was simulated and results in a small flood volume escaping from the drainage network that can be safely be contained within the road network (refer to the simulated results for the critical 240 minute storm in Appendix F).

Adoption and Maintenance

- 2.51 The proposed surface water drainage system will be constructed in accordance with Sewers for Adoption 7th edition (SFA7), however it will remain in private ownership and will be maintained by a Management Company organised by the Developer.
- 2.52 Some of the main roads, footpaths and shared areas will be adopted by Mid Sussex District Council under a Section 38 agreement. The remaining private roads and communal parking areas will be maintained by a Management Company, organised by the Developer.
- 2.53 Taking this approach will ensure shared drainage and infrastructure items are properly maintained. This should enable tight control over the operation and maintenance of the drainage / SuDS systems on site.

Attenuation Tank Maintenance

- 2.54 The primary purpose of the attenuation tanks is to attenuate surface water run-off during extreme rainfall events.
- 2.55 Regular inspection and maintenance is required to ensure the effective long-term operation of the below ground storage tanks, see table 2.1 below for details:

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Debris removal from catchment surface (where may cause risk to performance)	Monthly
	Remove sediment from pre-treatment structures.	Annually, or as required
Remedial Actions	Repair/rehabilitation of inlets, outlets, overflows and vents.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually and after large storms

	Survey inside of tank for sediment build-up and remove if necessary	Annually until evidence this is too regular, every 5 years thereafter.
--	---	--

Table 2.1: Attenuation Tank Maintenance Requirements

Pervious Pavement Maintenance

2.56 Pervious pavements are pavements that allow for pedestrian and/or vehicular traffic while allowing rainwater to infiltrate through the surface and into underlying structural foundation layers.

2.57 Regular inspection and maintenance is important for the effective operation of pervious pavements as designed, these are described below in table 2.2:

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required
	Removal of weeds or management using glyphosate applied directly into weeds by an applicator rather than spraying.	As required – once per year or less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost joining material.	As required.
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).
Monitoring	Initial inspection.	Monthly for three months after installation.
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action.	Three-monthly, 48h after large storms in first six months.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.
	Monitor inspections chambers.	Annually.

Table 2.2: Pervious Pavement Maintenance Requirements

Drainage Network Design Criteria

- 2.58 The positive drainage will be designed in accordance with Sewers for Adoption, and BS EN 752 – Drain and sewer systems outside buildings and the Building Regulations - part H (2002).
- 2.59 The surface water network design and rate of surface water runoff would be based on the Modified Rational method and designed in accordance with the Wallingford Procedure. In order to carry out the design of the networks, a number of Global Variables are used. These Global Variables / parameters are related to the location of the site in the UK and have been obtained from the Flood Estimation Handbook (FEH).
- 2.60 The positive surface water system would be designed such that:
- The pipes remain unsurcharged during the 1 in 2 year design storm;
 - The system should not flood during the worst case 1 in 30 year storm with a free outfall;
 - The surface water run-off from the proposed development would be safely contained on site for up to and including the worst case 1 in 100 year storm event, plus an additional 30% for climate change;
 - The pipe velocities are such that self-cleansing is achieved at lesser more moderate storm intensities :
 - Pipe roughness (ks) = 0.6
 - Minimum pipe velocity at full flow = 1.0 m/s
 - Cv Value of 0.84 (as agreed with WCSS)
 - Percentage Impermeable areas
 - Buildings = 100%
 - Carriageways and footpaths = 100%
 - Private and Communal Parking = 100%

Micro Drainage Software

- 2.61 The proposed and existing networks have been designed and analysed using the Micro drainage software package that is recognised as one of the industry standard design suites. There are two separate programmes used within the package to firstly generate and then analyse the completed model. These are 'System 1' and 'Simulation'.

- System 1: The surface water computer model has been generated in "System 1" in using proposed data, such as the cover levels, invert levels and catchment areas. This is used to size the pipes in the proposed network based on the global variable outlined above
- Simulation: Once the proposed drainage system has been generated it was analysed using 'Simulation'. This is a full hydrograph method for the determination of flood risk and system failure under extreme conditions. It can be used to analyse system overloads, storage, reverse flow characteristics, surcharging and backwater effects. It can also analyse against a wide variety of critical variables.

Return Periods & Critical Duration Storms

- 2.62 To determine the hydraulic requirements for an element of a drainage system, one must first consider the consequences of that capacity being exceeded and then identify an acceptable frequency for this to occur. This acceptable frequency is termed the return period, the period of time during which the stated rainfall can be expected to be exceeded on average only once, that particular element is then designed to accommodate a storm / flood with this return period.
- 2.63 Once the design return period is established the most critical storm duration for each of the elements is determined. These range in duration from 15 to 1440 minutes. For example;
- A 1 in 30 year, 30 minute duration storm for the northern catchment has an average intensity of 56.762mm/hr. This intensity of storm would be used to size the pipes and other drainage elements for conveyance purposes.
 - A 480 minute duration storm has an average intensity of only 8mm/hr (figures obtained from simulated results). However, the 480 minute storm lasts 16 times longer, therefore generating a much greater volume of water and would be used to size the attenuation tanks.

Condition 10 Conclusion

- 2.64 This surface water drainage strategy demonstrates that the west of wetlands catchment site can be drained satisfactorily without increasing flood risk elsewhere.

- 2.65 Intrusive ground investigations and ground water monitoring have determined that infiltration drainage is unlikely to be practical across **much** of the site. Discharge of surface water runoff directly into the chalk, which is designated a principal aquifer, has been discounted due to high recorded groundwater levels within this material and the inability to provide a minimum standoff distance from the saturated zone.
- 2.66 There are, however parcels to the **west** of the site, (as described in paragraph 2.4) that are yet to be developed and where bespoke infiltration drainage might be feasible. Parcel specific infiltration tests will be undertaken to determine the feasibility for each future land parcel where the standing ground water level is found to be in excess of 2.0m below the surface.
- 2.67 Surface water runoff will be discharged to the Black Ditch at a peak allowable discharge of 15 litres / second / hectares for up to the 1 in 100 year return period, plus 30% allowance.
- 2.68 This proposed rate of discharge will provide considerable betterment when compared to the pre-demolition brownfield arrangement. The provision of SuDS and attenuation features will store the balance of surface water runoff.
- 2.69 The proposed discharge rates represent a significant reduction when compared to the pre-demolition 1 in 1 year discharge rate of 390 litres / second, as follows:
- * Critical 1 in 100 year storm (+30% CC): 32% Reduction
 - * Critical 1 in 30 year Storm: 47% Reduction
 - * Critical 1 in 1 year Storm: 58% Reduction
- 2.70 The information contained within this report demonstrates that adequate surface water infrastructure will be provided to enable the consented scheme to be satisfactorily drained, and will enable the future Parcels within the west of the wetlands catchment to make a positive connection into the proposed surface water network.
- 2.71 The reserved matters planning applications for the future parcels will need to be accompanied by an individual surface water drainage strategy and technical note. Each technical note will also include this overall strategy that demonstrates the downstream receiving network has been satisfactory designed in accordance with the relevant standards.

- 2.72 Parcel specific soakaway tests will be undertaken to confirm the feasibility of using infiltration drainage on the future RM planning applications for the remaining land parcels. If feasible the infiltration drainage will be used in conjunction with the positive discharge rates described within this report.
- 2.73 Therefore, it is considered that this evidence base, when read in conjunction with the RM application for the individual parcels, will provide sufficient information to discharge the outline planning Condition 10.

APPENDIX A: Site Location & Pre-Demolition Layout

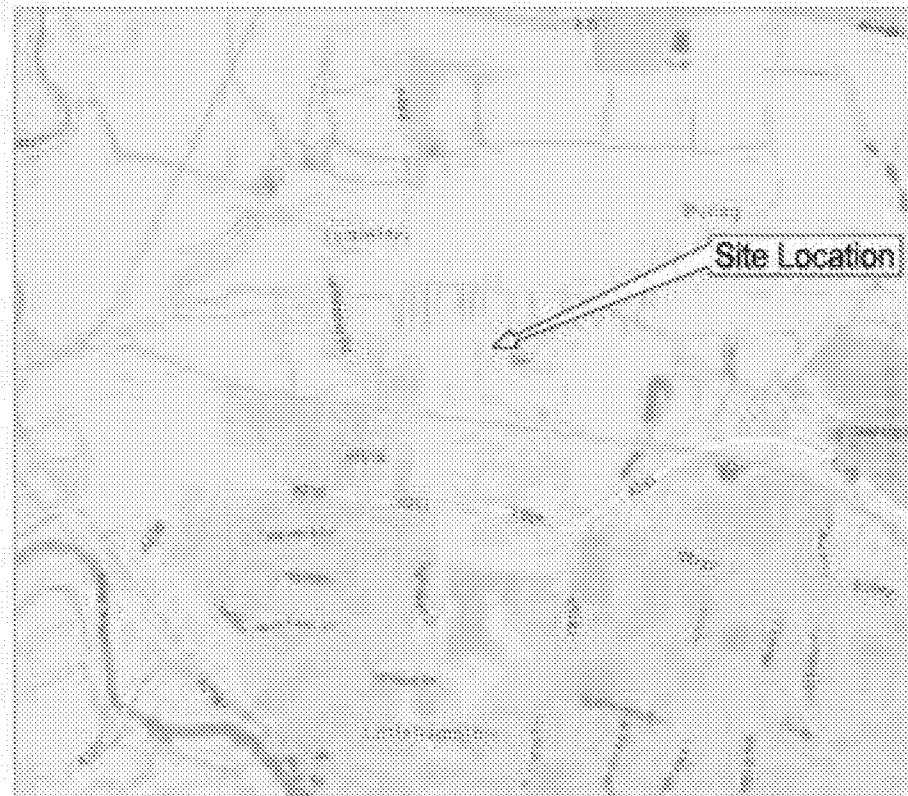
NOTES

1. This drawing is to be read in conjunction with all relevant documents and specifications.
2. Dimensions not to be scaled.

LOCATION

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 800
 Littlehampton
 West Sussex
 BN17 7PB

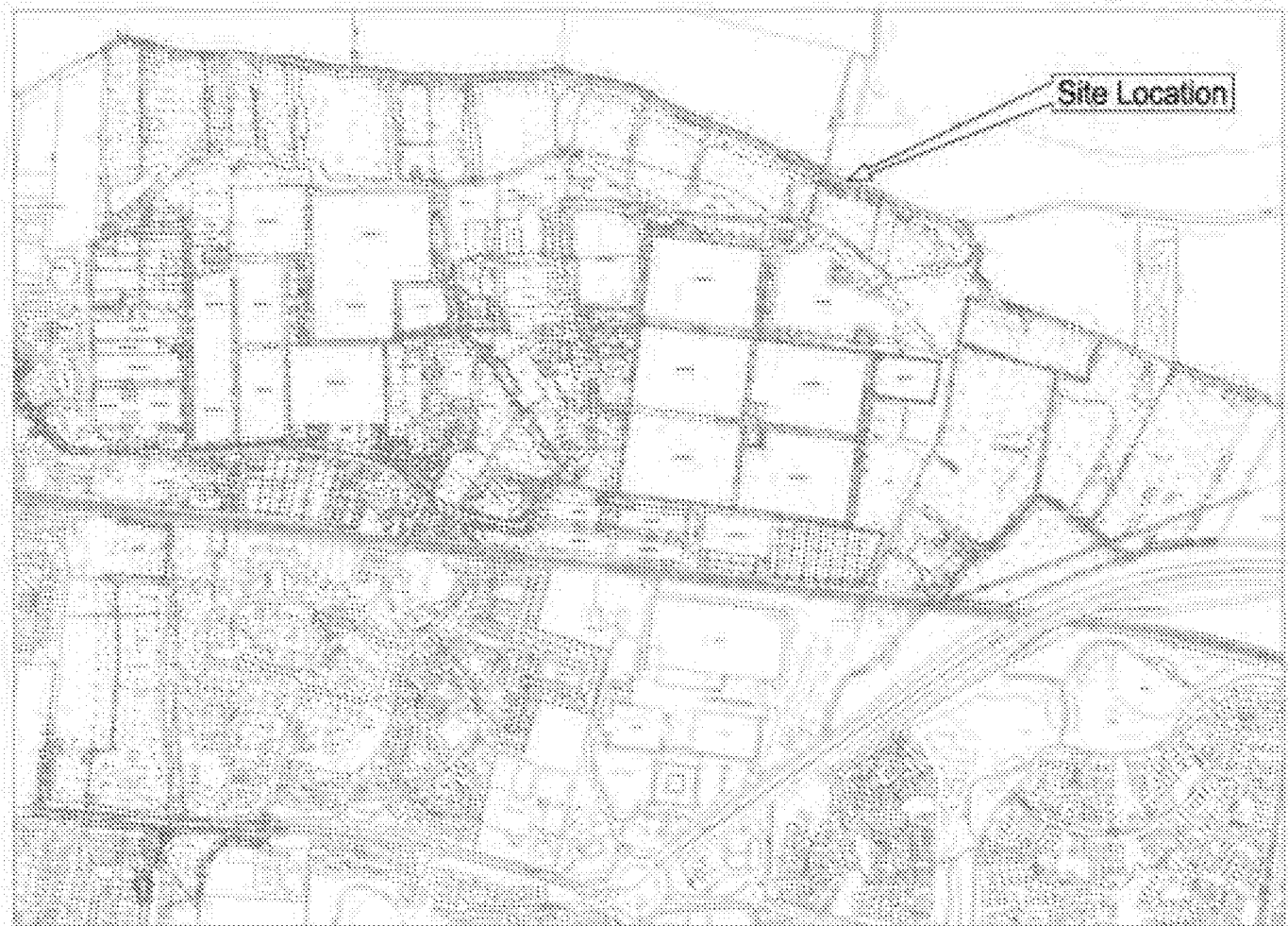
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Plan: NTS



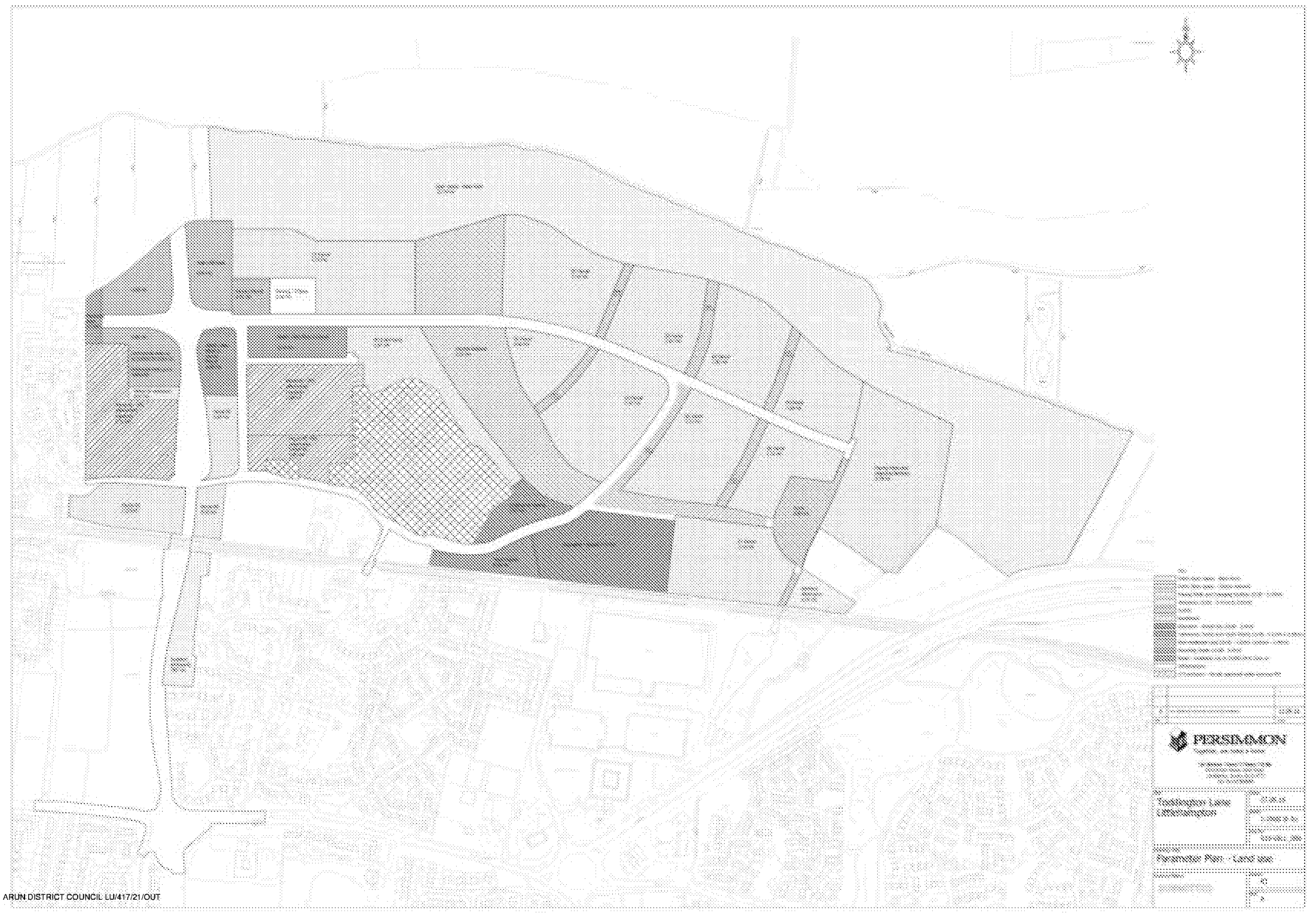
Plan: 1:10000



Glanville
 Commercial House
 80 Foston Road, Dorking
 Surrey, GU11 7AD
 Tel: 01323 815555 Fax: 01323 815556
info@glanville.co.uk www.glanville.co.uk

Project:		Land North of Toddington Lane, Littlehampton		
Title:		Site Location Plan		
Project Engineer:	J. Cliney	Scale:	As Shown/Nil	Drawing No. N/A
Project Director:	A. Rogers	Date:	December 04	

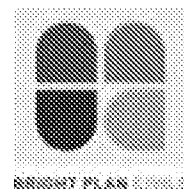
APPENDIX B: Land Uses & Drainage Areas Covered



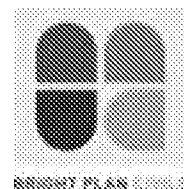
- © 2006 The Authors
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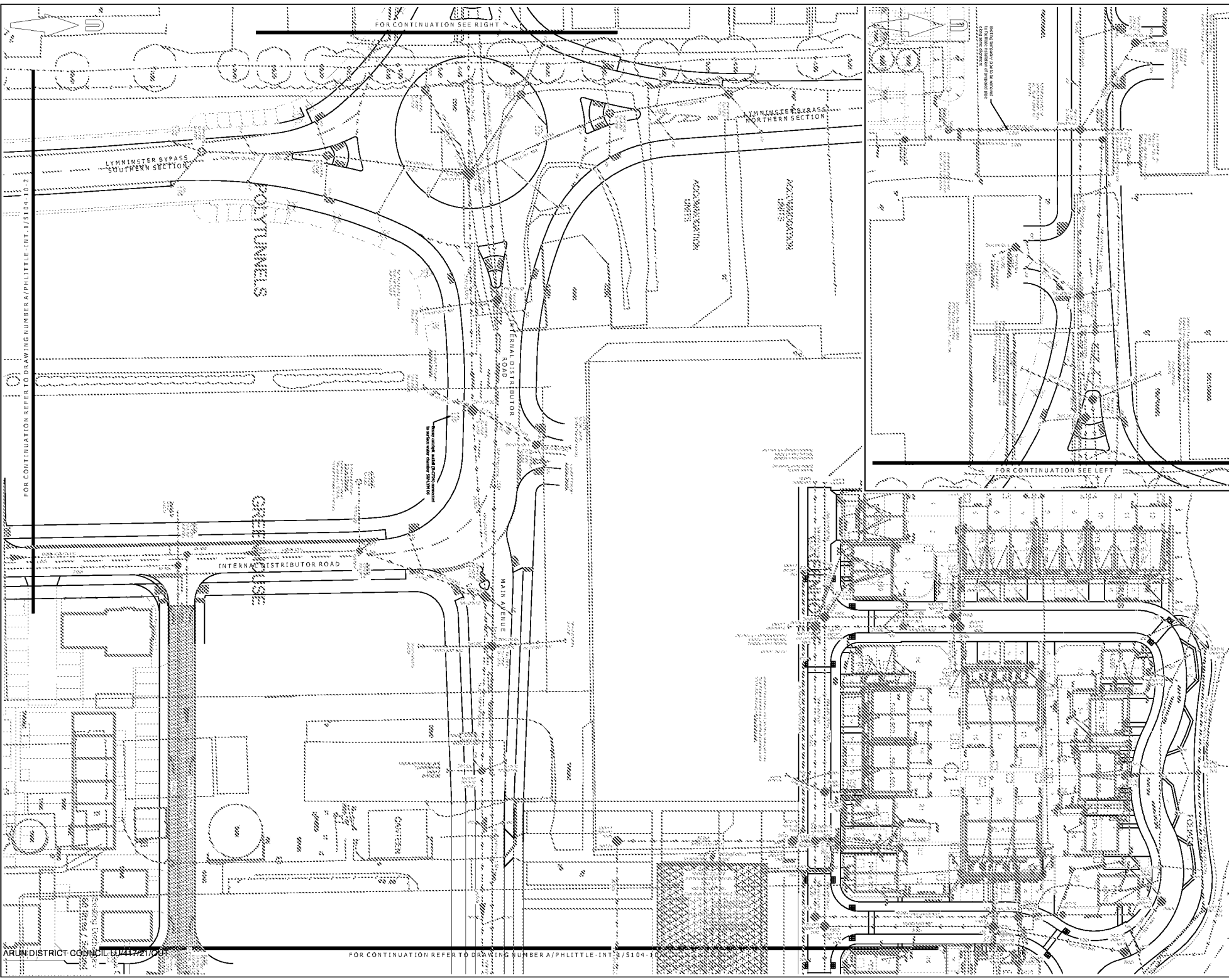
Parameter Not-Used



Appendix C Encompass Surveys Topographical Survey



Appendix D Mayer Brown Construction Issue/As Built Drawings



ARUN DISTRICT COUNCIL 01/4/21/001

FOR CONTINUATION REFER TO DRAWING NUMBER A/PH/LITTLE-INT.10/S104-10-3

FOR CONTINUATION SEE RIGHT

FOR CONTINUATION SEE LEFT

AD ORIGINAL

11/10/2019 10:00:00 AM

KEY

PROPOSED SURFACE WATER SEWER TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED SURFACE WATER MANHOLE CHAMBER TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED SURFACE WATER VORTEX SEPARATOR DOWNSTREAM DISCHARGE CHAMBER TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED SURFACE WATER FLOW CONTROL CHAMBER TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED SURFACE WATER ATTENUATION STRUCTURE TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED SURFACE WATER HEADWALL TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED FLOOD WATER SEWER TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

PROPOSED FLOOD WATER MANHOLE CHAMBER TO BE ADOPTED BY ICCA UNDER S.104 AGREEMENT

SOUTHERN WATER PUMPING STATION

PROPOSED PRIVATE SURFACE WATER SYSTEM

PROPOSED PRIVATE SURFACE WATER FIRM DRAIN

PROPOSED PRIVATE SURFACE WATER PERFORATED PIPE

PROPOSED PRIVATE FLOOD WATER SYSTEM

PROPOSED PERMEABLE SUB-BASE SURROUNDED WITH PERMEABLE GEOTEXTILE, WITHIN PRIVATE LAND

PROPOSED PERMEABLE SUB-BASE SURROUNDED WITH IMPERMEABLE GEOTEXTILE, WITHIN PRIVATE LAND

PROPERTY BOUNDARY

NOTES

1. The drawing is not to be scaled.

2. The drawing is to be read in conjunction with all other relevant engineering and landscaping drawings. Any discrepancies are to be referred to the Engineer immediately for clarification.

3. Proprietary items are to be constructed in accordance with manufacturer recommendations and requirements.

4. All drainage works shall be carried out in accordance with the requirements of all adopting authorities, the Local Authority, the Environment Agency and in conjunction with all relevant drain decisions, Codes of Practice and Schemes for Adopted Drains and any amendments as appropriate.

5. Street lighting shall be installed in all cases where new connections are to be made must be checked and confirmed prior to the commencement of any works.

6. All drainage shall comply with the typical details and the requirements of BS EN 124 and Part 7 of the Building Regulations.

7. All precast concrete units used in the drainage works shall be manufactured using sulphate resisting cement.

8. Manhole covers and frames shall be to BS EN 124 and shall be fabricated the strength classes of covers are shown in the manhole schedule.

9. Cover levels are to be adjusted locally to suit finished ground levels.

REV

DESCRIPTION

DATE

F1

Revised to include (IC)

SL

20/09/2019

F2

Revised to include (IC)

SL

13/10/2019

F3

SLA Draw (IC)

SL

01/05/2019

no.

PROJECT

DATE

DATE

sm3

super urban

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Telephone: 01323 715 300 Fax: 01323 715 301

web: info@superurban.co.uk www.superurban.co.uk

PERKINSON HOMES THAMES VALLEY

PROJECT

NORTH LITTLEHAMPTON

DATE

12/05/2019

BY

JD

FOR

SL

DATE

MARCH 2019

FILE

S104 ICCA.DWG

SECTION 104 DRAINAGE GENERAL ARRANGEMENT

SURFACE AND FLOOD WATER - SHEET 3 OF 4

Drawn By

10/04/2019

Check By

10/04/2019

A/PH/LITTLE-INT.10

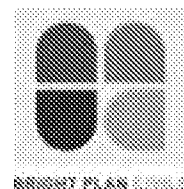
P3

A/PH/LITTLE-INT.10/S104-10-3

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0020	5.05	5.10	100	22.5	CLAY	1	1
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0021B	5.73	6.06	100	22.5	CLAY	1	1
0022	5.07	5.11	100	75.4	CLAY	1	1
0023	6.08	5.08	100	36.0	CLAY	1	1
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0029	6.81	-4.17	225	25.0	CLAY	1	1
0030	6.72	-4.01	225	18.0	CLAY	1	1
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0032B	6.54	5.06	100	75.7	CLAY	1	1
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0191	6.75	5.24	100	36.1	CLAY	1	1
0192	6.75	5.24	100	36.1	CLAY	1	1
0193	6.75	5.24	100	36.1	CLAY	1	1
0194	6.75	5.24	100	36.1	CLAY	1	1
0195	6.75	5.24	100	36.1	CLAY	1	1
0196	6.75	5.24	100	36.1	CLAY	1	1
0197	6.75	5.24	100	36.1	CLAY	1	1
0198	6.75	5.24	100	36.1	CLAY	1	

This detailed site plan illustrates the proposed development at 1000 West 10th Avenue. The plan shows a large rectangular building footprint with a central section and two side wings. To the left of the main building is a large, irregularly shaped area with a cross-hatched pattern, likely representing a parking lot or landscaped area. The plan also shows the surrounding streets: West 10th Avenue to the north, West 11th Avenue to the south, and West 12th Avenue to the east. The plan includes various annotations such as 'PROPOSED DEVELOPMENT', 'EXISTING BUILDING', 'PROPOSED PARKING', and 'PROPOSED LANDSCAPING'. The plan also shows the location of the proposed development relative to the surrounding streets and the existing building footprint.

[illegible]



Appendix E Arun District Council Correspondence

From: Paul Cann
Sent: 12 April 2021 13:18
To: Stuart Burnett
Cc: Kevin Macknay
Subject: RE: D1970 Parcel A and B, Land at Toddington Lane, Littlehampton (BN17 7PH)

Hi Stuart

The Persimmon sites suds strategy was agreed by the EA in circa 2011. It ultimately involved a restricted discharge to the Black Ditch (main river) with each phase incorporating attenuation, etc. There is obviously a strategy document in existence, which I assume you will check to ensure that the land in question is included within it.

Despite the strategy, we are always keen for infiltration to be utilised where possible, although there may be concerns from the EA in respect to any discharge direct into the underlying chalk.

Please note that the climate change allowance (30%) agreed in 2011 falls short of what we expect today, but if 40% can be catered for then that would be positive.

I have also added some comments in red below.

Regards

Paul Cann
Principal Drainage Engineer
Engineering Services



Arun District Council, Civic Centre, Maltravers Rd, Littlehampton, West Sussex, BN17 5LF
www.arun.gov.uk

Sign up to our newsletter [here](#)



From: Stuart Burnett
Sent: 12 April 2021 10:03
To: Kevin Macknay, Paul Cann
Subject: D1970 Parcel A and B, Land at Toddington Lane, Littlehampton (BN17 7PH)

Morning Kevin/Paul,

Hope you're both keeping well.

As you'll probably be aware, Persimmon are working on a development at Toddington Lane, Littlehampton at present. We have been instructed by another client (T&L Crawley No. 2 LLP) to assist with their adjacent development which concerns what they are referring to as 'Parcel A and Parcel B' in terms of preparing a flood risk assessment and drainage strategy for circa 90 No. residential units.

We've been informed that a covenant has been signed with Persimmon to provide drainage infrastructure and services to support this development in addition to the works that Persimmon are

currently undertaking, and I am in the process of understanding what exactly this involves in terms of what Persimmon are providing.

Although our involvement is at a very early stage, given the above arrangement, I am anticipating that the development of Parcels A and B will involve attenuated storage discharging to the piped system(s) that Persimmon have constructed, or are in the process of constructing.

I'm keen to understand whether you have any information relating to flood risk and/or wider drainage issues within the area. As a result, I include below our standard checklist as a guide to hopefully obtain some information which your respective authorities may hold. There's a marginal encroachment of flood zones to the north of the site(s) and I note that we are near Black Ditch here, too. Anything of interest which you may be able to share would be gratefully received.

Thank you as always for your time and assistance.





Flood Zones

- Please confirm the Flood Zones for this area. As you say there is slight encroachment into the site (zone 2/3). Suggest obtaining product 4 data from EA. See also our SFRA with future extents.
- Please confirm surface water, reservoir flooding, sewer flooding. Please provide plans and depth data from your GIS UFMSW for 30yr, 100yr & 1000yr as applicable (OS Datum). See enclosed map.
- Please confirm mapping and records for any surface water assets owned or maintained. None mapped in the vicinity. Obviously there are watercourses beyond the northern boundary (most shown on ordnance survey).
- Please confirm if there are any future drainage improvements proposed for this area. None known.
- Please confirm details of existing or planned flood alleviation and defences in this area. None known.
- Please confirm if you are aware of any historic flooding within the confines of the site. None known.
- Please confirm if you are aware of any historic flooding in close vicinity and/or on the public highway. None known.

Groundwater

- Please confirm details of any groundwater flooding issues in the area, including flood levels, flood extents and any available anecdotal information. None known.

Assets

- Please confirm mapping and records for any surface water assets owned or maintained. See above.
- Please confirm if there are any historic culverted watercourses within or in close vicinity to the site. Please provide map records where available. See above.

- Please can you provide any map records denoting the highway drainage network. Is this a piped system or soakaways? Refer to WSCC.

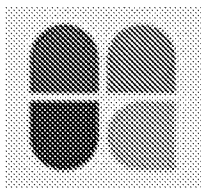
Policy/Future

- Please confirm the most recent Strategic Flood Risk Assessment (SFRA). 2016
- Please confirm if there are any future drainage improvements proposed for this area.
None known.
- Please confirm if any drainage studies and/or SWMP have/are being assess for this area.
None known.

Kind regards,

Stuart Burnett

Engineer



www.bpcivils.co.uk

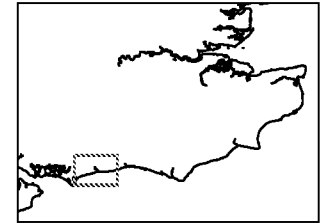
Bright Plan Civils, Transport Planning and Civil Engineering Consultants

Bright Plan Civils, 2 West Barn, Norton Lane, Chichester, PO20 3AF

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Key Plan



Legend

- Arun District SFRA boundary
- Main Rivers
- Aldingbourne Rile
- Ash Grove
- Barnham Lane Ditch
- Barnham Rile
- Black Creek
- Denny Ponds Ditch
- East Posing Drain
- Her Springs Ditch
- Herring Rile
- Fordbridge Rile
- Lidsay Rile
- Little Thurgarton Stream
- North Barnard Coten
- Pagham Harbour Channels
- Pagham Rile
- River Arun
- Rope Walk Ditch
- Ryeham Rile
- Sirdriey Manor Ditch
- West Posing Drain
- Yaphon Rile
- Ordinary watercourse

Rev	Date	Comments
A	June 2016	-



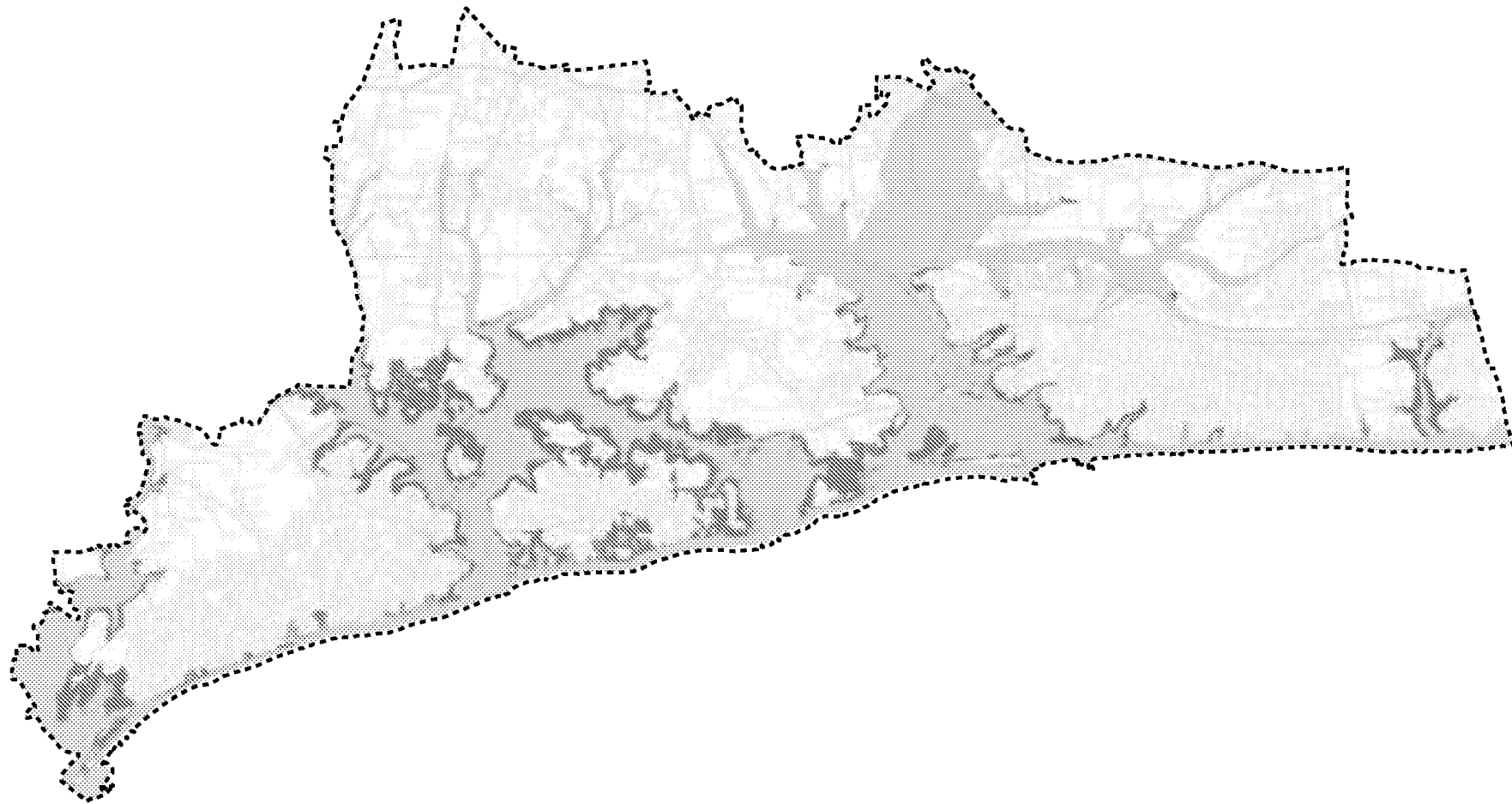
This map is based upon Ordnance Survey aerial photography and other data. It is not a guarantee of accuracy. It is not a substitute for a site visit. It is not a guarantee of accuracy. It is not a substitute for a site visit. It is not a guarantee of accuracy. It is not a substitute for a site visit.

ARUN DISTRICT COUNCIL

SFRA APPENDIX B WATERCOURSES

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hydrologic modeling (two level) uncertain as part of the FEMA to provide upstream climate change flood mapping in the Arun basin for Flood Zone 2. This modeling showed the total reduction for climate change in peak discharge to be 5.6% for the Sarawak river in February 2010 (and occurred in April 2010). Climate change for flood events had been twice in the higher tropical latitudes for the years 1970, 2001 and 2011. Present day flood risk information is available for comparison. Arun District is within the South East River Basin (SEAB) and the upstream subbasins are:

- 2001 = +15% flows
- 2001 = +26% flows
- 2011 = +42% flows

For freshwater models, unflooded areas will water level and dewatered areas will water level with some overlapping situations have been compiled to inform future flood risk within the Arun District. Again, climate change allowances provisions are for the years 2031, 2064 and 2111, with pressure day metrics for comparison.

 Arun District SFRA boundary
 Present Flood Zone 3a
 Future Flood Zone 3a (2031)
 Future Flood Zone 3a (2051)
 Future Flood Zone 3a (2111)

REF	Date	Comments
A	August 2015	-

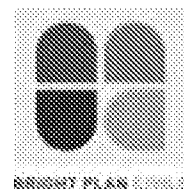


714. <http://www.irs.gov/efile/efiletrans.htm> 1997-98, 1998-99, and 1999-00. Downloaded on 10/24/01. See <http://www.irs.gov/efile/efiletrans.htm> for information on the e-file system.

SPRA APPENDIX D
CLIMATE CHANGE MAPPING

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Appendix F West Sussex County Council Correspondence

From: Kevin Macknay
Sent: 12 April 2021 13:17
To: Stuart Burnett [REDACTED] Paul Cann' <Paul.Cann@arun.gov.uk>
Subject: RE: D1970 Parcel A and B, Land at Toddington Lane, Littlehampton (BN17 7PH)

Stuart,

Please see my comments below.

Clearly this site is currently a major construction site, with the new Lyminster bypass running adjacent to your proposed development site. It is therefore likely that flood zone boundaries and surface water flow routes, within and adjacent to the site, may have changed due to earth movements and this should be considered during your design.

Regards,

Kevin

Kevin Macknay
Flood Risk Management – Team Leader
Highways, Transport and Planning
Place Services
West Sussex County Council
[REDACTED]

Location: Western Area Office, Drayton Lane, Nr. Chichester, West Sussex. PO20 2AL

[Report a problem with a road or pavement or raise a highways related enquiry](#)

Follow us at  [@WSHighways](#)

From: Stuart Burnett
Sent: 12 April 2021 10:03
To: Kevin Macknay, Paul Cann
Subject: D1970 Parcel A and B, Land at Toddington Lane, Littlehampton (BN17 7PH)

Morning Kevin/Paul,

Hope you're both keeping well.

As you'll probably be aware, Persimmon are working on a development at Toddington Lane, Littlehampton at present. We have been instructed by another client (T&L Crawley No. 2 LLP) to assist with their adjacent development which concerns what they are referring to as 'Parcel A and Parcel B' in terms of preparing a flood risk assessment and drainage strategy for circa 90 No. residential units.

We've been informed that a covenant has been signed with Persimmon to provide drainage infrastructure and services to support this development in addition to the works that Persimmon are currently undertaking, and I am in the process of understanding what exactly this involves in terms of what Persimmon are providing.

Although our involvement is at a very early stage, given the above arrangement, I am anticipating that the development of Parcels A and B will involve attenuated storage discharging to the piped system(s) that Persimmon have constructed, or are in the process of constructing.

I'm keen to understand whether you have any information relating to flood risk and/or wider drainage issues within the area. As a result, I include below our standard checklist as a guide to hopefully obtain some information which your respective authorities may hold. There's a marginal encroachment of flood zones to the north of the site(s) and I note that we are near Black Ditch here, too. Anything of interest which you may be able to share would be gratefully received.

Thank you as always for your time and assistance.





Flood Zones

- Please confirm the Flood Zones for this area.
Proposed development site 'B' has the EA's Flood Zones 2 and 3, from the Black Ditch, running adjacent to the sites norther boundary. See attached plan.
- Please confirm surface water, reservoir flooding, sewer flooding. Please provide plans and depth data from your GIS UFMSW for 30yr, 100yr & 1000yr as applicable (OS Datum).
The proposed development site is at limited risk of surface water flooding based on the current mapping for 1 in 30 and 1 in 100 storm events. See attached plan.
- Please confirm mapping and records for any surface water assets owned or maintained.
Our current mapping does not show any surface water assets owned or maintained by WSCC in this area.
- Please confirm if there are any future drainage improvements proposed for this area.
None that we are aware of. However, see comment above re. the current major development adjacent to the site.
- Please confirm details of existing or planned flood alleviation and defences in this area.
None that we are aware of.
- Please confirm if you are aware of any historic flooding within the confines of the site.
None that we are aware of. Given that the site was once 'greenhouses', much of the surface water may have been collected for irrigation.
- Please confirm if you are aware of any historic flooding in close vicinity and/or on the public highway.
None that we are aware of. We are aware that major changes have been made to the existing road layout and drainage as part of the on-going development. This may need to be considered.

Groundwater

- Please confirm details of any groundwater flooding issues in the area, including flood levels, flood extents and any available anecdotal information.
The area is shown to be at 'moderate' to 'high' risk of groundwater flooding. With ground water along the northern boundary being at or near to the surface during a 1in100 year event.

Assets

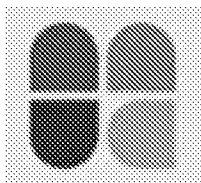
- Please confirm mapping and records for any surface water assets owned or maintained.
Our current mapping does not show any surface water assets owned or maintained by WSCC in this area.
- Please confirm if there are any historic culverted watercourses within or in close vicinity to the site. Please provide map records where available.
Historic mapping does not show any historic culverted watercourses within the proposed development site. Historic watercourse are shown running along the northern boundary of site 'B'.
- Please can you provide any map records denoting the highway drainage network. Is this a piped system or soakaways?
We are aware that major changes have been made to the existing road layout and drainage as part of the on-going development. You may wish to connect WSCC Highways Adoption Team for details.

Policy/Future

- Please confirm the most recent Strategic Flood Risk Assessment (SFRA).
WSCC January 2010.
- Please confirm if there are any future drainage improvements proposed for this area.
None that we are aware of.
- Please confirm if any drainage studies and/or SWMP have/are being assess for this area.
None that we are aware of.

Kind regards,

Stuart Burnett
Engineer



www.bpcivils.co.uk

Bright Plan Civils, Transport Planning and Civil Engineering Consultants

Bright Plan Civils, 2 West Barn, Norton Lane, Chichester, PO20 3AF





MILL LANE

FULLERS WALK



Appendix G Environment Agency Correspondence

Stuart Burnett
Bright Plan Civils

Our ref: SSD216226
Date: 13/05/2021

Dear Stuart Burnett,

Enquiry Regarding Product 4 for a Flood Risk Assessment for Toddington Lane, Littlehampton, BN17 7PH.

Thank you for your enquiry which was received on 12 April 2021.

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 1, 2 & 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 found at [w](#)

Flood Defences

There are no formal raised flood defences in the vicinity of the site.

Model Information

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

Flood History

We hold no record of previous flooding events affecting this 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 Toddington Lane, Littlehampton, BN17 7PH.
Licence	Open Government Licence
Information Warnings	Climate Change allowances for this fluvial element of the model only show the superseded 20% increase in flows. The current allowances should be checked here:  The tidal flood risk data provided is based on existing EA hydraulic models for existing 0.5% annual probability events with an allowance for climate change. Please note the climate change allowances provided are not up to date. These were updated on 17 December 2019. You should refer to 'Flood risk assessments: climate change allowances' for the most up to date allowances. You will need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.
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 2021 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.

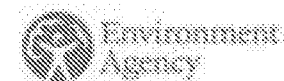
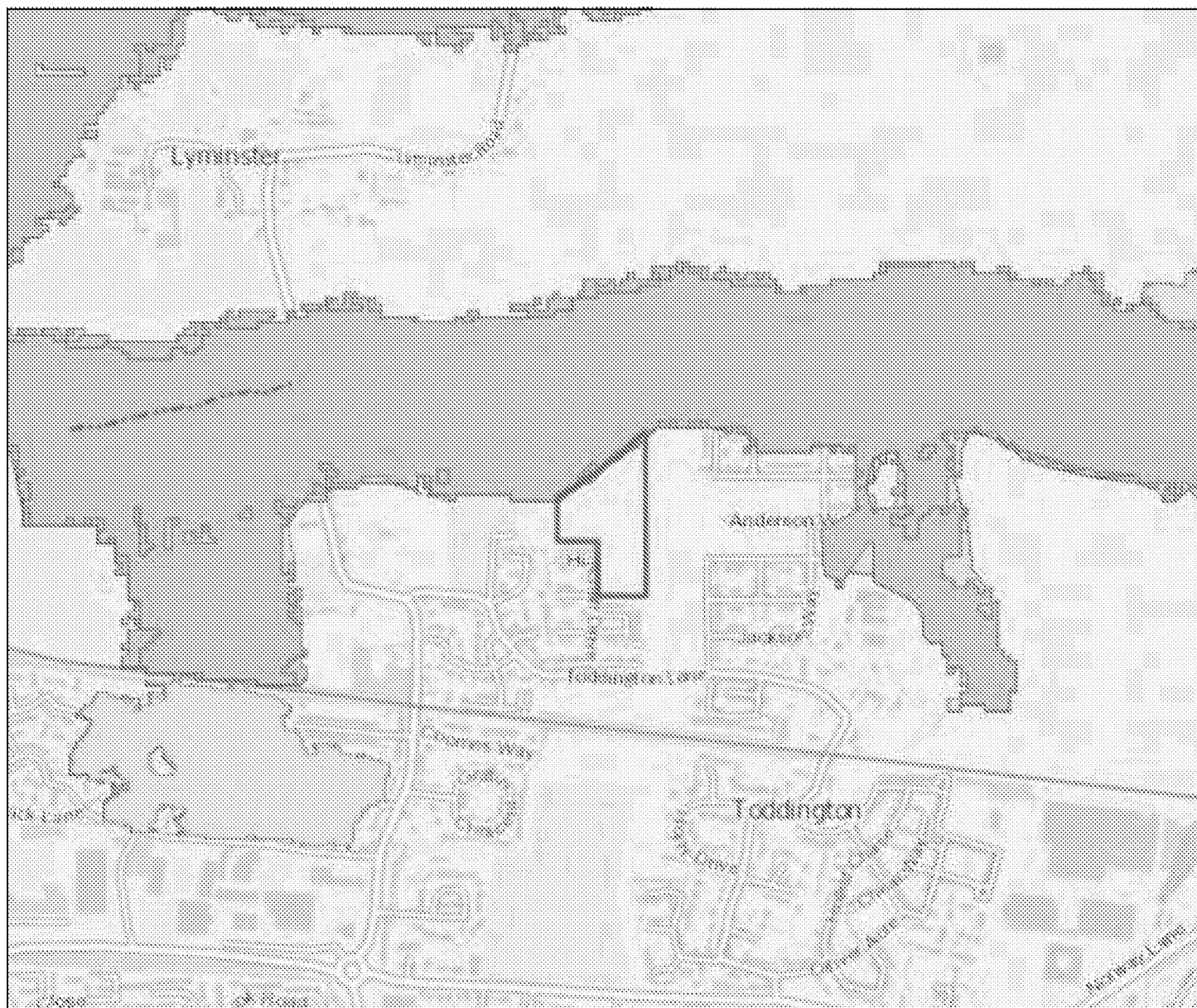
Yours sincerely,

Tom Lamboo

FCRM Officer, Partnership & Strategic Overview West Sussex, Solent and South Downs

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

Flood Map for Planning (Rivers and Sea). Centred BN17 7PH. Created 13/05/2021.



1: 10,000

0 Metres 250



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 occurring each year.

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Environment
Agency

N



Legend

 Site_Nodes

 Site_Boundary

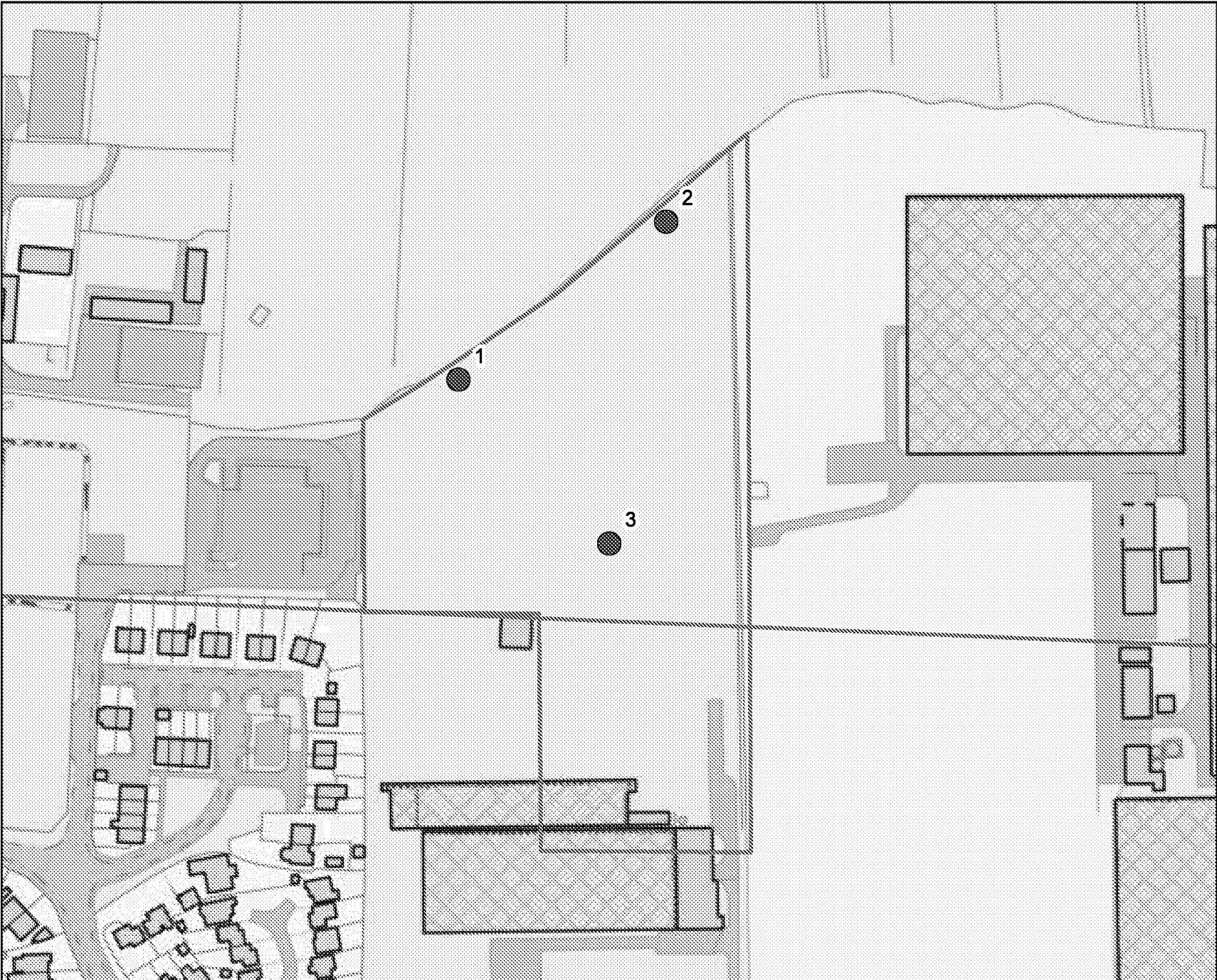
Scale: 1:2,000

0

0.045

0.09

Kilometers



Product 4 Flood Risk Data Requested by: Bright Plan Civils
Site: Land at Toddington Lane, Littlehampton, BN17 7PH

Table 1: Water Levels: Fluvial Undefended

Node Ref	NGR		Modelled Flood Levels in Metres AOD			
	Eastings	Northings	Undefended Annual Exceedance Probability			
			5%	1%	1% +CC*	0.1%
1	503015	104225	2.17	2.22	2.90	2.47
2	503092	104284	2.17	2.22	2.90	2.47
3	503071	104164	-	-	-	-

Table 2: Water Levels: Fluvial Defended

Node Ref	NGR		Modelled Flood Levels in Metres AOD			
	Eastings	Northings	Defended Annual Exceedance Probability			
			5%	1%	1% +CC*	0.1%
1	503015	104225	1.58	1.73	1.82	2.38
2	503092	104284	1.58	1.73	1.82	2.38
3	503071	104164	-	-	-	-

Table 3: Water Levels: Tidal Undefended

Node Ref	NGR		Modelled Flood Levels in Metres AOD		
	Eastings	Northings	Undefended Annual Exceedance Probability		
			0.5%	0.5% (2110)**	0.1%
1	503015	104225	2.48	2.99	2.51
2	503092	104284	2.48	2.99	2.51
3	503071	104164	-	-	-

Table 4: Water Levels: Tidal Defended

Node Ref	NGR		Modelled Flood Levels in Metres AOD		
	Eastings	Northings	Defended Annual Exceedance Probability		
			0.5%	0.5% (2110)**	0.1%
1	503015	104225	-	3.13	-
2	503092	104284	-	3.13	-
3	503071	104164	-	-	-

Table 5: Water Depths: Fluvial Undefended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Undefended Annual Exceedance Probability			
	Eastings	Northings	5%	1%	1% +CC*	0.1%
1	503015	104225	0.12	0.17	0.85	0.43
2	503092	104284	0.42	0.47	1.15	0.72
3	503071	104164	-	-	-	-

Table 6: Water Depths: Fluvial Defended

Node Ref	NGR		Modelled Flood Depths in Metres			
			Defended Annual Exceedance Probability			
	Eastings	Northings	5%	1%	1% +CC*	0.1%
1	503015	104225	0.01	0.01	0.08	0.40
2	503092	104284	0.24	0.40	0.48	1.06
3	503071	104164	-	-	-	-

Table 7: Water Depths: Tidal Undefended

Node Ref	NGR		Modelled Flood Depths in Metres		
			Undefended Annual Exceedance Probability		
	Eastings	Northings	0.5%	0.5% (2110)**	0.1%
1	503015	104225	0.43	0.94	0.46
2	503092	104284	0.73	1.24	0.76
3	503071	104164	-	-	-

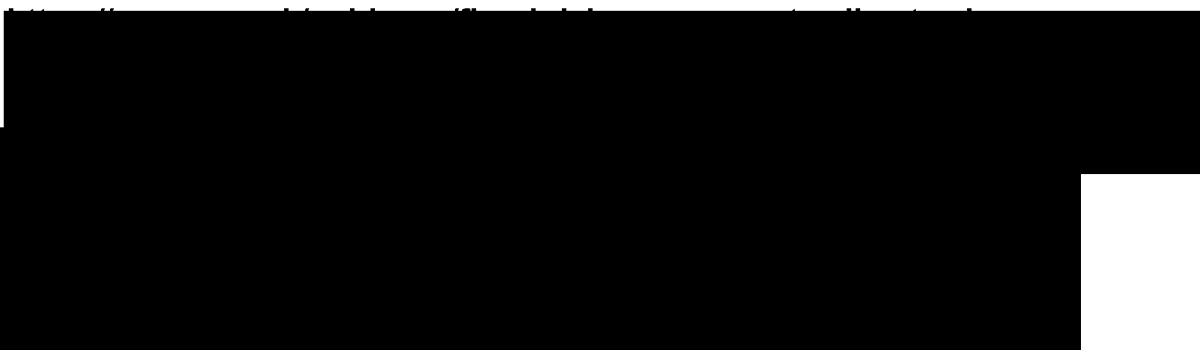
Table 8: Water Depths: Tidal Defended

Node Ref	NGR		Modelled Flood Depths in Metres		
			Defended Annual Exceedance Probability		
	Eastings	Northings	0.5%	0.5% (2110)**	0.1%
1	503015	104225	-	1.07	-
2	503092	104284	-	1.37	-
3	503071	104164	-	-	-

All levels taken from: Lower Tidal River Arun Strategy

Produced on: 13/05/2021

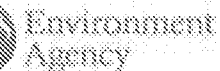
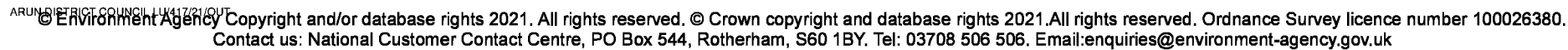
*** Climate Change allowances for this model only show the superseded 20% increase in fluvial flows. The current allowances should be checked here:**



**** The tidal flood risk data provided is based on existing EA hydraulic models for existing 0.5% annual probability events with an allowance for climate change. Please note the climate change allowances provided are not up to date. These were updated on 17 December 2019.**

You should refer to [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/424444/Climate-change-allowances-for-flood-risk-assessment-2019.pdf](#) for the most up to date allowances. You will need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.

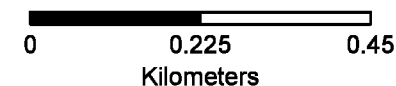
There is no additional information or health warnings for these levels/depths or the model from which they have been produced.



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

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

Scale: 1:10,000





Environment
Agency



N

Legend

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

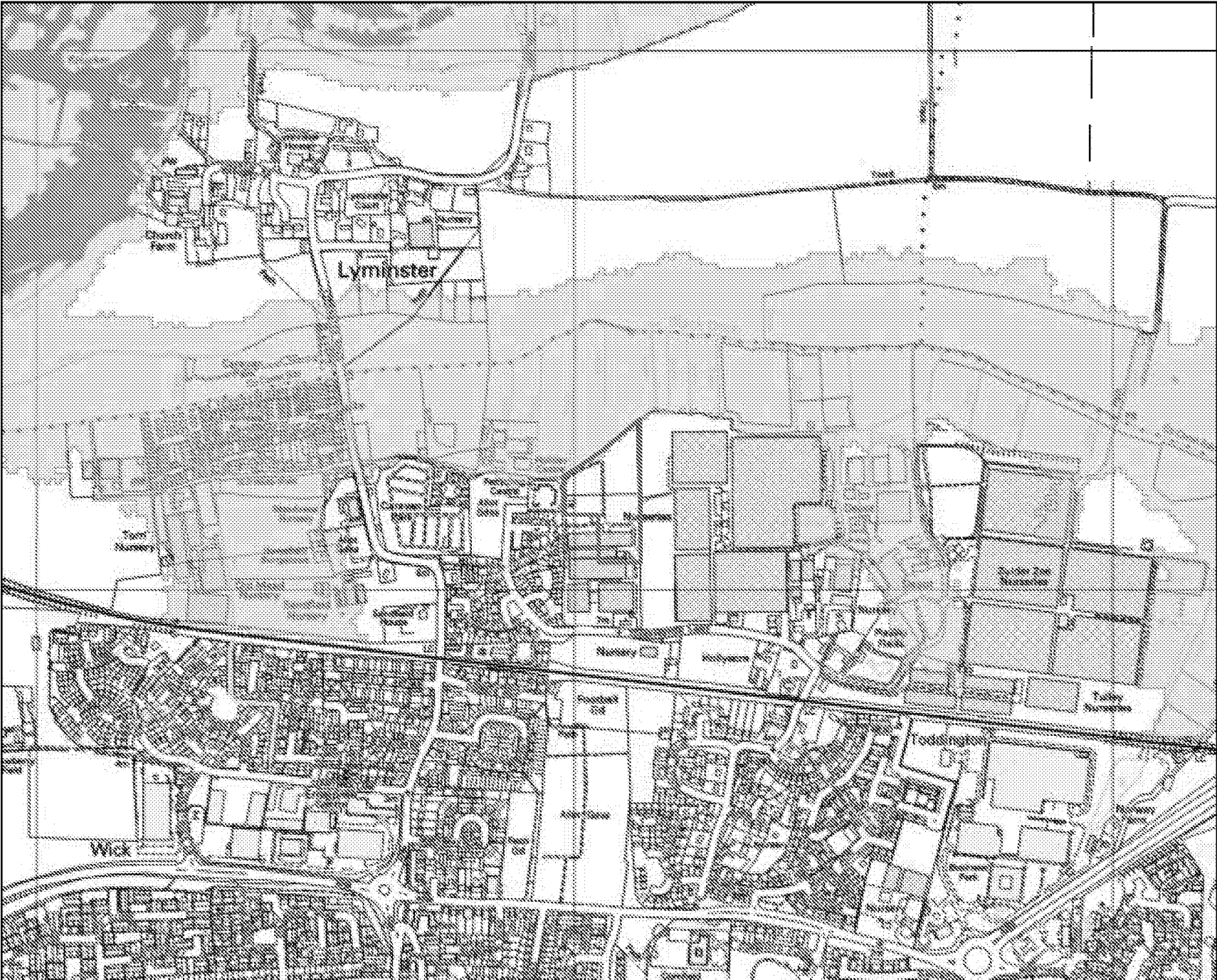
Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occurring in any given year.

Scale: 1:10,000



00.2250.45

Kilometers





Environment
Agency

N



Legend

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

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

Scale: 1:10,000

00.2250.45

Kilometers





Environment
Agency

N



Legend

Site_Boundary

0.5% AEP (Un defended Tidal)

0.5% AEP (2110) (Un defended Tidal)

0.1% AEP (Un defended Tidal)

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

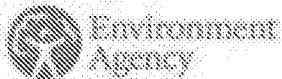
Scale: 1:10,000

00.2250.45

Kilometers



Risk of flooding from Surface Water. Centred BN17 7PH. Created 13/05/2021.



1: 10.000

0 Metres 250



Likelihood of flooding from Surface Water

-  High (>2.3%)
 Medium (2.3% - 1%)
 Low (1% - 0.1%)
 Very Low
 Flood Extent 1 in 30
 Flood Extent 1 in 100
 Flood Extent 1 in 1000

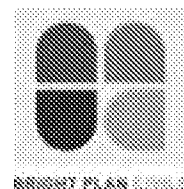
Likelihood of flooding from Surface Water

- | | |
|-----------|---|
| 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 |

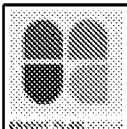
This information is shown on the Risk of Flooding from Surface Water map on GOV.UK.

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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



Appendix H Causeway Flow Hydraulic Calculations (Site A)



Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	250.0
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	1.500
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

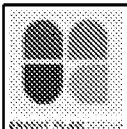
Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
13	0.021	5.00	7.050	1200	503068.235	104079.932	0.560
12	0.049	5.00	7.025	1200	503073.235	104079.932	1.350
14	0.043	5.00	7.200	1200	503088.226	104070.191	0.560
11	0.051	5.00	7.000	1200	503088.226	104079.928	1.425
8	0.014	5.00	6.700	1200	503088.261	104112.691	0.560
9	0.015	5.00	6.850	1200	503093.261	104107.691	0.560
10	0.007	5.00	6.825	1200	503084.725	104104.156	0.560
7	0.076	5.00	6.725	1200	503088.261	104107.691	1.335
5	0.013	5.00	6.700	1200	503061.759	104107.691	0.560
6		5.00	6.825	1200	503066.759	104102.691	2.825
4	0.039	5.00	6.675	1200	503066.759	104107.691	2.692
18	0.010	5.00	5.600	1200	503010.056	104158.108	0.560
17	0.010	5.00	5.500	1200	503010.056	104163.108	1.050
16	0.009	5.00	6.200	1200	503057.025	104158.108	0.560
15	0.020	5.00	6.150	1200	503057.025	104163.108	2.013
3	0.027	5.00	5.900	1200	503063.224	104153.039	0.560
2	0.071	5.00	5.850	1200	503066.759	104156.575	2.310
1			6.270	1200	503076.230	104170.011	2.872

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	13	12	5.000	0.600	6.490	6.457	0.033	150.0	150	5.10	162.7
1.001	12	11	14.991	0.600	5.675	5.575	0.100	150.0	225	5.34	160.0
3.000	14	11	9.737	0.600	6.640	6.575	0.065	150.0	150	5.20	161.6
1.002	11	7	27.763	0.600	5.575	5.390	0.185	150.0	225	5.77	155.3
4.000	8	7	5.000	0.600	6.140	6.107	0.033	150.0	150	5.10	162.7
5.000	9	7	5.000	0.600	6.290	6.257	0.033	150.0	150	5.10	162.7
6.000	10	7	5.000	0.600	6.265	6.232	0.033	150.0	150	5.10	162.7

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	0.818	14.5	17.3	0.410	0.418	0.021	0.0
1.001	1.065	42.3	56.7	1.125	1.200	0.070	0.0
3.000	0.818	14.5	35.2	0.410	0.275	0.043	0.0
1.002	1.065	42.3	128.9	1.200	1.110	0.164	0.0
4.000	0.818	14.5	11.5	0.410	0.468	0.014	0.0
5.000	0.818	14.5	12.3	0.410	0.318	0.015	0.0
6.000	0.818	14.5	5.8	0.410	0.343	0.007	0.0



Links

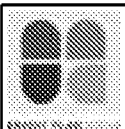
Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.003	7	4	21.502	0.600	5.390	3.983	1.407	15.3	225	5.88	154.3
10.000	5	4	5.000	0.600	6.140	6.107	0.033	150.0	150	5.10	162.7
11.000	6	4	5.000	0.600	4.000	3.983	0.017	300.0	225	5.11	162.6
1.004	4	2	48.884	0.600	3.983	3.540	0.443	110.3	225	6.53	147.9
14.000	18	17	5.000	0.600	5.040	5.007	0.033	150.0	150	5.10	162.7
14.001	17	15	46.969	0.600	4.450	4.137	0.313	150.0	150	6.06	152.4
16.000	16	15	5.000	0.600	5.640	5.607	0.033	150.0	150	5.10	162.7
14.002	15	2	11.723	0.600	4.137	4.059	0.078	150.0	150	6.30	150.1
18.000	3	2	5.000	0.600	5.340	5.307	0.033	150.0	150	5.10	162.7
1.005	2	1	16.439	0.600	3.540	3.398	0.142	115.8	225	6.76	145.9

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.003	3.364	133.7	215.4	1.110	2.467	0.276	0.0
10.000	0.818	14.5	10.7	0.410	0.418	0.013	0.0
11.000	0.750	29.8	0.0	2.600	2.467	0.000	0.0
1.004	1.244	49.5	245.5	2.467	2.085	0.328	0.0
14.000	0.818	14.5	8.2	0.410	0.343	0.010	0.0
14.001	0.818	14.5	15.4	0.900	1.863	0.020	0.0
16.000	0.818	14.5	7.4	0.410	0.393	0.009	0.0
14.002	0.818	14.5	37.2	1.863	1.641	0.049	0.0
18.000	0.818	14.5	22.2	0.410	0.393	0.027	0.0
1.005	1.214	48.3	350.6	2.085	2.647	0.475	0.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	5.000	150.0	150	Circular	7.050	6.490	0.410	7.025	6.457	0.418
1.001	14.991	150.0	225	Circular	7.025	5.675	1.125	7.000	5.575	1.200
3.000	9.737	150.0	150	Circular	7.200	6.640	0.410	7.000	6.575	0.275
1.002	27.763	150.0	225	Circular	7.000	5.575	1.200	6.725	5.390	1.110
4.000	5.000	150.0	150	Circular	6.700	6.140	0.410	6.725	6.107	0.468
5.000	5.000	150.0	150	Circular	6.850	6.290	0.410	6.725	6.257	0.318
6.000	5.000	150.0	150	Circular	6.825	6.265	0.410	6.725	6.232	0.343
1.003	21.502	15.3	225	Circular	6.725	5.390	1.110	6.675	3.983	2.467
10.000	5.000	150.0	150	Circular	6.700	6.140	0.410	6.675	6.107	0.418
11.000	5.000	300.0	225	Circular	6.825	4.000	2.600	6.675	3.983	2.467

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	13	1200	Junction		12	1200	Manhole	Adoptable
1.001	12	1200	Manhole	Adoptable	11	1200	Manhole	Adoptable
3.000	14	1200	Junction		11	1200	Manhole	Adoptable
1.002	11	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
4.000	8	1200	Junction		7	1200	Manhole	Adoptable
5.000	9	1200	Junction		7	1200	Manhole	Adoptable
6.000	10	1200	Junction		7	1200	Manhole	Adoptable
1.003	7	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
10.000	5	1200	Junction		4	1200	Manhole	Adoptable
11.000	6	1200	Junction		4	1200	Manhole	Adoptable

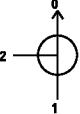


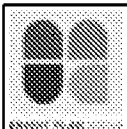
Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.004	48.884	110.3	225	Circular	6.675	3.983	2.467	5.850	3.540	2.085
14.000	5.000	150.0	150	Circular	5.600	5.040	0.410	5.500	5.007	0.343
14.001	46.969	150.0	150	Circular	5.500	4.450	0.900	6.150	4.137	1.863
16.000	5.000	150.0	150	Circular	6.200	5.640	0.410	6.150	5.607	0.393
14.002	11.723	150.0	150	Circular	6.150	4.137	1.863	5.850	4.059	1.641
18.000	5.000	150.0	150	Circular	5.900	5.340	0.410	5.850	5.307	0.393
1.005	16.439	115.8	225	Circular	5.850	3.540	2.085	6.270	3.398	2.647

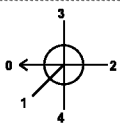
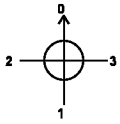
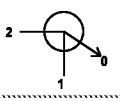
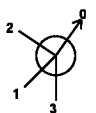
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.004	4	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
14.000	18	1200	Junction		17	1200	Manhole	Adoptable
14.001	17	1200	Manhole	Adoptable	15	1200	Manhole	Adoptable
16.000	16	1200	Junction		15	1200	Manhole	Adoptable
14.002	15	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
18.000	3	1200	Junction		2	1200	Manhole	Adoptable
1.005	2	1200	Manhole	Adoptable	1	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
13	503068.235	104079.932	7.050	0.560	1200				
							0	1.000	6.490
12	503073.235	104079.932	7.025	1.350	1200		1	1.000	6.457
							0	1.001	5.675
14	503088.226	104070.191	7.200	0.560	1200				
							0	3.000	6.640
11	503088.226	104079.928	7.000	1.425	1200		1	3.000	6.575
							2	1.001	5.575
							0	1.002	5.575
8	503088.261	104112.691	6.700	0.560	1200				
							0	4.000	6.140
9	503093.261	104107.691	6.850	0.560	1200				
							0	5.000	6.290
10	503084.725	104104.156	6.825	0.560	1200				
							0	6.000	6.265



Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
7	503088.261	104107.691	6.725	1.335	1200		1 2 3 4 0	6.000 6.232 6.257 6.107 5.390 5.390	150 150 150 225 225
5	503061.759	104107.691	6.700	0.560	1200		0	10.000	6.140 150
6	503066.759	104102.691	6.825	2.825	1200		0	11.000	4.000 225
4	503066.759	104107.691	6.675	2.692	1200		1 2 3 0	11.000 3.983 6.107 3.983 3.983	225 150 225 225
18	503010.056	104158.108	5.600	0.560	1200		0	14.000	5.040 150
17	503010.056	104163.108	5.500	1.050	1200		1 0	14.000 14.001	5.007 4.450 150
16	503057.025	104158.108	6.200	0.560	1200		0	16.000	5.640 150
15	503057.025	104163.108	6.150	2.013	1200		1 2 0	16.000 5.607 4.137 4.137	150 150 150
3	503063.224	104153.039	5.900	0.560	1200		0	18.000	5.340 150
2	503066.759	104156.575	5.850	2.310	1200		1 2 3 0	18.000 5.307 4.059 3.540 3.540	150 150 225 225
1	503076.230	104170.011	6.270	2.872	1200		1	1.005	3.398 225

Simulation Settings

Rainfall Methodology FSR
FSR Region England and Wales
M5-60 (mm) 20.000
Ratio-R 0.400
Summer CV 1.000

Winter CV 1.000
Analysis Speed Normal
Skip Steady State x
Drain Down Time (mins) 240
Additional Storage (m³/ha) 20.0

Simulation Settings

Check Discharge Rate(s) x Check Discharge Volume x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	40	10	0

Node 2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	3.540	Product Number	CTL-SHE-0089-5000-2310-5000
Design Depth (m)	2.310	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node 15 Online Orifice Control

Flap Valve	✓	Invert Level (m)	4.137	Discharge Coefficient	0.600
Replaces Downstream Link	x	Diameter (m)	0.150		

Node 13 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	6.490	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	6	Depth (m)	0.450
Safety Factor	1.0	Width (m)	5.500	Inf Depth (m)	
Porosity	0.32	Length (m)	38.545		

Node 14 Carpark Storage Structure

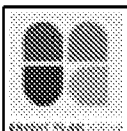
Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	6.640	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	2	Depth (m)	0.450
Safety Factor	1.0	Width (m)	43.200	Inf Depth (m)	
Porosity	0.32	Length (m)	10.000		

Node 9 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	6.290	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.450
Safety Factor	1.0	Width (m)	5.500	Inf Depth (m)	
Porosity	0.32	Length (m)	27.273		

Node 10 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	6.265	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.450
Safety Factor	1.0	Width (m)	12.545	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		



Node 8 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	6.140	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	4	Depth (m)	0.450
Safety Factor	1.0	Width (m)	25.091	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		

Node 5 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	6.140	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.450
Safety Factor	1.0	Width (m)	23.818	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		

Node 3 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.340	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	3	Depth (m)	0.450
Safety Factor	1.0	Width (m)	49.636	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		

Node 18 Carpark Storage Structure

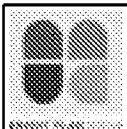
Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.040	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	17	Depth (m)	0.450
Safety Factor	1.0	Width (m)	17.636	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		

Node 16 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.640	Slope (1:X)	65.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.450
Safety Factor	1.0	Width (m)	15.818	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		

Node 6 Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	4.000	Depth (m)	1.200
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Inf Depth (m)	
Safety Factor	1.0	Pit Width (m)	11.000	Number Required	1
Porosity	0.95	Pit Length (m)	30.000		

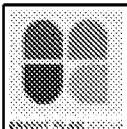


Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.98%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	13	13	6.888	0.398	37.2	7.2367	0.0000	FLOOD RISK
15 minute summer	12	12	6.872	1.197	43.6	2.3098	0.0000	FLOOD RISK
15 minute summer	14	14	6.812	0.172	45.0	13.4599	0.0000	SURCHARGED
15 minute summer	11	11	6.809	1.234	76.1	2.3676	0.0000	FLOOD RISK
15 minute summer	8	13	6.357	0.217	34.7	7.8433	0.0000	SURCHARGED
15 minute summer	9	12	6.402	0.112	13.2	0.7945	0.0000	OK
15 minute summer	10	12	6.379	0.114	9.0	1.6222	0.0000	OK
15 minute summer	7	12	6.374	0.984	137.0	2.3441	0.0000	SURCHARGED
15 minute summer	5	12	6.223	0.083	11.4	1.7507	0.0000	OK
480 minute winter	6	472	5.156	1.156	37.8	362.5520	0.0000	SURCHARGED
30 minute summer	4	19	5.188	1.205	193.3	1.7474	0.0000	SURCHARGED
60 minute summer	18	42	5.418	0.378	22.0	10.5800	0.0000	FLOOD RISK
60 minute summer	17	41	5.417	0.967	17.1	1.2958	0.0000	FLOOD RISK
15 minute summer	16	12	5.713	0.073	7.9	0.9012	0.0000	OK
15 minute summer	15	11	5.617	1.480	22.9	1.9985	0.0000	SURCHARGED
15 minute summer	3	13	5.506	0.166	45.5	10.9469	0.0000	SURCHARGED
15 minute summer	2	11	5.538	1.998	69.9	3.6111	0.0000	SURCHARGED
15 minute summer	1	1	3.398	0.000	4.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	13	1.000	12	28.3	1.610	1.961	0.0880	
15 minute summer	12	1.001	11	38.5	0.968	0.909	0.5962	
15 minute summer	14	3.000	11	17.5	1.007	1.208	0.1714	
15 minute summer	11	1.002	7	65.1	1.638	1.539	1.1042	
15 minute summer	8	4.000	7	-22.4	-1.312	-1.552	0.0880	
15 minute summer	9	5.000	7	11.5	0.881	0.799	0.0721	
15 minute summer	10	6.000	7	9.5	0.827	0.655	0.0791	
15 minute summer	7	1.003	4	113.5	2.854	0.848	0.8552	
15 minute summer	5	10.000	4	7.9	0.813	0.545	0.0485	
480 minute winter	6	11.000	4	-37.8	-0.951	-1.268	0.1989	
30 minute summer	4	1.004	2	-44.8	-1.126	-0.905	1.9442	
60 minute summer	18	14.000	17	-16.1	-0.920	-1.117	0.0880	
60 minute summer	17	14.001	15	-11.2	-0.636	-0.774	0.8269	
15 minute summer	16	16.000	15	6.4	0.772	0.440	0.0412	
15 minute summer	15	14.002	2	17.6	0.999	1.216	0.2064	
15 minute summer	3	18.000	2	-21.8	-1.315	-1.505	0.0880	
15 minute summer	2	Hydro-Brake®	1	4.7				50.5

Appendix I Causeway Flow Hydraulic Calculations (Site B)



Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	250.0
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	1.500
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

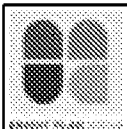
Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
6	0.007	5.00	6.300		503081.431	104255.058	0.560
5	0.024	5.00	6.300	1200	503076.431	104255.058	1.350
8	0.012	5.00	6.050		503071.431	104216.894	0.560
7	0.012	5.00	6.050		503081.431	104216.894	0.560
4	0.066	5.00	6.050	1200	503076.431	104216.894	1.354
9	0.032	5.00	6.000	1200	503067.106	104189.011	0.560
3	0.060	5.00	5.950	1200	503067.106	104211.511	1.450
11	0.012	5.00	5.600		503027.846	104206.511	0.560
10	0.005	5.00	5.800		503027.846	104216.511	0.560
2	0.098	5.00	5.650	1200	503027.846	104211.511	1.412
1			5.450		503014.846	104211.511	1.405
14		5.00	5.450		503014.170	104197.427	1.500
13	0.023	5.00	5.400	1200	503019.024	104192.383	1.497
12			4.920	1200	503023.305	104187.936	1.093

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	6	5	5.000	0.600	5.740	5.707	0.033	150.0	150	5.10	162.7
1.001	5	4	38.164	0.600	4.950	4.696	0.254	150.0	225	5.70	156.1
2.000	8	4	5.000	0.600	5.490	5.457	0.033	150.0	150	5.10	162.7
3.000	7	4	5.000	0.600	5.490	5.457	0.033	150.0	150	5.10	162.7
1.002	4	3	10.767	0.600	4.696	4.500	0.196	54.9	225	5.80	155.0
4.000	9	3	22.500	0.600	5.440	5.290	0.150	150.0	150	5.46	158.7
1.003	3	2	39.260	0.600	4.500	4.238	0.262	150.0	225	6.42	149.0
5.000	11	2	5.000	0.600	5.040	5.007	0.033	150.0	150	5.10	162.7
6.000	10	2	5.000	0.600	5.240	5.207	0.033	150.0	150	5.10	162.7

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	0.818	14.5	5.8	0.410	0.443	0.007	0.0
1.001	1.065	42.3	24.5	1.125	1.129	0.031	0.0
2.000	0.818	14.5	9.9	0.410	0.443	0.012	0.0
3.000	0.818	14.5	9.9	0.410	0.443	0.012	0.0
1.002	1.768	70.3	94.9	1.129	1.225	0.121	0.0
4.000	0.818	14.5	25.7	0.410	0.510	0.032	0.0
1.003	1.065	42.3	160.6	1.225	1.187	0.213	0.0
5.000	0.818	14.5	9.9	0.410	0.493	0.012	0.0
6.000	0.818	14.5	4.1	0.410	0.293	0.005	0.0



Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.004	2	1	13.000	0.600	4.238	4.150	0.088	147.7	225	6.62	147.2
7.000	14	13	7.000	0.600	3.950	3.903	0.047	150.0	150	5.14	162.2
7.001	13	12	6.173	0.600	3.903	3.827	0.076	81.2	150	5.23	161.2

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.004	1.073	42.7	244.2	1.187	1.075	0.328	0.0
7.000	0.818	14.5	0.0	1.350	1.347	0.000	0.0
7.001	1.116	19.7	18.8	1.347	0.943	0.023	0.0

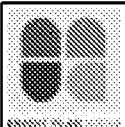
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Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	5.000	150.0	150	Circular	6.300	5.740	0.410	6.300	5.707	0.443
1.001	38.164	150.0	225	Circular	6.300	4.950	1.125	6.050	4.696	1.129
2.000	5.000	150.0	150	Circular	6.050	5.490	0.410	6.050	5.457	0.443
3.000	5.000	150.0	150	Circular	6.050	5.490	0.410	6.050	5.457	0.443
1.002	10.767	54.9	225	Circular	6.050	4.696	1.129	5.950	4.500	1.225
4.000	22.500	150.0	150	Circular	6.000	5.440	0.410	5.950	5.290	0.510
1.003	39.260	150.0	225	Circular	5.950	4.500	1.225	5.650	4.238	1.187
5.000	5.000	150.0	150	Circular	5.600	5.040	0.410	5.650	5.007	0.493
6.000	5.000	150.0	150	Circular	5.800	5.240	0.410	5.650	5.207	0.293
1.004	13.000	147.7	225	Circular	5.650	4.238	1.187	5.450	4.150	1.075
7.000	7.000	150.0	150	Circular	5.450	3.950	1.350	5.400	3.903	1.347
7.001	6.173	81.2	150	Circular	5.400	3.903	1.347	4.920	3.827	0.943

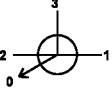
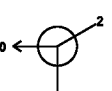
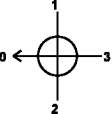
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	6		Junction		5	1200	Manhole	Adoptable
1.001	5	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
2.000	8		Junction		4	1200	Manhole	Adoptable
3.000	7		Junction		4	1200	Manhole	Adoptable
1.002	4	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
4.000	9	1200	Junction		3	1200	Manhole	Adoptable
1.003	3	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
5.000	11		Junction		2	1200	Manhole	Adoptable
6.000	10		Junction		2	1200	Manhole	Adoptable
1.004	2	1200	Manhole	Adoptable	1		Junction	
7.000	14		Junction		13	1200	Manhole	Adoptable
7.001	13	1200	Manhole	Adoptable	12	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
6	503081.431	104255.058	6.300	0.560			0	1.000	5.740	150



Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
5	503076.431	104255.058	6.300	1.350	1200		1 1.000	5.707	150
8	503071.431	104216.894	6.050	0.560			0 1.001	4.950	225
7	503081.431	104216.894	6.050	0.560			0 2.000	5.490	150
4	503076.431	104216.894	6.050	1.354	1200		1 3.000 2 2.000 3 1.001 0 1.002	5.457 5.457 4.696 4.696	150 150 225 225
9	503067.106	104189.011	6.000	0.560	1200		0 4.000	5.440	150
3	503067.106	104211.511	5.950	1.450	1200		1 4.000 2 1.002 0 1.003	5.290 4.500 4.500	150 225 225
11	503027.846	104206.511	5.600	0.560			0 5.000	5.040	150
10	503027.846	104216.511	5.800	0.560			0 6.000	5.240	150
2	503027.846	104211.511	5.650	1.412	1200		1 6.000 2 5.000 3 1.003 0 1.004	5.207 5.007 4.238 4.238	150 150 225 225
1	503014.846	104211.511	5.450	1.405			1 1.004	4.150	225
14	503014.170	104197.427	5.450	1.500			0 7.000	3.950	150
13	503019.024	104192.383	5.400	1.497	1200		1 7.000 0 7.001	3.903 3.903	150 150
12	503023.305	104187.936	4.920	1.093	1200		1 7.001	3.827	150

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m³/ha)	20.0
Summer CV	1.000	Check Discharge Rate(s)	x
Winter CV	1.000	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	40	10	0

Node 13 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	3.903	Product Number	CTL-SHE-0098-5000-1497-5000
Design Depth (m)	1.497	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node 14 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	19.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	3.950	Main Channel Slope (1:X)	200.0
Safety Factor	1.0	Time to half empty (mins)		Main Channel n	0.250

Inlets

1

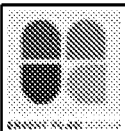
Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	100.5	0.0	1.500	324.0	0.0

Node 6 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.740	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.450
Safety Factor	1.0	Width (m)	5.500	Inf Depth (m)	
Porosity	0.32	Length (m)	12.567		

Node 7 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.490	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	11	Depth (m)	0.450
Safety Factor	1.0	Width (m)	5.500	Inf Depth (m)	
Porosity	0.32	Length (m)	20.949		



Node 8 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.490	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	11	Depth (m)	0.450
Safety Factor	1.0	Width (m)	5.500	Inf Depth (m)	
Porosity	0.32	Length (m)	20.945		

Node 9 Carpark Storage Structure

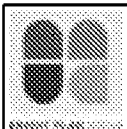
Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.440	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	15	Depth (m)	0.450
Safety Factor	1.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.32	Length (m)	31.500		

Node 10 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.240	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.450
Safety Factor	1.0	Width (m)	9.425	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		

Node 11 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	5.040	Slope (1:X)	100.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	4	Depth (m)	0.450
Safety Factor	1.0	Width (m)	20.943	Inf Depth (m)	
Porosity	0.32	Length (m)	5.500		



Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.12%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	6	13	5.898	0.158	12.2	2.1435	0.0000	SURCHARGED
15 minute summer	5	12	5.894	0.944	34.6	1.4363	0.0000	SURCHARGED
30 minute summer	8	22	5.838	0.348	31.0	9.1503	0.0000	FLOOD RISK
30 minute summer	7	22	5.838	0.348	31.0	9.1506	0.0000	FLOOD RISK
15 minute summer	4	11	5.852	1.156	75.4	2.5470	0.0000	FLOOD RISK
30 minute summer	9	24	5.738	0.298	38.2	14.6063	0.0000	FLOOD RISK
15 minute summer	3	11	5.822	1.322	74.0	2.6975	0.0000	FLOOD RISK
30 minute summer	11	21	5.246	0.206	26.4	6.6838	0.0000	SURCHARGED
15 minute summer	10	12	5.294	0.054	4.4	0.4471	0.0000	OK
15 minute summer	2	11	5.261	1.023	146.5	2.7180	0.0000	SURCHARGED
240 minute winter	1	240	5.206	1.161	47.4	0.0000	0.0000	OK
240 minute winter	14	240	5.206	1.256	24.6	0.0000	0.0000	FLOOD RISK
240 minute winter	13	236	5.200	1.297	5.1	1.9060	0.0000	FLOOD RISK
15 minute summer	12	1	3.827	0.000	4.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	6	1.000	5	9.6	0.770	0.665	0.0880	
15 minute summer	5	1.001	4	20.2	0.517	0.476	1.5178	
30 minute summer	8	2.000	4	-21.5	-1.220	-1.486	0.0880	
30 minute summer	7	3.000	4	-21.5	-1.220	-1.486	0.0880	
15 minute summer	4	1.002	3	44.9	1.130	0.639	0.4282	
30 minute summer	9	4.000	3	18.5	1.062	1.281	0.3961	
15 minute summer	3	1.003	2	61.8	1.554	1.460	1.5614	
30 minute summer	11	5.000	2	-16.9	-0.958	-1.166	0.0880	
15 minute summer	10	6.000	2	3.7	0.671	0.256	0.0281	
15 minute summer	2	1.004	1	125.7	3.162	2.947	0.5170	
240 minute winter	1	Flow through pond	14	24.6	0.036	0.008	230.4219	
240 minute winter	14	7.000	13	4.7	0.365	0.322	0.1232	
240 minute winter	13	Hydro-Brake®	12	4.9				124.1